A Process and Tool for Evaluation of Accessible User Experience with Websites and Apps for Screen Reader Users who are Blind

By

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Abstract

Evaluating user experience (UX) during usability testing is an established practice towards designing more enjoyable information systems for end users. Currently no published process or tool exists for UX evaluation for users with disabilities. Accessible User Experience (AUX) focuses on integrating accessibility into UX design to create enjoyable digital experiences for everyone, regardless of age or ability.

An exploration of the emotional experiences of six individuals who are blind was done through interviews, including hands-on sessions with websites/apps using their laptops/phones. An AUX evaluation tool was developed to measure Comfort, Likability, Autonomy, Agency and Pleasure, and feedback was obtained from interviewees. This study also is an examination of 'pleasure points', presenting an inclusive process for conducting AUX studies with participants who are blind.

Keywords: Accessible User Experience, Accessibility, Screen Reader, Inclusive Design, Usability Testing

Dedication

To my wonderful and patient partner Allister!

To Sambhavi for the inspiration and the wonderful help.

To Kate for not giving up and for having faith in me.

To Bharat for supporting me when I needed it the most.

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1 Introduction

This paper reports the results of a Major Research Project that explored the emotional experiences of blind people using websites and apps on their computers and phones. The objective of the study was to design a tool for evaluating blind users' emotional experiences. These users must rely on a screen reader in order to interact with their devices. A screen reader is the generic name for a software tool that assists individuals who are blind, or visually impaired, in interacting with their computing devices. It converts the text, data, and elements displayed on the screen into synthesized speech. It can also send this information to an output device, used by some, called a refreshable Braille display that provides the output in Braille notation. This paper will use the term 'screen reader users' when referring to the user group of blind, or visually impaired people, who use screen readers.

1.1 Research context and problem

User Experience (UX) design is a field concerned with the design of enjoyable websites and applications for users (Hassenzahl & Tractinsky, 2006). The International Standards Organization (ISO) defines UX as: "a person's perceptions and responses that result from the use and/or anticipated use of a product, system or service." (ISO DIS 9241-210:2010 - clause 2.15) UX is a

complex domain encompassing many concepts of varying degrees of usefulness.

User experience evaluation is carried out to finds ways to improve the experience of users; the findings are used to redesign the product; system or service being tested. Practitioners, however, report that traditional usability testing methods are not adequate for evaluating UX ("All About UX", n.d.). Therefore, a number of methods are currently being developed for investigating how people feel about the system, product or service under investigation ("All About UX", n.d.).

It is common knowledge that the majority of Web users interact with the Web visually; websites are designed to cater to the needs of these users. This puts at a distinct disadvantage those users who are blind or visually impaired, who rely on a screen reader to auditorily interact with websites. The Web Accessibility Initiative (WAI) of the World Wide Web Consortium ("World Wide Web Consortium [W3C]", 2014) provides guidance on improving the accessibility of websites and apps.

Although there is research focusing on accessibility for people with disabilities, those studies focus on users being able to interact with the system and *not* on the evaluation of their emotional experiences when designing better websites and apps for this group. The few studies that reviewed the emotional experiences of users who are blind, or visually impaired, have primarily revealed these users' frustration regarding the inaccessibility of the websites (Lazar, Allen, Kleinman & Malarkey, 2007; Lazar, Feng & Allen, 2006). An examination of multiple studies describing UX evaluation reveals that the aforementioned studies were not conducted with users with disabilities.

Designing for improving the user experience for all users, including blind and low vision users, is essential to make websites and applications more inclusive. A community of UX researchers is in aiming to push for greater inclusion in design by developing a manifesto for Accessible User Experience (AUX) where they urge for a focus of accessibility efforts on delivering quality user experiences ("A (Rough) Manifesto for Accessible User Experience", 2015).

1.2 Design Challenge

The objective of this MRP is to create a tool for measuring user experience during usability/accessibility testing of websites and apps with users who are blind and use a screen reader. To this end, this project explores the emotional experiences of screen reader users when they use websites and apps. It also examines the effect of technology on user experience, specifically the use of touchscreen devices by people who have been using keyboard-based devices.

1.2.1 Research Questions

Primary Research Question: How can a tool be designed for measuring the Accessible User Experience (AUX) of users who are blind when interacting with websites and applications?

Secondary Research Question: Does the type of interaction (touchscreen vs. keyboard) have an effect on the emotional experiences of users who are blind when interacting with websites and applications?

1.3 Approach and Methods

An exploratory approach was employed since there is a lack of information available from the literature concerning the area being studied. This paper attempts to systematically understand the experiences of screen reader users who are blind and the ways in which technology mediates their user experience. Borrowing methods from the Usability and UX domains, interviews were conducted with screen reader users employing a think-aloud protocol and hands-on activities using their laptop and phone. These methods are explained in Section 3. The data gathered was then analyzed to identify the components of AUX that could form the basis for building an accessible evaluation tool.

1.4 Outcomes

This project designed a tool for evaluating Accessible User Experience (AUX) during usability/accessibility testing of websites and applications with screen reader users. Based on the interactions with participants who are blind, a process for carrying out these tests in an inclusive manner is outlined. Findings

from an examination of the different experiences reported with using websites and apps with a laptop vs. phone are also presented. Potential future research areas are identified.

1.5 Summary and Report Outline

This paper reports the results of an exploration into the emotional experiences of people who are blind when they use websites and apps with the objective of creating a tool for measuring their emotional experiences during usability/accessibility testing of websites and apps. It also examines the effect of technology on the emotional experiences of screen reader users, specifically between using touchscreen devices and keyboard-based devices.

Following this introductory section, a review of related literature is presented in the next section. The process of the research is described in Methods in Section 3. Results from the research are in Section 4, followed by the Discussion of the research and its related objectives in Section 5. Contributions from the research and possible future work are listed in the final section.

2 Literature review

2.1 Introduction

This section presents a review of past research from which a conceptual framework was constructed to guide this exploratory study about evaluation of Accessible User Experience (AUX) for screen reader users. Sub-section 2.2 presents five themes relevant to the research with an overview of key literature under each theme. Beginning with an examination of User Experience (UX) design concepts, this review introduces the characteristics of non-visual interaction which in this context can be defined as accessing websites and apps using a screen reader. The next stage of this exploration regards AUX, discussing it both as a field as well as its growing importance and interest. This is followed by a discussion of the evaluation or measurement of UX. The thematic literature review concludes with a brief introduction to positive psychology. This is in the context of reframing the experience of screen reader-based interaction from a 'frustrating' one, as it is seen traditionally, to an 'enjoyable' one. Sub-section 2.3 develops a conceptual framework derived from

the literature review as the starting point for the exploration of AUX. Sub-section 2.4 summarizes the contents of the section.

2.2 Themes Explored

2.2.1 User Experience Design

Alben (2006) defines UX as,

> All the aspects of how people use an interactive product: the way it feels in their hands, how well they understand how it works, how they feel about it while they're using it, how well it serves their purposes, and how well it fits into the entire context in which they are using it.

UX is a multidisciplinary concept, with at least 25 other definitions ("All About UX", n.d.). In this sub-section, we will examine key theoretical contributions to UX design by Hassendahl, Sheldon, Mehrabian, Russell, Porat, Tractinsky, Forlizzi, Battarbee and Dewey with the objective of deriving a framework for the research.

Experience Design - Marc Hassenzhal and Sheldon.

With respect to experience design, Hassenzhal, along with Sheldon, developed an overview of a set of needs suitable for experience design (Hassenzahl. 2010). These are:

- Autonomy: Feeling that you are the cause for your own actions rather than feeling external pressures forcing you to act;
- Competence: Feeling that you are capable and effective in your actions rather than feeling incompetent or ineffective;
- Relatedness: Feeling that you have regular intimate contact with people who care about you rather than feeling lonely and uncared for;
- Popularity: Feeling you are liked, well-respected and have influence over other people rather than feeling like a person whose advice or opinion that people ignore;
- Stimulation: Feeling that you get plenty of enjoyment/pleasure rather than feeling bored and under-stimulated by life;

- Security: Feeling safe and in control of your life rather than feeling unsafe and threatened by your surroundings.

Evaluation of Concepts in Accessibly, Usability and User Experience - Petrie & Bevin

Petrie and Bevin's work, although developer focused, aims to assist developers in their creation of digital products amongst an audience which includes those with accessibility requirements and explains the differences between usability and user experience.

Within their explanations the two start by explaining how user friendliness and ease of use are actually sub-components associated with usability, and then breakdown the ISO 9241 standard's definition of usability. They then break the concepts of usability down into effectiveness, learnability, memorability and safety as a means to show that the definition of usability is not exact, but it is relative to the environmental circumstances around the digital product being considered, such as the user's goals or context of use (Petrie & Bevin, 2009).

The authors then move on to accessibility, referencing the ISO standard for accessibility, highlighting that although a specific term exists for accessibility,

there is a great range of definitions. The definitions that they refer to range from focusing on usability for the maximum set of users that could be accommodated, towards more specific definitions of people with disabilities navigating the internet and how they interact with, navigate to, and perceive content on the web. This is more of a subset of usability concerned with a subset of users. They highlight that the two definitions are rather dichotomous in order to show a lack of consensus around the aims and focus on accessibility (Petrie & Bevin, 2009).

The authors then move on to user experience then talk about its difference from usability, as usability focuses on the successful achievement of particular tasks in specific use cases, but not on the positive and emotional impact of successful task achievement. They focus on how user experience focuses on user reactions that go beyond concerns of ease of use, and go more into areas of entertainment and user fulfillment. Petrie and Bevin focus on the different aspects of user experience and how it moves beyond the realm of usability. While examining the difference between usability and user experience, Bevin suggests that the definition of usability can be enlarged to encompass user experience

through broadening the interpretation of user satisfaction to incorporate four new areas of assessment (Petrie & Bevin, 2009). These four areas are:

- Likeability: the level to which the user is satisfied with the achievement of their practical goals.
- Pleasure: the level to which the user is satisfied with their achievement of hedonistic goals
- Comfort: the level in which the user is satisfied with physical comfort
- Trust: the level in which the user is satisfied with the product and that it behaves based on their expectation of how they intend it to behave.

Mehrabian/Russell model for Environmental Influence.

This model focuses on how perceptions of the environment affect the emotional state of an individual. The environmental stimuli can lead to three distinct emotional states, referred to as PAD: Pleasure, Arousal & Dominance.

- Pleasure focuses on the degree to which a person feels happy or satisfied in a place.

- Arousal focuses on the degree of stimulation caused by the atmosphere.
- Dominance is the degree in which a person feels they have influence over their surroundings and is in control of the situation.

As a result, the person's emotional state influences their behavior within the environment through their approach or avoidance response. This model has been used to assess physical environments. In recent times, it has been found applicable to virtual online environments as well (Porat and Tractinsky, 2012).

Porat and Tractinsky created a research model variant which built upon the Mehrabian/Russell model by focusing on the perceived environmental stimuli of expressive aesthetics and usability and its effect on the emotional states of pleasure, arousal and dominance and the approach and avoidance responses in the context of a web store (Porat and Tractinsky, 2012).

Through expanding upon the environmental stimuli the model was augmented to focus specifically on the digital features of websites, which

differentiate them from physical environments. Tractinsky had found through previous research that users perceived the aesthetics of web pages along two dimensions: classical and expressive aesthetics. (Porat and Tractinsky 2012).

Classical aesthetics represent the degree to which the design is clean and balanced and is a strong representation of how digital environments correspond to physical environments through qualities such as visual clarity, order and legibility. Expressive aesthetics relate to the creativity and innovativeness of the design, including aspects of ornamentation, originality and creativity. It includes attributes of complexity, novelty and stimulation in an effort to increase user engagement and arousal (Porat and Tractinsky, 2012).

Tractinsky's research focuses on how classical aesthetics is strongly correlated with evaluation of usability, whereas expressive aesthetics was shown as being more indicative of overall attractiveness and user's first impressions of a website. Both classical and expressive aesthetics were shown to contribute to user satisfaction (Porat and Tractinsky, 2012).

Forlizzi & Battarbee – Models & Approaches to Experience Design

1. Product Centred Models – They provide information to creatives in the process of developing products as to how to create a good experience. The models developed from this approach are often some variety of checklist or design guideline that can be applied in the product's development. Most models heavily emphasize goal and task based thinking in order to achieve experience design objectives (Forlizzi and Battarbee, 2004).

2. User Centered Models – these help designers understand the people who will be the end users of the products that they create. User centered models offer ways to understand people's actions and aspects of their experience in an effort to ensure that the product meets their human needs. In contrast to product centered design, user centered models focus on fun and action oriented models of behaviour in order to meet experience design objectives. User centered design objectives attempt to target motivation and

actions in a particular context as an important method to evaluate user experience (Forlizzi and Battarbee, 2004).

3. Interaction Centered Models are somewhat of a hybrid of product centered and user centered models as they examine how products bridge the gap between product designers and users. Interaction centered models have a basis in philosopher John Dewey's notions of experience as a totality in which a user engages their entire self in relation with an object in a particular situation. Most research flows from a concept whereby the focus is on attempting to get understanding of how people engage with products in the world (Forlizzi and Battarbee, 2004).

Forlizzi and Battarbee further refine Dewey's theory and continue to build off of the interaction design model with their own specific framework, which focuses on the interactions between individuals and products and the experiences that are produced as a result. Their model emphasizes the importance of these experiences, when examining them in the greater context of social interaction in which people interpret specific events in an effort to

create meaning. The framework describes user interactions as well as the dimensions of those interactions. The user-product interactions can be further broken down into three categories: fluent, cognitive and expressive (Forlizzi and Battarbee, 2004).

Fluent interactions are automatic and skilled interactions between users and products. These interactions do not require the user's attention, allowing users to focus on the outcomes of the activities. Examples of these fluent interactions include riding a bicycle, making morning coffee or checking time on a phone.

Cognitive user-product interactions instead focus on the product. The outcome of these interactions can be knowledge or confusion, and errors, in the case that a product does not match anything we are used to or have encountered before. These experiences often happen while people are travelling abroad and are encountering foreign configurations for things such as toilets, taps and electrical outlets, or using an online support form to solve a technical problem. Ultimately cognitive experiences wind up changing the user

through having them develop a new skill to come up with a solution, and often change the environmental context as a result (Forlizzi and Battarbee, 2004).

Expressive user-product interactions help the user form a relationship with the product or some aspect of it. With expressive interactions users may modify, change or personalize the product in an effort to create a better fit between the product and their needs. Examples of expressive user-product interactions can include customizing cars, changing UI elements for phones (Forlizzi and Battarbee, 2004).

User-product interactions take place within specific contexts. These contexts can be defined as types of experience. These experiences can be defined specifically as: experience, an experience, and co-experience (Forlizzi and Battarbee, 2004).

Experience is the constant stream of self-talk that occurs in conscious thought. It focuses on how we assess goals relative to the people, products and environments that surround us in the moment. Examples of experience include

walking in nature or using instant messaging systems (Forlizzi and Battarbee, 2004).

'An experience' is more focused, as it is something that can be articulated or named. It could happen from a number of product interactions and emotions, but it has a particular character that can be remembered as well as creates an emotional response to its completion. It has a beginning and an end and it often produces emotional and behavioural changes for the user. Examples of 'an experience' include going on a roller coaster ride, watching a movie, or finding an online community of interest such as a specific Reddit thread (Forlizzi and Battarbee, 2004).

Co-experience focuses on user experience in social contexts. Specifically, co-experiences take place as experiences that are created together or shared with others. Certain experiences people find worth sharing will be brought up with others in an effort to share attention. Co-experiences can produce a range of reactions and interpretations from others, from expected to unusual, and from agreeable to dismissive. One might reciprocate, reject or ignore

experiences offered by others. Social situations greatly influence co-experience. Interactive technology can play a large role in co-experience through providing a communications infrastructure and the possibility to create, edit and share content with others. Examples of co-experience include playing a mobile messaging game with friends, or interacting with others in a museum exhibit (Forlizzi and Battarbee, 2004).

Emotion experience - Forlizzi & Battarbee posit that emotion is at the heart of any human experience and is an essential part of user-product interactions as well as user experience. From a psychological standpoint, emotion has three basic functions: to influence our plans, organize the procedures associated with the plans, and to assist in the evaluation of the outcomes. From a design focus, emotion fills the gap between people and products and affects how users plan to and interact with the products, as well as the perceptions and outcomes surrounding these interactions. Forlizzi and Battarbee posit that the concept of pleasure is associated with an emotional outcome of a product interaction and that the pleasure from these interactions

can often be a result from a perceived benefit in the product (Forlizzi and Battarbee, 2004).

Summary of concepts.

Important concepts from the discussion are summarized in Table 1.

Table 1: UX Concepts

Proponents	**UX concepts**
Hassendahl	Autonomy, Competence, Relatedness, Popularity, Stimulation, Security
Mehrabian & Russell	Pleasure Arousal, Dominance
Porat & Tractinsky	Classical, Expressive, Engagement, Arousal
Forlizzi & Battarbee	Total experience, Engagement, Fluent, Cognitive, Expressive
Bevan	Likability, Pleasure, Comfort, Trust

These concepts are used in deriving the conceptual framework for the study in sub-section 2.3.

Table 1: UX Concepts

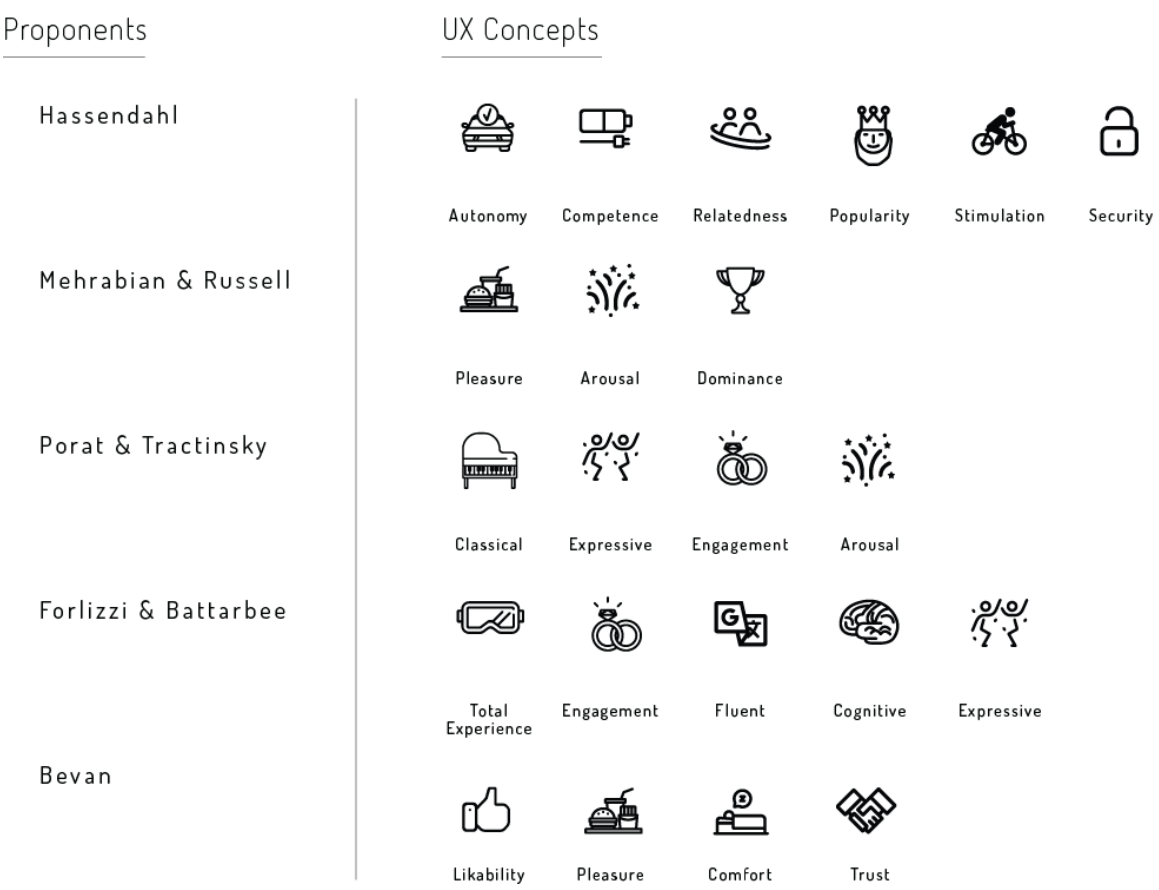

Figure 1: UX Concepts

2.2.2 Non-visual interaction

Screen Reader. The term screen reader is generic for a system that reads out the contents of the screen on a computer or mobile device. There are several screen reader programs available, both commercially and in the form of free, open source software. Some popular commercial screen readers used for accessing the computer/Internet are JAWS, Window-Eyes, HAL,[1] and VoiceOver. Free, open-source screen readers such as NVDA and Orca,[2] as well as low cost products such as System Access,[3] are also available. However, JAWS is reportedly the most popular screen reader in use in North America (WebAim, 2015).

Issues relating to online interactions via a screen reader, examined under the umbrella of Web accessibility,[4] form a sizeable portion of the literature on HCI (Petrie, Hamilton & King, 2004; Petrie & Kheir, 2007; Strain, Shaikh, & Boardman, 2007**;** Theofenos & Redish, 2003; Watanabe, 2007). There are many

[1] HAL®, http://www.yourdolphin.com/productdetail.asp?id=5).
[2] Orca: the gnome project, http://live.gnome.org/Orca
[3] Serotek software solutions, http://serotek.com/
[4] Web accessibility is the degree to which users with disabilities are able to interact with the Web and make use of the information and services provided online.

studies about barriers to information access when using a screen reader and factors of interface design that facilitate accessibility. But there is a lack of empirical research about what emotions these factors produce in screen reader users, particularly to investigate features that produce positive emotions and enhancing the design for a more positive experience. This is a potential area for research.

2.2.3 Accessible User Experience (AUX)

A community of UX researchers led by David Sloan, Henny Swan and Sarah Horton are developing a Manifesto for Accessible User Experience (AUX) (A (Rough) Manifesto for Accessible User Experience, 2015). They are envisioning this as a community of practice to "examine accessibility through the lens of user experience." The Manifesto sees accessibility as being:

- A core value, not an item on a checklist
- A shared concern, not a delegated task
- A creative challenge, not a challenge to creativity
- An intrinsic quality, not a bolted-on fix

- About people and not technology.

Seminars are being organized on AUX by Shawn Henry of W3C-WAI and Neil Ewers from the Trace R&D centre at the University of Wisconsin, Madison. AUX principles and guidelines are being published (Quesenbery, 2014). Leonie Watson, an advocate of AUX, has presented a practical guide to AUX in several forums (Watson, 2014). This research is a step in the direction of strengthening this AUX movement.

2.2.4 Positive Psychology

Positive psychology is about the study of the human pursuit of individual happiness as something central to human life. Until two decades ago, psychology was confined to the study of mending an injured or unhappy mind. Around the turn of the century, Seligman and Csikszentmihalyi (2000) started a new paradigm of study about Positive Psychology or the "knowledge of what makes life worth living." Since then, happiness has been a subject of many empirical studies (Kahneman, 2011; Lopez & Snyder, 2009; Lyubomirsky, 2007; Seligman, 2011).

Lyubomirsky (2007) states that the pursuit of happiness requires the acquisition of positive experiences on a day-to-day basis and a more general assessment of life as positive and meaningful and that a good part of happiness depends on activities and is, thus, variable. This idea gave rise to the concept of "designing for happiness" in the design domains to provide a positive experience. A natural follow up was the concept of evaluation of users to determine what makes them happy and how happy they become. The paradigm of positive emotions is a focus this study has drawn from positive psychology.

2.3 Conceptual framework

Two frameworks, by Hassenzahl and Bevan respectively, were selected from the UX concepts presented in sub-section 2.2 to form the lens for data analysis. The reasons for selection were simplicity and precision.

Hassenzahl (2010)

- **Autonomy**: Feeling that you are the cause of your own actions rather than feeling that external forces or pressure are the cause of your action.

- **Competence**: Feeling that you are very capable and effective in your actions rather than feeling incompetent or ineffective.
- **Relatedness**: Feeling that you have regular intimate contact with people who care about you rather than feeling lonely and uncared for.
- **Popularity**: Feeling that you are liked, respected, and have influence over others rather than feeling like a person whose advice or opinion nobody is interested in.
- **Stimulation**: Feeling that you get plenty of enjoyment and pleasure rather than feeling bored and under stimulated by life.
- **Security**: Feeling safe and in control of your life rather than feeling uncertain and threatened by your circumstances.

Bevan (2008)

- **Likability**: the extent to which the user is satisfied with their perceived achievement of pragmatic goals, including acceptable perceived results of use and consequences of use.
- **Pleasure**: the extent to which the user is satisfied with their perceived achievement of hedonic goals of stimulation, identification and evocation (Hassenzahl, 2003) and associated emotional responses (Norman's (2004) visceral category).

- **Comfort**: the extent to which the user is satisfied with physical comfort.
- **Trust**: the extent to which the user is satisfied that the product will behave as intended.

The data gathered were analyzed using this framework as the lens.

Figure 2: Conceptual Framework

2.4 Summary

This section focused on situating the research in theoretical and practical work around UX, AUX and screen reader users. A brief introduction was provided to positive psychology as an important guiding principle for the conceptual framework that was derived from the theoretical study. Following an exploratory data collection, as described in the next section, this framework will be used during the analysis of that data to arrive at a set of components for building an evaluation tool for AUX.

3 Methods

3.1 Introduction

This research consisted of an exploratory study which examined the interactions between six individuals who are blind using websites and apps in order to understand their diverse experiences. The goal was to develop a testable hypothesis to arrive at user experience insights. Since not much information was available from the literature about user experience for this user group, an exploratory approach was adopted. The primary method used for data collection was a series of semi-structured interviews supported by hands-on online information activities (with participant observation and a think-aloud protocol). Participants used a laptop as well as a smartphone to access websites and apps during the session. Qualitative data was collected.

This section will describe the design and implementation of the study and provide details about data collection and analysis. Sub-section 3.2 describes the research design in terms of approach adopted and methods selected. Sub-section 3.3 provides details about the research process for the recruitment of

participants and conduct of interviews. Section 3.4 describes the methods used for the analysis of the qualitative data gathered during the research, including a discussion of the validity of the research process. Section 3.5 concludes the chapter with a summary.

3.2 Research Design

A review of literature in the areas of user experience design revealed that there are no available studies about user experience for people with disabilities on which a research design could have been developed. As a result, the research design was adapted from traditional usability study methods for screen reader users derived from human-computer interaction (HCI) studies in a user experience setting to explore accessible user experience. The data was collected through interview recordings (including think-aloud protocols), video shooting of laptop/phone screen, and observational notes.

The following studies were drawn upon to develop the research process:

- Usability studies conducted with screen reader users in the fields of HCI (Lazar et al., 2007; Strain, Shaikh, & Boardman, 2007**;** Theofenos & Redish, 2003; Watanabe, 2007)
- UX studies conducted with sighted users (Bevan, 2008; Hassenzahl & Tractinsky, Porat & Tractinsky, 2012).

The following techniques were used:

- Semi-structured interviews
- Hands-on Activities
- Think-aloud protocols

3.2.1 Semi-structured Interview

To keep the interview flexible enough to allow for participant flexibility with the opportunity to maximise participant insights, a semi-structured or semi-standardized (Berg, 2007) format of interviewing was followed. Questions were asked around the following a pre-prepared set of themes as needed:

- Incident(s) where user felt a negative emotion such as frustration or anger while using a website or app.
- Incident(s) where user experienced a positive emotion such as happiness or enjoyment while using a website or app.

- User's experiences of interacting with a website or app using the smartphone (with touchscreen and Voiceover) vs. the laptop (with keyboard and JAWS).

3.2.2 Hands-on Activities

The method of observing users engaged in task performance to understand the processes involved in user-system interaction is commonly used in HCI studies. However, in usability testing, participants are asked to perform benchmark tasks in a laboratory setting, and their performance is measured and recorded. Performance was not measured in favour of exploring qualitative experiences. Hands-on online information activities were used as part of the interview, where participants performed online activities to demonstrate their answers. Online activities provided an opportunity to observe participants during the session which allowed several key insights to be made. These activities provided an understanding of how the participants felt when they interacted with websites and apps using their screen reader on the laptop and using their iPhone with its built-in screen reader.

3.2.3 Think-aloud protocols

Think-aloud protocols were collected during the online activities to externalize participants' thought processes and interpret their actions. Notes were recorded based on observations of various aspects such as the participants screen reader use, their online information selection behaviour, their negotiation of visual elements on the Web using their screen reader as well as information that could not be captured through the audio recordings.

Previous studies (Coyne & Nielson, 2001; Craven, 2003) have reported that screen reader users overall took longer to complete hands-on tasks than sighted users. Subsequently less activities were planned for each session to give every participant additional time to demonstrate what they wished to.

3.3 Research Process

3.3.1 Recruitment

Recruitment of participants was twinned with the recruitment for a separate research project led by Dr. Sambhavi Chandrashekar since the user profile was similar between the studies. Six English-speaking adults (four men

and two women) who are blind and use a screen reader to interact with websites and apps were recruited by Dr. Chandrashekar of which permission was obtained to conduct separate interviews for this study. An email introduction about the research and the consent form were sent to each participant by email. The form contained affirmations about their having read and understood various details in the information letter. To indicate their consent, participants were asked to type in their name and the current date on the form following "I agree." They returned the consent form via email following which a date, time and venue were set for the interview session. To ensure a successful and ethically appropriate test session, it is important to create a climate of trust and comfort for the participants. This was partly achieved by providing them with the option of doing the interview at a place of their choice. Four participants chose to meet at OCAD university with their laptop and iPhone; one requested to go over to their office and one participant requested in interview take place at their home.

3.3.2 Interview Session

Data for the research was primarily derived from interviews with each of the participants. All of them used a laptop with the Windows Operating System, Firefox browser and JAWS screen reader and an iPhone during the session. Some also used NVDA screen reader on their laptop.

Interviews lasted, on an average, around 90 minutes each. Interview questions were based on the three theme areas, with plenty of discussion around each. A semi-structured interview method was employed because it enabled addition or deletion of probes to interviews between subsequent subjects, so as to refine the examination as demanded by the context within the broad framework of the research design. Notes were taken during the interview session, and a summary was written soon after the session was over.

Each participant used their own laptop and iPhone to demonstrate their answers and to additionally show other related experiences. The screen of the participants' laptop/phone was video recorded to capture the interaction. Participants specifically turned on their display for visibility. However, this data

was not very useful as there was no visual feedback about how the web page was being used. This is due to how JAWS screen readers work since there are no visual indicators when it is navigating a page. Many times there was a mismatch between the audio feedback from JAWS and the visual feedback displayed on the page.

The participants themselves were not video recorded; however, audio recordings of the interview sessions were arranged to enable transcription and analysis of the data at a later date.

Following the practice session for the think-aloud, there was a warm-up conversation with the participants around reading news on the CBC website. The process of think-aloud was explained as voicing thoughts, feelings, and opinions while doing the task (Strain, Shaikh, & Boardman, 2007). In case participants wanted to say something while their screen reader was talking, they were advised to pause the screen reader (by pressing the CTRL key), and then resume the screen reader (by pressing the CTRL key again). This ensured that the recording did not contain any sound overlays that would make transcription

difficult. This method of pausing and restarting the screen reader using the CTRL-key (fondly called the "shut up" key by some participants) is the accepted practice among users of screen readers and has been reported in past studies (Theofenos & Redish, 2003).

3.3.3 Inclusive AUX Evaluation Process

The researcher had developed a protocol for conduct of usability sessions with screen reader for another course. This research study gave an opportunity to put that into practice. The process that was followed for the six sessions is summarized below:

This could be of assistance to facilitators of usability testing with screen reader users.

Consent Process.

- Consent documents were provided beforehand in an electronic format via email. It must be noted that accessible formats could be any WCAG 2.0 compliant e-mail or electronic documents that the participant would

be able to listen to, or if the participant is Braille literate, Braille paper documentation that they can consult and sign to indicate consent[5].

- Participants indicated their consent electronically by typing the words 'I AGREE' and typing in their name and date below that. If on paper, the consent form could be signed and sent back to the researcher.[6]

Before the Participant Arrives.

- Before commencing the usability test, all test materials and consent and documentation were reviewed for readiness.[7]
- A pilot test with the equipment and materials had been conducted for another study a few weeks prior to the initial test session. Through that it became obvious that wireless Internet connectivity for the participant might become difficult to organize and a room with wired connectivity needs to be booked in advance. The pilot test also provided practice for

[5] From pilot testing.
[6] "Signing Your Name and Handwriting If You Are Blind or Have Low Vision." VisionAware. 2015. Accessed July 23, 2015. http://www.visionaware.org/info/everyday-living/essential-skills/reading-and-writing/signing-your-name-and-handwriting/1235. **
[7] "Running a Usability Test." Usablity.gov - Improving the User Experience. June 24, 2015. Accessed July 23, 2015. http://www.usability.gov/how-to-and-tools/methods/running-usability-tests.html#PAGE_4. **

the researcher in ensuring how the protocol should be tweaked to accommodate all tests within allocated time.[8]

- A naturally quiet room was selected as the location for conducting the test. This is to ensure that competing noise does not distract the participants and fragment their attention, which might negatively affect the test results.[9]
- Details of the user testing location with specific travel instructions were provided to the user beforehand. The weather was good and there was no road repair between the transit stop and testing location, else these would have also been communicated to the participant. Participants we helped in choosing the optimal transit options.[10]
- The researcher met the participant at the closest transit stop or station and accompanied them to the test venue in the three cases where the

[8] From pilot testing.
[9] "Communicating Effectively with People Who Are Blind or Vision Impaired." Communicating Effectively with People Who Are Blind or Vision Impaired. 2012. Accessed July 26, 2015. http://www.visionaustralia.org/living-with-low-vision/family-friends-and-carers/communicating-effectively-with-people-who-are-blind-or-vision-impaired.
[10] From pilot testing.

testing was done at the university. In three cases, the researcher commuted to the venue chosen by the participant.

- Participants were advised to wait near the ticket vending office in the transit station, as these were unique locations easily reachable by both. Ideally, providing a reference to a physical environment they can touch, such as a seat, a post or a light would give them an improved navigation aid and will be less confusing for them.[11]
- Participants were asked if they would want to be guided from the transit to the testing location. In all three cases, participants accepted the researcher's offer to guide the participant from their arrival location to the testing location.[12]
- The researcher ensured that an elbow was offered for guidance only if they did not have a dog guide with them.[13] The key in assisting the

[11] "About Vision Loss: Meeting a Blind Person." Vision Serve. 2015. Accessed July 26, 2015. http://www.visionservealliance.org/index.php?option=com_content&view=article&id=81&Itemid=521.
[12] From pilot testing.
[13] "What Do You Do When You Meet a Blind Person? Proper Etiquette for Interacting With a Person That Is Blind or Visually Impaired." Department of Human Services - Commission for the Blind and Visually Impaired | 2008. Accessed July 22, 2015. http://www.state.nj.us/humanservices/cbvi/faq/etiquette/blind/.

participant is always to respect their dignity and autonomy. It is good to remember that initiating physical touching is an infringement of people's personal space and it is important to work within your participant's comfort level in order to achieve a smooth functioning testing session.[14]

- Participants were consulted about their preferred assistive technologies and computer systems. Even though they brought their own systems, a spare was arranged with the preferred combination for use in case of failure of their system.[15] [16] Forcing participants to use systems with configurations they are not familiar with could affect the results of the usability testing and could lead to unintended user frustration for the participant.
- Participants were guided to the testing room with care. When arrived at a closed door, they were informed that there is a door and that it opens away from them. Upon arriving at a flight of stairs, they were alerted that

[14] "Etiquette: Meeting and Working with Disabled People." University of Cambridge (DRC). April 13, 2012. Accessed July 22, 2015. https://www.admin.cam.ac.uk/univ/disability/support/etiquette.html.
[15] From pilot testing.
[16] From pilot testing.

they are about to walk up (or down) stairs. The researcher came to a full stop before the stairs and indicated to the participants the location of the handrail. Likewise, the researcher stopped at the end of the stairs and informed them that it was the last step of the stairs. When entering the test room its layout was described to the participant, including the general shape of the room and the arrangement of the furniture.[17]

- It was ensured that the doors and cabinets of the test environment remain closed to ensure that there are no obstacles cluttering the walkways and avoid potential hazards for the participant and their mobility tools.[18]

After the Participant arrived but Before Testing.

- The researcher first ensured that the service animal, where accompanying, was provided a comfortable space to rest for the duration

[17] "When You Meet a Blind Person." Disabled World. April 30, 2014. Accessed July 22, 2015. http://www.disabled-world.com/disability/awareness/meeting-blind.php.
[18] "What Do You Do When You Meet a Blind Person? Proper Etiquette for Interacting With a Person That Is Blind or Visually Impaired." Department of Human Services - Commission for the Blind and Visually Impaired | What Do You Do When You Meet a Blind Person? 2008. Accessed July 22, 2015. http://www.state.nj.us/humanservices/cbvi/faq/etiquette/blind/.

of the test. It is not advisable to touch or pet a dog guide while it is on duty because it is not a pet but a highly trained mobility support. The risk of disrupting the animal might result in a negative effect on its performance of its duties to support the participant.[19] [20]

- Participants were introduced to a research team member who was present in the room during all the sessions and the roles of both members for the usability testing were explained.[21] This way the participant was able to identify who was actually going to be asking them the testing questions.
- The researcher placed the participant's hand in their guiding arm on the seat and the participant found the seat by following the researcher's arm.[22]

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[19] "Etiquette: Meeting and Working with Disabled People." University of Cambridge (DRC). April 13, 2012. Accessed July 22, 2015. https://www.admin.cam.ac.uk/univ/disability/support/etiquette.html.
[20] "Tact and Courtesy." American Foundation for the Blind - Tact and Courtesy. 2015. Accessed July 26, 2015. http://www.afb.org/info/friends-and-family/etiquette/tact-and-courtesy/235.
[21] "Etiquette: Meeting and Working with Disabled People." University of Cambridge (DRC). April 13, 2012. Accessed July 22, 2015. https://www.admin.cam.ac.uk/univ/disability/support/etiquette.html.
[22] "Being a Sighted Guide." American Foundation for the Blind - Being a Sighted Guide. 2015. Accessed July 23, 2015. http://www.afb.org/info/friends-and-family/etiquette/being-a-sighted-guide/235.

- A large work area was provided on a table in front of the chair. Adaptive technology users may require extra space for their computing device and output readers such as braille displays. Two participants brought their braille readers, one had their braille typewriter on their office table and three participants used Bluetooth keyboard with their iPhone for demo purposes.[23]
- Upon settling down, the participants were asked if they had any questions or constraints and the session protocol was explain to them, including how the session was going to be run and how recording devices were going to be set up and used.[24]
- Participants were paid the compensation amount and their signature obtained on the printed consent form as received from them. All participants wrote their names even if not very legibly. Their fingers were guided to place the pen at the right starting point on the paper.

[23] From pilot testing.
[24] From pilot testing.

People who are blind are capable of signing their name on paper documents once the place where they need to sign is indicated to them.[25]

- Before starting the session, the researcher ensured that the participant's laptop; screen reader and phone were working and connected to the Internet.
- Usually, individuals who are blind keep their screens off. The participant was advised to turn on the display on the laptop and the phone and it was ensured that the screen stays active for recording during the session.[26]
- The audio recorder was started and the testing protocol information was first recorded with the date and participant number information.
- While setting up the screen reader, both the screen reader volume and device volume were set at maximum.[27]

[25] "Signing Your Name and Handwriting If You Are Blind or Have Low Vision," VisionAware., 2015, http://www.visionaware.org/info/everyday-living/essential-skills/reading-and-writing/signing-your-name-and-handwriting/1235.
[26] From pilot testing.
[27] From pilot testing.

- NVDA screen reader was chosen for use as the secondary screen if others failed. It is free and popular among screen reader users.[28]

During the Session.

- With three people in the room, the researcher made sure to mention who he was addressing at any point.[29]
- The session length was limited to 1.5 hours so as not to be physically and mentally taxing on the participant or the service animal and they were offered to take breaks if they wished.
- Participants were guided to the bathroom when they requested.
- On occasions when the researcher or team member needed to step out of the room during the testing session they informed the participant, and again when they returned. Testing was resumed after informing the participant. [30]

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[28] "Focus Highlight." NVDA Community Addons http://addons.nvda-project.org/addons/focusHighlight.en.html.
[29]"Communicating Effectively with People Who Are Blind or Vision Impaired." 2012. Accessed July 26, 2015. http://www.visionaustralia.org/living-with-low-vision/family-friends-and-carers/communicating-effectively-with-people-who-are-blind-or-vision-impaired
impaired.
[30] From pilot testing.

- The participants were advised to pause their screen reader when they voiced they think-aloud so that the audio recording is not muddled with two voices speaking at the same time.[31]
- The researcher ensured that the website suggested for warm up was compliant with WCAG accessibility standards so that accessibility issues do not come in the way of this exercise.
- The researcher ensured that the questions asked were relevant to the user experience and not accessibility, meaning they were 'how do you feel' questions and not 'are you able to do' questions.

After the Session Ended.

- Video/audio recording equipment were turned off.
- The researcher announced that the user testing session had ended and thanked the participant for their participation.

[31] Chandrashekar, S., Stockman, T., Fels, D., and Benedyk, R. (2006). Using think aloud protocol with blind users: a case for inclusive usability evaluation methods. In Proceedings of the 8th international ACM SIGACCESS Conference on Computers and Accessibility (Portland, OR, October 23 - 25, 2006). DOI: 10.1145/1168987.1169040.

- The participant was offered a hand to shake with a verbal cue and by advancing the hand within their range of grasp.[32]
- The participant was asked if they have any questions they would like to be answered or comments that they could provide.
- They were also asked if they could be contacted for a follow-up or clarification if found necessary while analyzing the data.[33]
- The participant was walked back to the transit stop or station they wished to go to.

3.4 Participant feedback

After data analysis, a prototype AUX evaluation tool was developed for testing. This tool was sent to the six interviewees by email and their responses were obtained in the context of one use case (twitter website and app). Section 4.4 provides details of the tool and results from this exercise. Approval was

[32] "About Vision Loss: Meeting a Blind Person." Vision Serve. 2015. Accessed July 26, 2015. http://www.visionservealliance.org/index.php?option=com_content&view=article&id=81&Itemid=521.
[33] "Running a Usability Test." Usablity.gov - Improving the User Experience. June 24, 2015. Accessed July 23, 2015. http://www.usability.gov/how-to-and-tools/methods/running-usability-tests.html#PAGE_4.

sought and obtained from the Research Ethics Board of OCAD University for an amendment to the previously approved protocol.

3.5 Data Analysis and Validity

All descriptive data were transferred into a spreadsheet, further broken up into units of analysis and coded/sorted. The qualitative content analysis procedures as outlined in Berg (2007) and Foss & Waters (2007) were used to generate a hypothetical framework for accessible user experience. According to Berg (2007) content analysis is chiefly a "coding operation and data interpretation process". The visible, obvious aspects of the text, or what the text "says," are referred to as manifest content, and the underlying meaning of the text, or what the text "talks about" is referred to as the latent content. Analysis of the former deals with interpretation of the content aspects of the text, while analysis of the latter involves interpretation of the underlying meanings of the text. The limitation of content analysis is that it does not allow the testing of causal relationships (Berg 2007).

One of the important components of data validity in terms of trustworthiness is transferability, or the "extent to which the findings can be transferred to other settings or groups" (Polit & Hungler 717). There was an conscious attempt to use direct quotations from interview participants throughout the presentation of findings and their discussion in addition to interpretation of the data, providing a chance for the reader to look for alternative interpretations.

Six persona profiles were created based on data from the six participants to illustrate the diversity of the participants, and thereby the validity. Personas also improve reader engagement with the report text.

3.6 Summary

This section presented the research methodology used, describing the research design, the multiple methods used for data collection, their sequencing and implementation, the data analysis method used, and the steps taken to ensure trustworthiness of the research results.

The next section provides the results of the research, followed by discussion and conclusion in Section 5 and Section 6.

4 Results

4.1 Introduction

This section presents the demographics of the six participants in this research followed by which six personas built on the data about each participant is presented. These personas are built in such a way that key characteristics are retained and identifying characteristics are masked and pseudonyms are assigned to ensure privacy. More information about personas is given in section 4.3. The AUX evaluation tool derived from data analysis is presented next, followed by results from the examination of the effect of technology on AUX. A section summary wraps up the section.

4.2 Demographics

Four men and two women with age ranging from 35 to 60 participated in the research. All of them are blind with 5 of the participants having congenital blindness and one having acquired blindness. All of the participants use a screen reader to interact with their computing devices. All of them primarily use a laptop with Windows Operating System, Firefox browser and

JAWS screen reader to interact with websites and computer applications. They all use an iPhone with VoiceOver to interact with mobile websites and apps. Yet, their profiles show diversity along occupation, information-seeking interests, nature of use of websites/apps and proficiency in the use of computer/phone, screen reader and websites/apps.

4.3 Personas

The idea of personas emerged first in the fields of interaction design and marketing. Personas are a method for enhancing engagement and reality (Grudin & Pruitt, 2002). Pruitt & Adlin define personas as "detailed descriptions of imaginary people constructed out of well-understood, highly specific data about real people" (3). Cooper (1999) introduced personas to the HCI domain through his famous book, *The Inmates Are Running the Asylum: Why High Tech Products Drive Us Crazy and How to Restore the Sanity*. Personas can be used for a variety of purposes such as to aid in design, to understand phenomena, to promote reader engagement, and to illustrate results. For this research project, personas were created based on the data of each of the six

interviewees to illustrate their diversity as an indicator of the validity of the results and to enhance communication during discussion of the research outcomes in the section below.

4.3.1 Persona 1: Hong

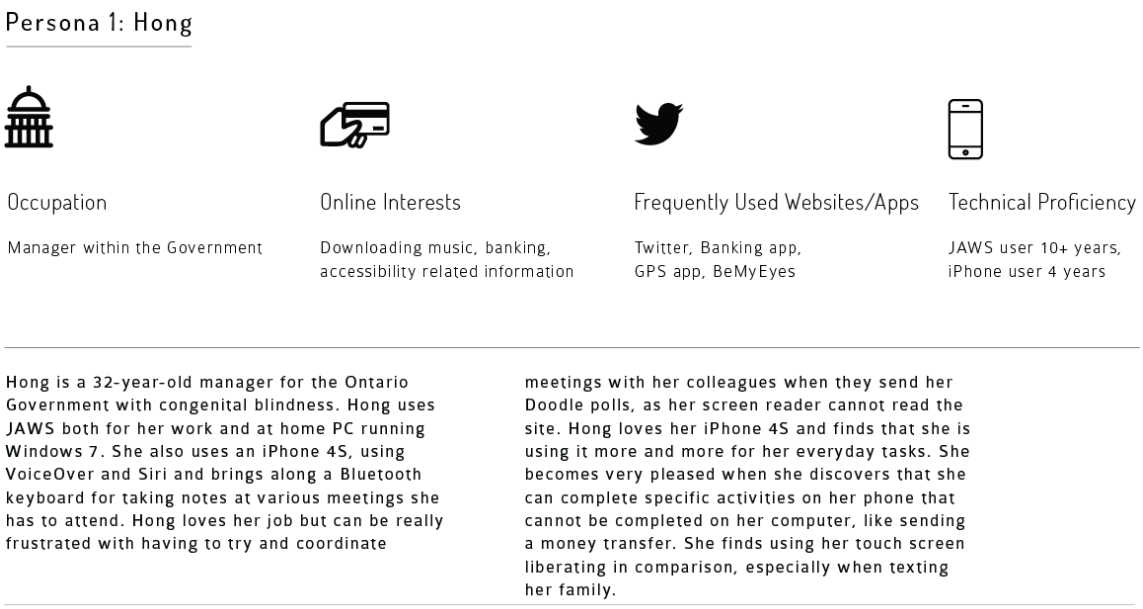

Figure 3: Profile of Hong

- **Occupation:** Manager within the Government
- **Online Interests:** Downloading music, banking, accessibility related information

- **Frequently Used Websites or Apps:** Twitter, Banking app, GPS app, BeMyEyes
- **Technical Proficiency:** JAWS user 10+ years, iPhone user 4 years

Hong is a 32-year-old manager for the Ontario Government with congenital blindness. Hong uses JAWS both for her work and at home PC running Windows 7. She also uses an iPhone 4S, using VoiceOver and Siri and brings along a Bluetooth keyboard for taking notes at various meetings she has to attend. Hong loves her job but can be really frustrated with having to try and coordinate meetings with her colleagues when they send her Doodle polls, as her screen reader cannot read the site. Hong loves her iPhone 4S and finds that she is using it more and more for her everyday tasks. She becomes very pleased when she discovers that she can complete specific activities on her phone that cannot be completed on her computer, like sending a money transfer. She finds using her touch screen liberating in comparison, especially when texting her family.

4.3.2 Persona 2: Samantha

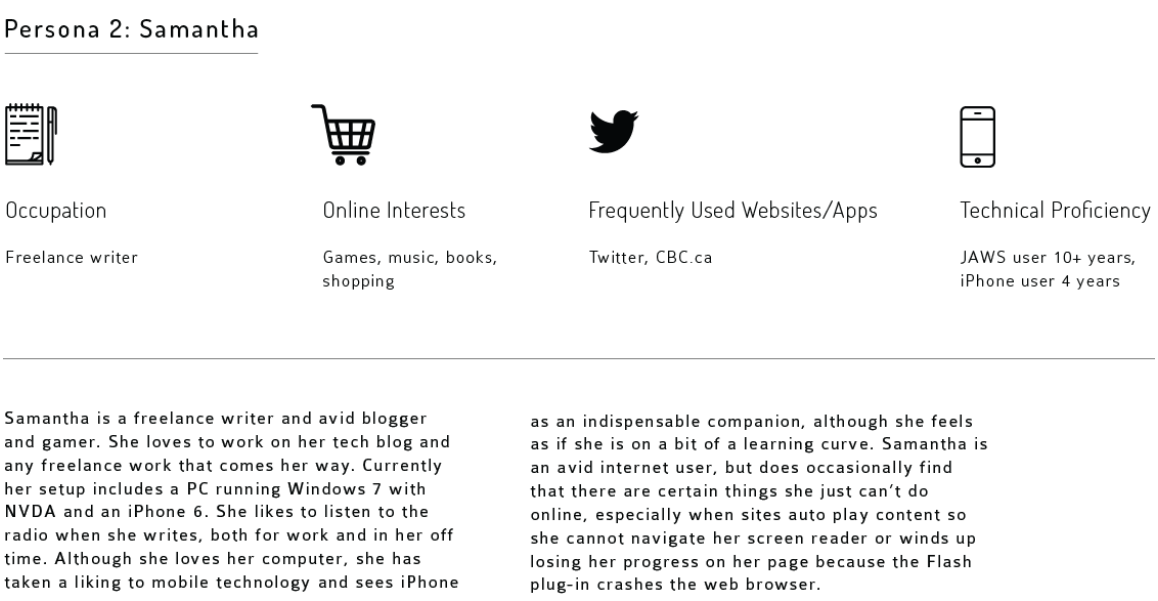

Figure 4: Profile of Samantha

- **Occupation:** Freelance writer
- **Online Interests:** Games, music, books, shopping
- **Frequently Used Websites or Apps:** Twitter, CBC.ca
- **Technical Proficiency:** JAWS user 10+ years, iPhone user 4 years

Samantha is a freelance writer and avid blogger and gamer. She loves to work on her tech blog and any freelance work that comes her way. Currently her setup includes a PC running Windows 7 with NVDA and an iPhone 6. She likes to listen to the radio when she writes, both for work and in her off time. Although she loves her computer, she has taken a liking to mobile technology and sees iPhone as an indispensable companion, although she feels as if she is on a bit of a learning curve. Samantha is an avid internet user, but does occasionally find that there are certain things she just can't do online, especially when sites auto play content so she cannot navigate her screen reader or winds up losing her progress on her page because the Flash plug-in crashes the web browser.

4.3.3 Persona 3: Jose

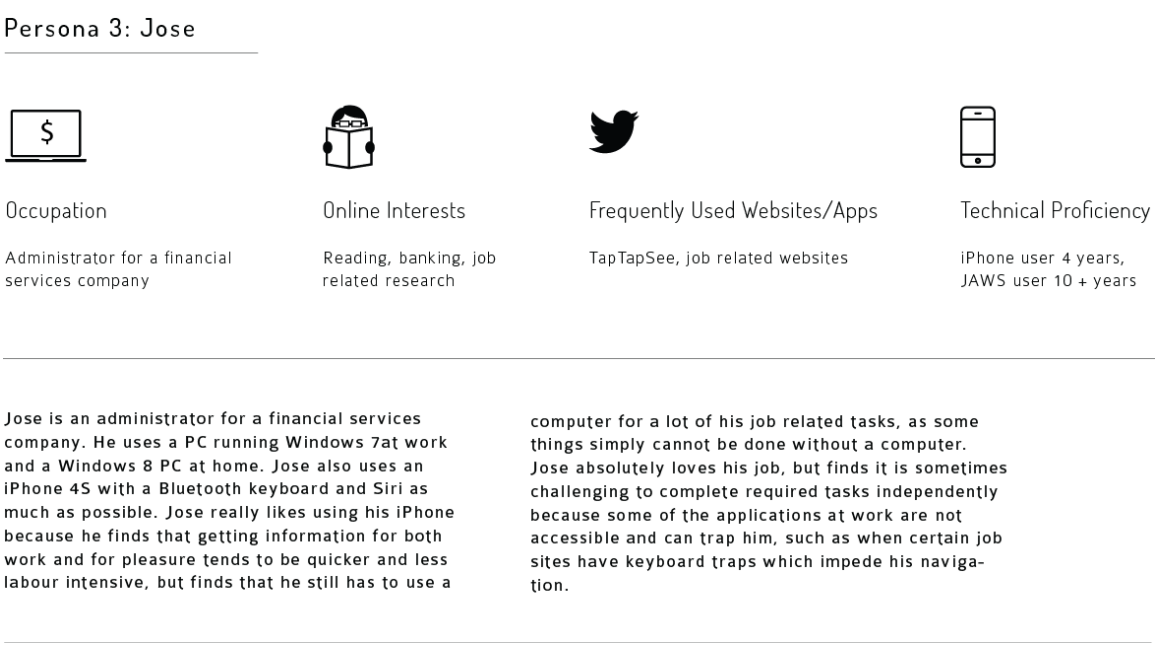

Figure 5: Profile of Jose

- **Occupation:** Administrator for a financial services company
- **Online Interests:** Reading, banking, job related research
- **Frequently Used Websites or Apps:** Twitter, TapTapSee, job related websites
- **Technical Proficiency:** iPhone user 4 years, JAWS user 10 + years

Jose is an administrator for a financial services company. He uses a PC running Windows 7at work and a Windows 8 PC at home. Jose also uses an iPhone 4S with a Bluetooth keyboard and Siri as much as possible. Jose really likes using his iPhone because he finds that getting information for both work and for pleasure tends to be quicker and less labour intensive, but finds that he still has to use a computer for a lot of his job related tasks, as some things simply cannot be done without a computer. Jose absolutely loves his job, but finds it is sometimes challenging to complete required tasks independently because some of the applications at work are not accessible and can trap him, such as when certain job sites have keyboard traps which impede his navigation.

4.3.4 Persona 4: Karan

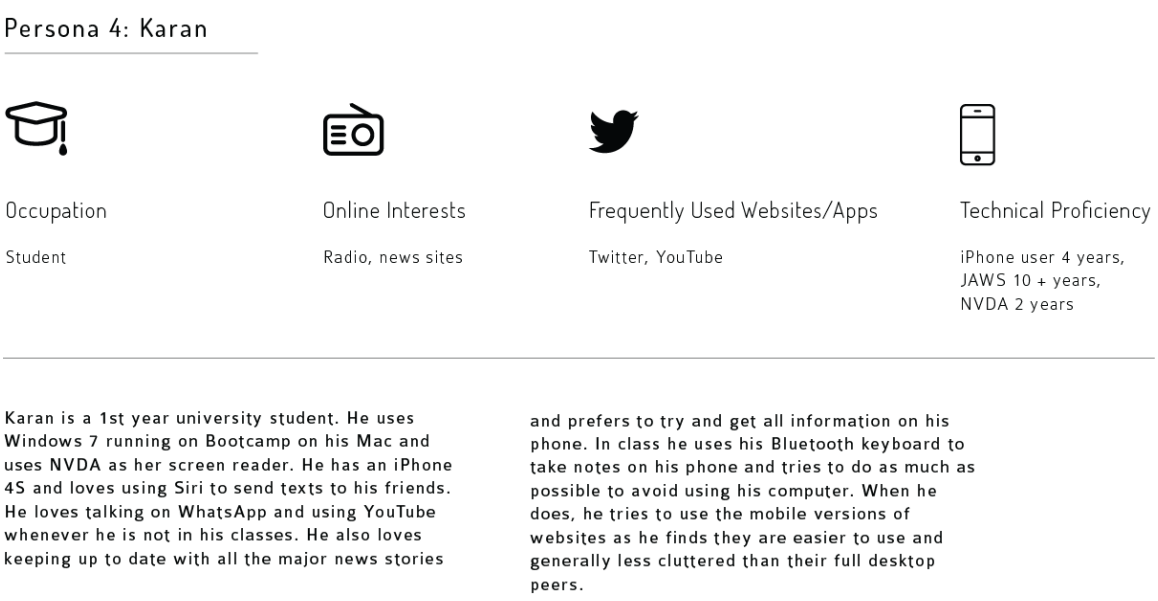

Figure 4: Profile of Karan

- **Occupation:** Student
- **Online Interests:** Radio, news sites
- **Frequently Used Websites or Apps:** Twitter, YouTube
- **Technical Proficiency:** iPhone user 4 years, JAWS 10 + years, NVDA 2 years

Karan is a 1st year university student. He uses Windows 7 running on Bootcamp on his Mac and uses NVDA as her screen reader. He has an iPhone 4S and loves using Siri to send texts to his friends. He loves talking on WhatsApp and using YouTube whenever he is not in his classes. He also loves keeping up to date with all the major news stories and prefers to try and get all information on his phone. In class he uses his Bluetooth keyboard to take notes on his phone and tries to do as much as possible to avoid using his computer. When he does, he tries to use the mobile versions of websites as he finds they are easier to use and generally less cluttered than their full desktop peers.

4.3.5 Persona 5: Fatima

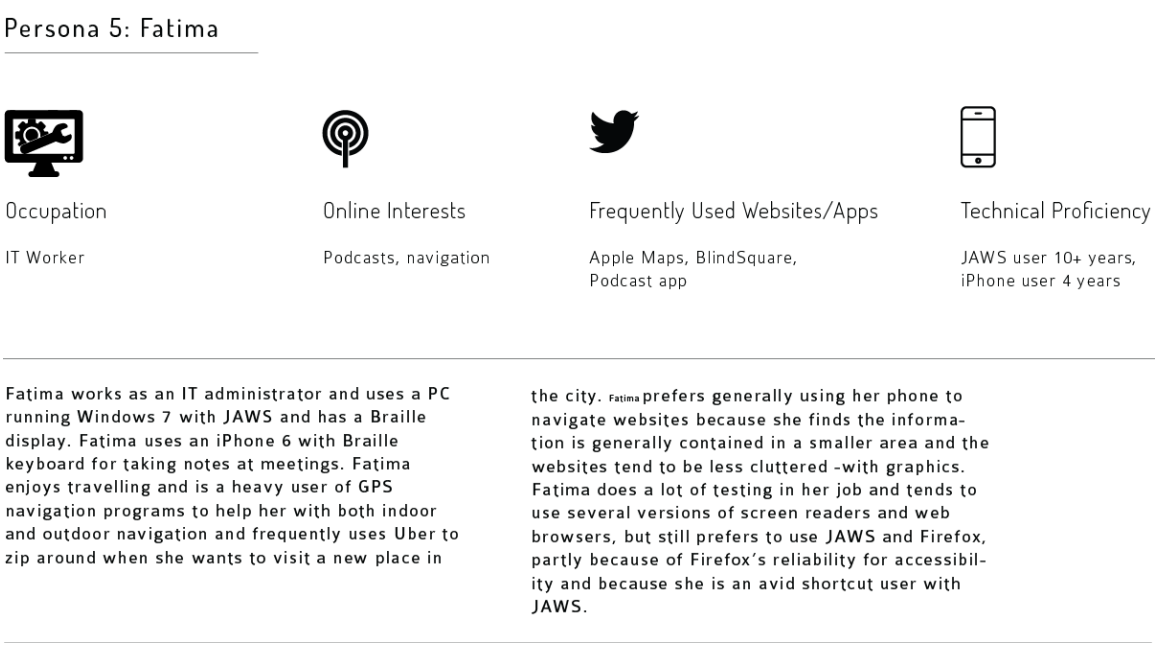

Figure 5: Profile of Fatima

- **Occupation:** IT Worker
- **Online Interests:** Podcasts, navigation
- **Frequently Used Websites or Apps:** Twitter, Apple Maps, BlindSquare, Podcast app
- **Technical Proficiency:** JAWS 10 + years, iPhone 4+ years

Fatima works as an IT administrator and uses a PC running Windows 7 with JAWS and has a Braille display. Fatima uses an iPhone 6 with Braille keyboard for taking notes at meetings. Fatima enjoys travelling and is a heavy user of GPS navigation programs to help her with both indoor and outdoor navigation and frequently uses Uber to zip around when she wants to visit a new place in the city. Fatima prefers generally using her phone to navigate websites because she finds the information is generally contained in a smaller area and the websites tend to be less cluttered -with graphics. Fatima does a lot of testing in her job and tends to use several versions of screen readers and web browsers, but still prefers to use JAWS and Firefox, partly because of Firefox's reliability for accessibility and because she is an avid shortcut user with JAWS.

4.3.6 Persona 6: Travis

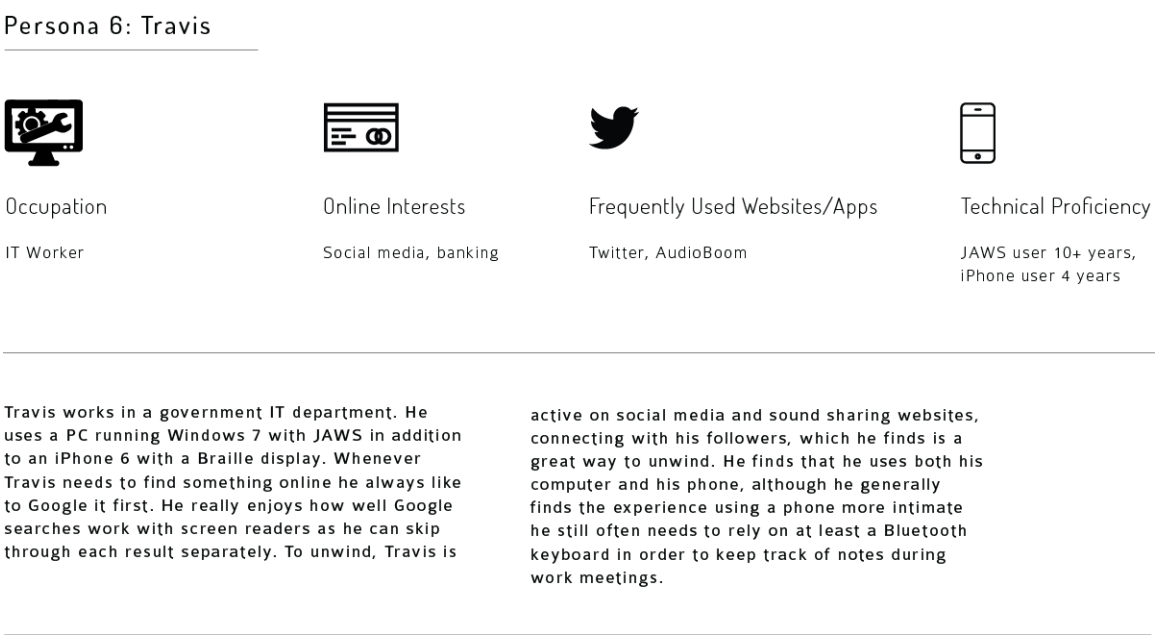

Figure 6: Profile of Travis

Occupation: IT Worker

Online Interests: Social media, banking

Frequently Used Websites or Apps: Twitter, AudioBoom

Technical Proficiency: JAWS user 10+ years, iPhone user 4+ years

Travis works in a government IT department. He uses a PC running Windows 7 with JAWS in addition to an iPhone 6 with a Braille display.

Whenever Travis needs to find something online he always like to Google it first. He really enjoys how well Google searches work with screen readers as he can skip through each result separately. To unwind, Travis is active on social media and sound sharing websites, connecting with his followers, which he finds is a great way to unwind. He finds that he uses both his computer and his phone, although he generally finds the experience using a phone more intimate he still often needs to rely on at least a Bluetooth keyboard in order to keep track of notes during work meetings.

4.3.7 Personas Summary

The personas are designed for two purposes. The first purpose is to humanize data to the reader and to allow readers to understand the human effects of accessible user experience issues. The second purpose is to demonstrate the wide diversity of professions amongst screen reader users. Furthermore, the personas are able to highlight the differing interests each participant has with online products such as enjoying, news sites, audio dramas, podcasts and banking. Although all the users can use the same assistive devices

each user will have a custom set up for their technology. These unique set ups can be illustrated though how the participants utilized alternative keyboards for their phone in both braille and standard varieties.

4.4 Evaluation Tool

4.4.1 Deriving the Framework

Based on the analysis of interview data, as referenced in subsection 3.2.1 and 3.2.2, using the conceptual framework introduced in sub-section 2.3, this study developed a five-point framework for Accessible User Experience, Comfort, Likability, Autonomy, Agency and Pleasure or (CLAAP). The CLAAP framework draws upon Hassenzhal's concepts of autonomy and competence; however, based upon the outcomes of the study's interviews and task-based exercises, a decision was made to exclude Hassenzhal's concepts pertaining to relatedness, popularity, simulation. The reasons for excluding these concepts came out of the participant's feedback whose responses focused more on task-based observations rather than descriptions of their personal attributes, such as if they required assistance on a task. The rejected concepts in Hassenzhal's

model, such as popularity and relatedness and security, have more to do with people's perception of their social surroundings rather than their personal interaction with technology. In the case of simulation, Hassenzhal's concept of simulation was removed because it was too similar to Bevin's concept of pleasure, and there was a concern that participants would feel that the questions would be too similar, and perceive them as redundant. In the case of Hassenzhal's concept of competence, a decision was made to rename the concept to "agency". Agency contains a positive association which was useful since it helps emphasise an exploration of whether or not a technology is empowering the participant. Competence, on the other hand, often has negative and potentially demeaning associations and could potentially affront the dignity of the participants. From Bevin's work, the concepts of likeability, pleasure and comfort were chosen while omitting the concept of trust. The justification for the omission, in this case, is that through the interview and task based responses the participants described expectations, but the participants never gave any indication of whether or not the products behaved the way the participants expected.

The terms are arranged to make the acronym CLAAP to signify the positive feeling associated with clapping of hands. This framework consists of the following components and definitions:

- **Comfort** – when the interface is intuitive to use
- **Likability** – when expectations are met or exceeded
- **Autonomy** – when users can perform independently
- **Agency** – when users feel empowered and competent
- **Pleasure** – when users experience engagement

Adopting this paradigm, the five components have been identified and derived through the study of points of positive user experience. Since accessibility generally focuses on the barriers and accessibility errors, and therefore negative interactions which produce a negative user experience, the aim of this study is to focus on the positive and pleasurable aspects within user experience evaluation that typically does not consider users with disabilities. Proponents of the science of positive psychology state that positive emotions serve as markers of flourishing, or optimal wellbeing (Seligman & Chikszentmihayli). The term 'pleasure point' is proposed for the five

components of the CLAAP framework, in contrast to the search for 'pain points' in conventional usability studies.

A UX evaluation tool was developed based on the above five components. The tool was sent out to the six interviewees for feedback. Responses received are mentioned in the next section.

A detailed protocol for conducting UX studies with participants who are blind was drafted based on the experiences during the interviews. The outcome of this study is thus a process and tool for AUX evaluation with users who are blind.

4.4.2 Questionnaire

After establishing the CLAAP framework, it was decided to then evaluate the utility and ability to identify pleasure points. This was achieved through the creation of a questionnaire whose questions were derived from the 5 CLAAP components. The tool was emailed out to the same 6 participants who participated in the semi-structured interviews and task-based exercises. In the instructions to the questionnaire, a task was given for the participant to visit the

Twitter website and or app. Twitter was chosen for this study as all participants during their interviews had mentioned having used the service either currently or before. They were then encouraged to consider the experience of their visit while answering the questions. Each question itself, for the purposes of being understandable to the reader, did not mention each CLAAP name in the question.

From Bevan's discussion around likability, it was decided that since the criteria was focused on whether expectations of the user were met, therefore, the questions in the CLAAP framework, that would be asked of participants, would follow the Bevan criteria in asking for expectations, not likability. For pleasure, since the criteria focused on user engagement, engagement would be the question that would actually be assessed. In the case of comfort, since it was focused on the intuitiveness of the interface, CLAPP would ask about the intuitive nature of the product rather than its comfort. For autonomy, since it focuses on independence, the questionnaire would ask a question around independence. For agency, since it focused on empowerment and competence, it would focus on

navigation as there was a concerted effort as to avoid making users feel like the questions around empowerment were similar to independence, or avoid seeming like the test was questioning their competence.

The questionnaire itself, in order to make it fully accessible, was done in an email document inviting the participants with a question sentence along with an empty space to indicate a space for participant's responses (refer to Section 8.1 Appendix 1 for a copy of the questionnaire). The participants were then given a consent form as well as instructions as to how to return the questionnaire based on a specific time deadline.

4.4.3 Participant Responses

After the email was sent out, all participants responded to the questionnaire. Within the responses, it was immediately apparent that the participants had interpreted the instructions of their experience with the Twitter app or website very differently. Of the six participants, three users used the website, two users used an accessible desktop app and one user used both the website and the app. Of particular note was that, depending on the website being

used, the users all had very different responses to the questionnaire. Participants who used the website did not report any pleasure points instead indicating only pain points in their responses. This displeasure can be perfectly illustrated by Fatima's response to whether she felt that she was able to accomplish all the tasks on the website independently. Fatima responded to this saying that although she did feel that was the case, "it [Twitter website] is cumbersome and takes too much time and effort to perform simple tasks." In contrast, Samantha responded very well to her experience in her assessment of the Twitter app, and in the same question by saying, "Yes, I never needed sighted help in dealing with the Twitter app." Karan, on the other hand, through deciding to assess both the website and the application was able to blend both sentiments of Fatima and Samantha together in his assessment, referring to the whether the site met his expectations mentioning that, "I guess it's a good feeling to verify that the app is indeed accessible. The website is okay to use, but I'd rather use the iPhone app because I find it easier to use in general." These expectations are echoed by Travis, who was using his EasyChirp desktop client and stating, "The website is okay. I prefer to use the EasyChirp website over the Twitter desktop website."

This is a position felt similarly with Hong, as referenced by her statement, "I tried a couple of Twitter clients before and the Apple option the iPhone...I find Chicken Nugget [the desktop Twitter client] far more easy and accessible."

4.5 Technology and User Experience

A major insight that has come from observations during the user sessions was that specific technological set up used played a big role in the interaction of screen reader users with websites and apps. Furthermore, it was also seen that the mode of interaction between the technology and the user also contributed to their UX. This provided a useful insight that UX is not just about how a website or app is designed; part of it also comes from the interaction. The user's electronic devices such as computer, browser, screen reader and input-output devices/mechanisms, all contribute to their user experience. This aspect was brought out in several ways as detailed below.

The participants actively use their IT devices both in personal life and at work/school. They feel there has been a major change in the past five years towards the rise of mobile technology. Two of them purchased a MacBook Pro

through Ontario's Assistive Devices Program and all have personally purchased either an iPhone 4S or a later version.

An important emotional experience that relates to technology is how different feelings are evoked between doing the same activity on the laptop and on the phone. This divide is evidenced by through response of the participants the user experience evaluation tool. The tool itself asked the participants for feedback on 5 key metrics of user experience. The site chosen to evaluate upon was twitter and participants had the option of preforming their evaluations on the website or app or in combination.

When the site was assessed by the same individuals for the same metric (expectations) the results deferred. Karan noted that: "the iPhone app is very accessible and easy to use. Although I was pleasantly surprised to find it accessible and I enjoy using it." In contrast, the same user when assessing the website mentioned: "The website is OK to use, but I rather use the iPhone app because I find it easier to use in general." In both instances Karan was preforming the same activities, navigating the site to view content. Yet these

observations were not unique. Fatima when asked if they could navigate the website independently described the user experience as "…cumbersome as it takes too much time and effort to perform simple tasks." In contrast, Jose had overwhelming positive experience with the app noting that it had exceeded his expectations as it was: "very accessible, tweets can be sent and navigation comes easily. It should be noted that the comments about the improved user experience for mobile devices revolved less around the screen reader and more focused on the interaction model as evidenced by Jose's describing why he prefers the iPhone to his computer: "…because you can get information with shorter journeys and less keystrokes."

4.6 Summary

Results from the research was presented in this section. Six personas built on the data about each participant were presented in sub-section 4.3. These personas display the key characteristics of each participant while masking identifying details. The AUX evaluation tool and results from the examination of the effect of technology on AUX, presented in sub-sections 4.4 and 4.5 respectively, are discussed in the next section.

5 Discussion

5.1 Introduction

Individuals experience a variety of emotions, both negative and positive, while using a website, an app or any other product. Usability, defined as "the extent to which a product, service or environment can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use," (ISO) does not effectively capture the affective aspects of such access and interaction. User experience (UX) goes beyond this largely system-oriented paradigm of "effectiveness, efficiency, satisfaction," to take into account a number of other factors, such as likability, pleasure, comfort and trust (Bevan, 2008). User experience differs from 'experience' in a general sense, in that it explicitly refers to the experience(s) derived from users encountering products, services or artefacts through a user interface ("User Experience Whitepaper", 2011). The notion of user experience has different meanings for different professionals, with a variety of definitions across different domains ("All About UX", n.d.). Bevan claims that UX can be

measured as the user's satisfaction with achieving pragmatic and hedonic goals, and pleasure (Bevan, 2009).

AUX is about integrating accessibility into UX design and practice to create "genuinely inclusive high-quality digital experiences for everyone, regardless of disability or age" (Sloan, 2014).

This paper presents an exploration of the emotional experiences of persons who are blind when they use websites and apps on their computers and smart phones and comes up with a process and tool for evaluating the Accessible User Experience (AUX) aspects of such interactions.

5.2 Accessible User Experience

5.2.1 Why AUX?

This research argues for the need to study AUX. There is not much research or dialogue yet around this topic. The Manifesto of AUX is a community of practice started by David Sloan, Henny Swan and Sarah Horton to "examine accessibility through the lens of user experience" ("A (Rough) Manifesto for Accessible User Experience", 2015). The Manifesto sees

accessibility as being about people and not technology. This movement needs to be strengthened and this research is a step in that direction.

5.2.2 Evaluation of AUX

UX design, as a field, is concerned with the design of enjoyable websites and apps for users (Hassenzahl & Tractinsky, 2006). As seen previously in Section 2, there are tools used for evaluating UX during usability studies involving users but these do not consider users with disabilities. There are around 50 tools currently available to help designers and developers measure and evaluate UX ("All About UX", n.d.). However, there is no published process or tool that specifically focus on UX evaluation for users with disabilities, or specifically for users who are blind or visually impaired, even though they face some of the greatest accessibility challenges with the predominantly visual nature of the web.

The tool developed through this research is in the form of an electronic questionnaire that is screen reader users accessible. It contains five questions along the dimensions of Comfort, Learnability, Autonomy, Agency and

Pleasure or CLAAP. The dimensions were arrived at qualitatively and this is a limitation of the research. And while an attempt was made to evaluate the tool with the users, there needs to be more effort made towards refining the tool before other researchers and practitioners could adopt it, which will be discussed in greater detail in the following section. What is of value is the process of conducting the user experience evaluation sessions with screen reader users in an inclusive manner, as described in Section 3.

5.2.3 Reflection on the CLAAP Framework

The evaluation tool that was created with the CLAAP framework is simply a first attempt at developing a useful AUX resource for user experience designers hoping to work with users who have disabilities. The disruptive effect that was hoped to come from this tool is in trying to get individuals within both the UX and AUX field to consider the pleasurable user experience for people who are disabled. Those within the accessibility movement have considered user experience for disabled users but have only done so through focusing on the negative feelings associated with pain points and user

frustration. The AUX movement is still nascent, and as it has been established in the literature review, very little work has been done within the conventional user experience field to consider disabled users in terms of actually developing evaluation methods to determine pleasurable user experience. The goal of this tool was to contribute to the AUX field by bringing attention to this disparity and attempting to provide a solution that could either inspire other designers and AUX practitioners to consider pleasurable user experience for disabled users within the field or give other AUX practitioners a tool to assist in usability testing.

The tool, although it was effective in its first version at capturing key insights, contained several drawbacks. The selection of Twitter, although useful as all participants had experience with the application, did elicit some confusion from the several participants they were unsure of why Twitter was selected. A future remedy to this problem is to make it apparent that whatever common digital product that is selected should have a rationale to the participants justifying the selection. Moreover, the positivity or negativity of the participant

responses varied widely depending on the products used. The open-endedness of allowing participants to engage with either the app or the website led to a great diversity of access points with confusion amongst participants, with some users using desktop based applications, such as Chicken Nugget, the Twitter app for iPhone, or web based accessible websites such as EasyChirp, with one participant assessing both the app and the desktop. As a result, the tool should be designed in a way so that the participants assessed a single digital platform at a time, such as the website or app, with follow-up questionnaires designed to assess additional specific platforms. In an effort to ensure that in the questionnaire that question 4 and 5 were different, question 5 became quite stretched from its source material. The question was based on the agency component of the CLAAP framework but it was further into the components of experience and competence into navigation experience, it was apparent that the derivations may have gone too far as the participants answers to the question did focus on their own their own abilities and instead focused their assessment of the technical components of the navigation setup. Since this tool is designed to derive user pleasure points through their positive experiences,

their commentary around technical setup of accessible navigation components made it difficult to produce relevant insights from the question. Moreover, the question around agency could have been better defined as several key areas that impact agency were not considered. For users, being able to successfully recover where they are in an app or website from a computer error or mistake give a user a great deal of agency. Furthermore, these feelings of agency can be broadened in include questions around the effect adaptation and personalization of sites and apps as they are both concrete examples of where users are given control to change their computing environment to match their personal preferences. It was also evident, that there needs to be further analysis into delineating between user feedback that is positive versus user feedback that is pleasurable as both concepts are distinct. Based on how the responses of the participants in this study, it was hard to determine if the participants who had good experiences with twitter, had experiences that could be clearly defined as positive or pleasurable, thereby making it hard to clearly gauge the precise emotional state of the users.

In summary more could be done to improve the tool, along with more revisions and user testing is definitely needed and the product that has been selected for testing should include a better rationale. There should be more context given to the user to better help them understand the testing tasks they are being asked to perform. This could also be accomplished by integrating Heuristic Evaluation concepts into the test. Heuristic Evaluation is based off of the model developed Jakob Nielsen whereby the participants evaluate issues in the interface design which could better facilitate users in the uncovering of pleasurepoints (Nielsen, 1995). One of the main benefits in adopting an approach using Heuristic Evaluation is that method allows evaluators to provide more assistance to participants though hints and answering questions (Nielsen, 1995). This allows for more time saved and allows for recognition that screen readers may occasionally need assistance due to the limitations of the technology they use. Furthermore, the current long answer question format makes it difficult for cross measurement across participants. The inclusion of an accessible Likert scale for screen readers could be helpful to better track measurements across participants as well to help with quantitative data analysis.

To continue to improve the product there needs to be better clarity as to what products the users should choose to use to make their assessment. The language should be specific if examining, for example, a digital or desktop application, as seen in the responses, as the users may have totally different pleasure points depending on the product. In that vein there should be questions specifying the specific sorts of adaptive technologies in use, such as screen readers or keyboards, as the interaction model may also have an effect on the pleasure points the users identify in their responses.

5.2.4 Pleasure points

Drawing from positive psychology, this research introduces a term 'pleasure points' in contrast to the traditional conversation about 'pain points' that prevail in user testing. Components of a design that evoke positive emotional reactions from users are termed as pleasure points. The process of evaluation of pleasure points while testing websites and apps with screen reader users and a tool to facilitate the existence of pleasure points are the original contributions of this research.

It must be emphasized that the AUX tool was not designed to solely look at pleasure points. Rather, the tool is designed to balance out the overemphasis of pain points in UX research. Since this tool evaluates UX and not positive UX, the responses that are extracted from the tool will vary based on the mindset of the user both during and after using the website or app. If the user has a genuinely good experience, then it will be measured and recorded in their feedback on the tool. If they have negative experience this information will also be captured, thereby giving UX designers who attempt to evaluate a website the ability to get information on exactly what evokes good feelings and what does not.

5.3 Impact of Technology on AUX

5.3.1 Screen Reader Interaction

The goal of screen reader design has always been to "allow a blind user to interact with online interfaces in an efficient and intuitive manner." (Edwards, Mynatt, & Stockton, 1995, p. 56). However, screen readers

inherently put constraints on users. Understanding the process of interaction involving a screen reader would require an understanding of how a typical screen reader program works online and to consider its capabilities and limitations. The screen reader reads out the text content of web pages displayed on the screen. Screen readers also indicate to the user the interaction elements of web pages such as buttons, forms, links, and menus when encountered. The user then activates the desired element or text using a keyboard. Furthermore, screen reader users typically do not use a mouse.

Treviranus (1997) points out the significant limitations that screen reader users face online (which continue to exist even today):

- Information output is presented only in text form.
- Information access is sequential, unless the web page is designed to facilitate navigation with a screen reader.
- Visual objects are inaccessible except through text alternatives, if provided.
- Users hear only small portions of text at a time, leading to a loss of context.

- Information overload occurs when users are forced to hear repeating portions of common text, such as website headers on every page, that visual users easily avoid.
- Users interact with the computer only through the keyboard, which makes mouse-only interactions, so prevalent on the Web, impossible for them to interact with.

These drawbacks slow down navigation for screen reader users and make it difficult for them to locate the information they want, sometimes causing frustration (Lazar, Feng, Allen, Kleinman, & Malarkey, 2007). This situation is compounded by the fact that visual cues on web pages that aid navigation and interpretation are not directly available to them such as breadcrumbs. Their online interactions are also limited by how proficiently they can use their screen reader to negotiate web pages.

Participants articulated many of the above constraints during the sessions, confirming that they exist even today, despite all advances made in Web accessibility, thus showing that technology plays a role in user experience in the case of screen reader users.

5.3.2 Keyboard vs. Touchscreen

It was observed, however, that all six participants were happy with the mobile device they were using. All of them used iPhones with the VoiceOver screen reader and reported being very happy with the touch screen interactions. Three of them reported that they had bought Mac systems (two of them Macbooks and one, an iMac), but all three of them had abandoned the Mac systems and gone back to using their Windows laptops with JAWS screen reader even though the same VoiceOver screen reader that is on the phone is built into the Mac systems as well. This makes easy to theorize that it might not be the screen reader so much as the type of input interaction that makes the participant's experience with their phones more enjoyable. Sometimes this is the case even for the same product where by users have very different experiences vising website or app. There is not enough evidence in this research to conclusively state this but this is an area worth further exploration. Proficiency of the user in using these technologies also appears to have a role.

5.4 Summary

In summary, this section examined the findings around AUX and the impact of technology on it for interactions of screen reader user with websites and apps. Overall, this research is a positive step in the direction of supporting the move by the UX community to focus on AUX as a concept for those using assistive technologies or having other interaction constraints. Furthermore, the finding about technology being a component of user experience, specifically about input interaction through keyboard and touchscreen interfaces producing different experiences, is an area that deserves further research.

6 Conclusion

6.1 Contributions to Inclusive Design

This paper has sought to make several key contributions to the field of Inclusive Design. Inclusive Design looks at the needs of extreme users on the spectrum of individual abilities who are commonly ignored when designing products or solutions for user groups. This paper follows a similar approach. Although all users could benefit for enhanced tools evaluating pleasure points in User Experience, extreme users in this case, screen reader users, were selected. The reason for their inclusion is that members of the UX community often ignore them as they perceive them to be an insignificant user population of outliers.

Furthermore, an inclusive approach was taking in collecting data from the participants. Participants were offered consent documentation that was inclusively designed and the ability to participate in the sessions at a location that was fully accessible to them at their choosing using whatever adaptive technology resources they would like to use.

Finally, even though the tool was designed though interviews with screen reader users, a curb cut effect exists where the tool can be used on other user groups as well. The testing criterion of autonomy and agency could be helpful to many other user groups who require accessibility support such as those with hearing loss, those with low vision users and seniors. Moreover, because the tool can be an effective barometer of people's emotional states when using websites or apps the tool can be used with the general population as well. As a result, this is process exemplifies the principles of Inclusive Design as the tool developed in this paper was designed out of attempting to meet the needs of extreme users also has the ability to benefit the general population.

6.2 Future work

Future work that could be developed from this paper could be in the following three areas:

1. Refining the evaluation tool. By replicating the process with screen reader users with different profiles, interests and

proficiencies, the set of evaluation criteria could be expanded, as also the process could be refined.

2. Users with other constraints (dexterity, cognition, hearing) that disable them from accessing content on websites and apps could be included in the testing.
3. A large-scale quantitative study could be conducted to arrive at the components for UX evaluation.

6.3 Parting Thoughts

Screen reader users still face many challenges when it comes to accessing and enjoying digital content. Although barriers are actively being reduced by those in the web accessibility community more can be done on the part of UX designers. The promotion of Accessible User Experience (AUX) is a great first step in redressing this balance but a core tenant of UX must not be forgotten. Users all deserve the opportunity to experience pleasure when using digital products whether they be disabled or not. It is with this hope that the tool developed in this paper will advance the concept of evoking user pleasure

within the field of AUX in an effort to elevate it to the same stature as it is within the UX field. Ultimately providing a pleasurable user experience is the goal of every User Experience Designer and people with disabilities should not have to be left out of partaking in this experience.

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8 Appendix

8.1 Appendix A – Pleasure Points Evaluation Tool

Imagine that you have just used the twitter website or app. With that experience in mind, please answer the following questions:

Q1: Does the website or app exceed your expectations? If so, how? Please describe in detail.

A1:

Q2: What parts of the twitter website or app engaged you the most?

A2:

Q3: Did you find the twitter website or app intuitive to use? If so, describe how?

A3:

Q4: Do you feel that you are able to accomplish all the tasks on the twitter website or app independently?

A5:

Q5: Could you describe your navigation experience on the twitter website or app?

A6: