6-27-2016

Blind and Visually Impaired Users Adaptation to Web Environments: A Qualitative Study

Raneem Saqr
University of South Florida, rsagr@me.com

Follow this and additional works at: http://scholarcommons.usf.edu/etd
Part of the Databases and Information Systems Commons

Scholar Commons Citation
Blind and Visually Impaired Users Adaptation to Web Environments: A Qualitative Study

by

Raneem R. Saqr

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy
Department of Information Systems and Decision Sciences
Muma College of Business
University of South Florida

Co-Major Professor: Anol Bhattacherjee, Ph.D.
Co-Major Professor: Rosann Webb Collins, Ph.D.
Alan R. Hevner, Ph.D.
Balaji Padmanabhan, Ph.D.

Date of Approval:
May 6, 2016

Keywords: use patterns, adaptive IS use, disability, browsing behavior

Copyright © 2016, Raneem R. Saqr
DEDICATION

This dissertation, except for its shortcomings, is dedicated to:

My father who instilled in me a love for knowledge.

My mother who her prayers have guided me through life.

My husband and best friend who believes in me even when I don’t believe in myself.
AKNOWLEDGMENTS

I would like to express my deepest gratitude to my advisors Dr. Rosann Webb Collins and Dr. Anol Bhattacherjee for their support and guidance throughout this dissertation work.
TABLE OF CONTENTS

List of Tables ..............................................................................................................................................iv

List of Figures ...........................................................................................................................................v

Abstract ......................................................................................................................................................vi

Chapter One: Introduction ........................................................................................................................1
  1.1 Context of Study ..................................................................................................................................3
     1.1.1 The Case of Disability in America .........................................................................................3
     1.1.2 Legislation and Laws ................................................................................................................5
     1.1.3 Conceptualization of Disability ..............................................................................................7
     1.1.4 Visual Disability ......................................................................................................................11
     1.1.5 Technology and Visual Disability ..........................................................................................11

Chapter Two: Literature Review ...............................................................................................................13
  2.1 Information System Use ....................................................................................................................14
     2.1.1 Information System Use Patterns and User Adaptation .......................................................15
  2.2 Browsing Strategies for the Blind and Visually Impaired Users .....................................................18
  2.3 Web Accessibility: Guidelines and Measures ..................................................................................23
     2.3.1 Evaluating WAI Guidelines and Accessible Websites .......................................................25

Chapter Three: Interviews ........................................................................................................................30
  3.1 Data Collection and Participants .........................................................................................................31
  3.2 Interview Questions ............................................................................................................................32
  3.3 Data Analysis Methods and Procedures ............................................................................................33
     3.3.1 Open Coding .............................................................................................................................33
     3.3.2 Axial Coding ..............................................................................................................................34
     3.3.3 Selective Coding .......................................................................................................................34
  3.4 Results ................................................................................................................................................35
     3.4.1 Preliminary Open Coding .........................................................................................................35
     3.4.2 Initial Conceptual Model ..........................................................................................................37
     3.4.3 Coders Training .......................................................................................................................38
Chapter Four: Online Surveys ................................................................. 66
  4.1 Data Collection and Participants .................................................. 66
  4.2 Survey Questionnaire .................................................................... 67
  4.3 Data Analysis Methods and Procedures .......................................... 68
  4.4 Results .......................................................................................... 68
     4.4.1 Descriptive Analysis ............................................................... 68
     4.4.2 Identified Challenges .............................................................. 69
     4.4.3 User Adaptation Strategies ...................................................... 73
     4.4.4 Final CodeBook ..................................................................... 74

Chapter Five: Observational Tasks...................................................... 76
  5.1 Data Collection and Participants .................................................. 76
  5.2 Observational Setting and Tasks ................................................... 77
  5.3 Data Analysis Methods and Procedures .......................................... 80
  5.4 Results .......................................................................................... 80
     5.4.1 Participants Overview .............................................................. 82
     5.4.2 User Adaptation Strategies ...................................................... 86

Chapter Six: Discussion and Conclusion ............................................. 88
  6.1 Discussion ..................................................................................... 88
     6.1.1 Building the Conceptual Model ............................................... 88
     6.1.2 General Discussion ................................................................. 98
     6.1.3 Methodological Rigor ............................................................. 103
  6.2 Contributions of the Study ............................................................ 105
     6.2.1 Research Implication ............................................................... 105
     6.2.2 Practical Implication ............................................................... 106
  6.3 Limitations ................................................................................... 108
  6.4 Conclusions ................................................................................ 109

Chapter Seven: Future Research .......................................................... 111
  Enhanced Design Experiment ............................................................ 111
  Eye Tracking and Adaptive Interface .................................................. 114
References ........................................................................................................................................ 117

Appendices .................................................................................................................................... 128
  Appendix A: Table 1A Studies on BVI Behaviors ................................................................. 128
  Appendix B: Interview Informed Consent ................................................................. 134
  Appendix C: Interview Protocol .................................................................................. 135
  Appendix D: An Open Coding Example ..................................................................... 137
  Appendix E: Sample of Online Survey ................................................................. 139
  Appendix F: Observation Informed Consent .......................................................... 142
  Appendix G: Observational Task .................................................................................. 143
  Appendix H: IRB Study Approval .................................................................................. 144
LIST OF TABLES

Table 1. Browsing Behaviors of BVI ................................................................. 21
Table 2. WCAG 1.0 vs. WCAG 2.0: adapted from Peters et al. (2010) .................. 25
Table 3. Initial Codebook .............................................................................. 35
Table 4. Interview Study Participants .............................................................. 40
Table 5. Summary of Blind and Visually Impaired Users Challenges ................. 45
Table 6. Summary of BVI users’ adaptation strategies .................................... 56
Table 7. Online Survey Sampling-Quota ......................................................... 66
Table 8. Summary statistics of survey participants .......................................... 69
Table 9. Final Codebook Addition .................................................................. 74
Table 10. Observational Tasks ....................................................................... 79
Table 11. Observation Study Participants ......................................................... 80
Table 12. Task Completion and Time Comparison .......................................... 81
Table 13. Observational tasks challenges ....................................................... 86
Table 14. Observation participants’ user adaptation strategies ....................... 87
Table 15. Axial Coding Examples .................................................................. 89
Table 16. Potential Experimental Study Design .............................................. 114
LIST OF FIGURES

Figure 1. Interaction of ICF’s components (WHO, 2001) .................................................. 10
Figure 2. Initial Stages of developing the conceptual model .............................................. 38
Figure 3. Observational Task 2 example ........................................................................... 78
Figure 4. Task 1 challenge example ................................................................................... 83
Figure 5. Task 2 challenge A example ................................................................................ 84
Figure 6. Task 2 challenge B example ................................................................................ 84
Figure 7. Coding process for the theme of Disability ......................................................... 90
Figure 8. Coding process for the theme of Individual Differences .................................... 91
Figure 9. Coding process for the theme of Design Features .............................................. 92
Figure 10. Coding process for the theme of Assistive Technology ................................... 93
Figure 11. Coding process for the theme of User Adaptation .......................................... 94
Figure 12. Coding process for the theme of Use Outcomes .............................................. 95
Figure 13. Study Conceptual Model ................................................................................. 98
ABSTRACT

Although much research exists on human behavior in online environments, research on users with disabilities is still rare. To draw more attention to this population, this dissertation explored browsing patterns and adaptive behaviors of people with visual disability across different online environments common in daily activities: social network, e-commerce, online information, and search engines’ websites. The main objective of this study is to propose a conceptual framework of how blind and visually impaired users browse and adapt to different web environments. We achieve this objective using a qualitative approach through three studies. In the first study, the researchers collect data by means of in-depth, semi-structured interviews with six users with different levels of visual impairment. In the second study, we use survey questionnaires with open-ended questions to reach a larger sample of study participants. Finally, we conduct a follow-up observational study as means to confirm our results. Open, axial, and selective coding are used for data reduction and analysis as part of the grounded theory method.
CHAPTER ONE:

INTRODUCTION

Technological progress has had a tremendous impact on our lives. Yet, technologies are still inefficient to use by people with disabilities, especially the visually impaired. The Internet in particular and associated business models and applications, are having a significant impact on many aspects of people’s private, social, and professional lives (Amit & Zott, 2001; Webster, 2014). Addressing the impact of web technologies on blind and visually impaired users creates opportunity for research to explore a different set of questions regarding not just the impact and importance of information systems (IS) in the lives and routines of this special user group, but also the role this population can play in specifying better technologies and systems that suit their needs.

Recent research on IS and users with disabilities, although still very rare, has focused predominantly on questions of accessibility (Federici et al., 2005; Jaeger, 2004; 2006; Keller et al., 2001; Loiacono & McCoy, 2004; Saqr & Bhattacherjee, 2012). A few

---

1 Portions of this chapter have been previously published in Proceedings of the Eighteenth Americas Conference on Information Systems, Seattle, Washington, August 9-12, 2012.
authors further investigated issues related to the needs and requirements for disability determination from a medical perspective (Feldman et al., 2011), the digital disability divide and social inclusion (Vicente & López, 2010; Watling, 2011), stigma associations and disguise in online environments (Jaeger et al., 2013), and identification with virtual avatars (Stendal et al., 2012).

The majority of research concerns web-accessibility with a focus on the inclusive features of certain applications or potential improvements (Feldman et al., 2011; Loiacono & McCoy, 2004). The perspective of the psychological motives for using these systems and on how improvements are perceived remain largely unexplored in the IS domain. In other words, prior research has focused on how IS impacts people with disabilities rather than on how people with disabilities perceive or use IS.

To understand this special need population, this dissertation draws on disability literature, IS use pattern and user adaptation literature, and ecological rationality framework to employ an interdisciplinary approach that proposes a model to explore and identify the needs, challenges, motivations, and pattern behaviors from the perspective of the blind and visually impaired (BVI) users when using websites. We also put forth design recommendations for each web environment to help web designers become better informed of the real needs and strategized of this population. Thus, we have the following research questions:
1. What are the factors (technological or personal) that influence visually impaired users behavior in various web environments?

2. How do people with visual impairments adapt their browsing to different web environments in order to achieve desired outcomes?

In the following sections, we provide a general overview of the study’s context which includes people with disability in the United States, laws and legislation concerning disabilities, disability models, and existing technologies for people with visual impairments. The rest of the dissertation proceeds as follows: Chapter Two reviews relevant research of the different studies on IS use patterns, user adaptation behavior, web accessibility as well as the use of technology and websites by the blind and visually impaired population. Chapter Three describes the dissertation methods employed. We present a detailed description of the qualitative methods and coding process implemented. Chapter Four presents our findings of the different studies conducted and the study’s proposed conceptual model. Finally, Chapter Five and Six presents our discussion, expected contributions and conclusion.

1.1 Context of Study

1.1.1 The Case of Disability in America

According to the United States Census Bureau, nearly one in five people in the United States have a disability. The census reports that more than 56 million people –
19% of the population – had a disability in 2010, according to a broad definition of
disability (U.S. Census Bureau, 2010), an estimated 25 million of whom suffer from
some level of vision loss. (National federation of the Blind, 2010) This number
percentage is projected to increase as the American population ages. (U.S. Census
Bureau, 2014) Though advancements in technologies have improved many aspects of
our lives in a general sense, the disabled population has not seen their fair share of these
benefits. Very little effort has been made to understand the needs of disabled people or
design technologies addressing their needs.

Nowadays, the Internet is a ubiquitous technology. Its ubiquity has greatly
helped many industries such as commerce, education, and services to improve their
offering and increase efficiency. Advocates for disabled Americans are demanding that
legislations concerning people with disabilities to be able to leverage the Internet and
related technologies to improve their lives. There is a legal mandate on government
websites or government funded websites to be accessible to the disabled population, yet
the majority of public websites are not accessible. Thus, people with disabilities,
specifically individuals with vision impairment, are facing many challenges when using
the Internet.

The National Federation of the Blind (NFB) has filed lawsuits claiming that
companies have a legal obligation to make their websites as accessible as their stores.
They aim to make companies to install the digital version of the brick and mortar
accessibility advantages. (Palazzolo, 2013) According to The Wall Street Journal, the NFB and the National Association of the Deaf have won legal suits against companies such as Target and Netflix regardless of the companies’ argument that their websites are beyond the scope of the American Disability Act. Trying to avoid bad publicity and increase their market share, several other companies, including eBay Monster.com and Ticketmaster, have worked with the NFB to make their websites more accessible to people with disabilities. (Palazzolo, 2013)

In an effort to adapt laws to technology, “The U.S. Department of Justice is expected to issue new regulations on website accessibility later this year that could take a broad view of the ADA’s jurisdiction over websites (Palazzolo, 2013)”. Some argue the law is not the right instrument to ensure accessible websites and that this is a huge burden on companies. A counter argument is that, while the cost of making a website accessible depends on its complexity, it is much cheaper to build an accessible website than to retrofit an existing one. According to Wentz et al. (2011), companies are expected to spend about 10% of their total website costs on retrofitting, but only spend between 1% and 3% to build accessible websites from the start.

1.1.2 Legislation and Laws

Many countries around the world have enacted legislations to ensure individuals in different groups are not discriminated against, including people with disabilities. In many countries, web-based information provided by the government must be
accessible. The United States, United Kingdom, Australia, and countries in the European Union have legislation in force to ensure that the disabled has equal accesses over the Internet. Those legislations include the use of accessible technology and design on the web. (Adam et al., 2006; Peters et al., 2010)

In the United States, the Rehabilitation Act was updated in 1998; “Section 508” states the electronic and information technology used by federal agencies and federal supported agencies should be accessible to people with disabilities. Section 508 identifies specific requirements to ensure technology accessibility to disabled user2. Currently the legislation only applies to federal and governmental websites and not private sector websites, which are the majority (Adam et al., 2006; Peters et al., 2010). Due to a number of lawsuits filed in the past few years by the NFB, the U.S. Department of Justice is expected to update the legislations to include a broader sector to the web accessibility mandate (Palazzolo, 2013).

In October 1999, the United Kingdom Disability Discrimination Act (DDA, 1995) made discriminating against disabled people by denying them service or providing them with a worse or lower standard of service against the law. Service providers are expected to adjust their services, facilities, and products to be accessible to the disabled. In 2002, the Disability Rights Commission included website providers in the category of

2 Section 508 guidelines are comparable to W3C’s Web Accessibility Initiative’s (WAI) Guidelines.
“service providers,” making them comply with the law. Similar legislations and acts are found across the European Union and Australia. (Adam et al., 2006; Peters et al., 2010)

Furthermore, The United Nations General Assembly adopted the Convention on the Rights of Persons with Disabilities in 2006. Article 9 of the Convention addresses accessibility and specifies state parties should ensure the equal access of people with disability to information technologies and systems, including the Internet. The article also promotes the inclusion of people with disabilities in information technologies and systems life cycle to improve product outcome and reduce cost.

Clearly, the main purpose of all the above-mentioned policies is to enable persons with disabilities to live independently and participate fully in all aspects of life.

1.1.3 Conceptualization of Disability

The search for agreement on what constitutes a disability has been continuing for decades (Iezzoni & Freedman, 2008; Mitra, 2006). There have been many attempts to conceptualize disability from various viewpoints including medical, social, and political perspectives. Prior studies focused on two prominent disability models: the medical model and the social model.

The medical model of disability views disability as a ‘problem’ that belongs to the disabled individual. It views disabilities as a medical condition or disease; people with disabilities are considered as individuals with limitations and their contribution to the society is restricted to them being “cured” (Toboso, 2010).
During the 1980s, the disability movement emerged with its theoretical expression of the social model of disability. Instead of accepting the medical approach, the social model of disability adopted the approach that the disability was a result of a dysfunctional social system preventing their participation and excluding them. This social exclusion led the disabled from having access equal to that of the non-disabled. Shakespeare (1992) claimed the real success of the disability movement was that it shifted the focus from the physical disability to the root cause of it: discrimination and prejudice. In contrast to the medical model, the social model argues that while the medical facet of disability is undeniable, far more important is the salient role played by features of the environment (social and physical) in creating the disadvantages people with disabilities experience (Bickenbach et al., 1999; Kurzban & Leary, 2001; Park et al., 2003; Preston & Rajé, 2007).

In 1976, the World Health Assembly of the World Health Organization (WHO) paid tribute to the social model of disability by approving a classificatory instrument incorporating a version of the social model (Bickenbach et al., 1999). The International Classification of Impairments, Disabilities and Handicaps (ICIDH) was published in 1980 (WHO 1980). One year after the publication of the ICIDH, Disabled People International (DPI) provided a competing classification of disability based on a proposal presented by the Union of the Physically Impaired Against Segregation (UPIAS). In contrast to the ICIDH, the UPIAS proposal offered a two-element model, which used
the terms ‘disability’ and ‘handicap,’ although the latter was later changed into ‘impairment’ (Barnes, 1991; Driedger, 1989) and provided the best definition of these two key concepts:

Impairment: Lacking part or all of a limb, or having a defective limb, organism or mechanism of the body;

Disability: The disadvantage or restriction of activity caused by a contemporary social organization which takes no or little account of people who have physical impairments and thus excludes them from the mainstream of social activities.

Taken together, the definitions have the virtue of explicitly stressing the importance of the social environment. Following the UPIAS model, disabled people are those with impairments who experience disability as a collection of socially induced discriminatory restrictions that limit opportunity for full and equal participation (Bickenbach et al., 1999). The UPIAS model implicitly stresses the socially exclusive potential of a disability. It refers more to functional limitations as found in the ICIDH under the term disability. The social implication of the UPIAS model was further stressed by the UPIAS statement “in our view, it is society which disables physically impaired people. Disability is something imposed on top of our impairments by the way we are unnecessarily isolated and excluded from full participation in society. Disabled people are therefore an oppressed group in society” (UPIAS, 1976).

Another definition of disability frequently applied in recent research is based on the International Classification of Functioning, Disability and Health (ICF) introduced
in 2001. Since then, a growing number of authors have focused on the ICF-based
definition of disability (Cerniauskaite et al., 2011). The ICF model integrates the medical
and social models of disability and aims at achieving a comprehensive definition by
combining biological, individual, and social aspects (WHO, 2001).

According to the ICF model, disability is a dynamic complex interrelationship
between the health condition of an individual and various contextual factors (WHO, 2001). The interaction between health condition and the contextual factors might have
an impact on body functions and structures, activities, and social participation (WHO, 2001). According to the ICF model, a disability constitutes the “difficulty in functioning
at the body, person, or societal levels, in one of more life domains, as experienced by an
individual with a health condition in interaction with contextual factors” (Leonardi et
al., 2006). Figure 1 illustrates the ICF and its components.

![Figure 1. Interaction of ICF’s components (WHO, 2001)](image-url)
1.1.4 Visual Disability

Although many kinds of disability exist, broadly classifiable into mental, sensory (e.g. visual, auditory), and physical disabilities (Bickenbach et al., 1999), the remainder of this dissertation is focused on people with visual disabilities. The primary reason focusing on blind and visually impaired users is that the majority of technologies are designed with the sighted individual in mind. Thus, people without sight struggle the most when interacting with technological interfaces (Panchanathan et al, 2012).

The WHO classification of visual impairment covers a wide range of vision impairment. When the vision in the better eye with best possible glasses correction is:

- 20/30 to 20/60 is considered mild vision loss, or near-normal vision
- 20/70 to 20/160 is considered moderate visual impairment, or moderate low vision
- 20/200 to 20/400 is considered severe visual impairment, or severe low vision
- 20/500 to 20/1,000 is considered profound visual impairment, or profound low vision
- Less than 20/1,000 is considered near-total visual impairment, or near total blindness
- No light perception is considered total visual impairment, or total blindness

1.1.5 Technology and Visual Disability

The limited literature on technology support for the disabled suggests technology can play a large role in integrating people with disabilities in society and offer them experiences typical of normal people. Much of this research focuses on technologies to assist the disabled in a learning environment. Many projects were
carried out to enhance the experience of students with physical, sensory, and mental disabilities (Williams et al., 2007). Prior research points out a few library and information services specialized to the needs of the visually impaired. Those that relate to technology are (Babalola & Yacob, 2011):

- Talking books and newspapers: audio versions of books and periodic that are pre-recorded.
- Screen magnifiers: software that enlarges text and content such as Zoomtext.
- Screen readers: software that reads out the content to the user such as Windows-Eyes and Apple VoiceOver.
- Voice recognition software: software that enables users input/output data and commands through speech such as Dragon.

Some of the above technologies, namely screen readers and screen magnifiers, help improve website accessibility among the visually impaired population. However, we do not know to what extent the improved accessibility translates into actual use of websites among the visually impaired. In other words, does the improvement of website technical accessibility make the whole website accessible for use by this population?
CHAPTER TWO:

LITERATURE REVIEW

The purpose of this study is to form a deep understanding of the browsing behaviors of blind and visually impaired IS users. Specifically, I aim to explore, describe and identify the different use pattern behaviors of this population in different online environments. To carry out this qualitative study, it is important to examine the current state of the literature.

In light of the proposed research questions, three main areas of the literature are reviewed: (a) IS use, including IS use patterns and adaptive IS use, (b) blind and visually impaired users’ behaviors on online environments, (c) web accessibility for the disabled population in general and BVI in specific.

To conduct this selected literature review, I used multiple information sources, including professional journals, books, dissertations, and credible Internet resources. Most articles were collected via a computerized search of the ABI/Inform online database.

---

3 Portions of this chapter have been previously published in Proceedings of the Eighteenth Americas Conference on Information Systems, Seattle, Washington, August 9-12, 2012.
database. The keywords used in the search were: disabilities, information systems, information technology, IS use patterns, adaptive use, vision impairment, and web accessibility. These articles were examined, synthesized, and analyzed, results of which are presented below.

2.1 Information System Use

Information system literature is very rich in explaining and measuring system usage (Barki et al, 2007). System usage is conceptualized in four different research domains: IS acceptance, IS success, IS implementation and IS as a decision making tool (Burton-Jones and Straub, 2006). When it comes to IT adoption and use, there is an extensive research on the behavioral and cognitive antecedents of system usage, which was determined from theories such as the theory of reasoned action and the theory of planned behavior. IS acceptance theories have evolved over time to reach a unified consolidated theory of IT acceptance and use. (Venkatesh et al, 2003) In IS success models, system usage was not only a dependent variable resulting from system and information quality, but also an antecedent to determine the impacts and benefits of IT on individuals and organizations. (DeLone and McLean 1992) In the IS implementation domain, researchers look at system usage as dependent variable determined by the implementation process. Specifically, researchers looked for the key characteristic of IT implementation that results in greater use of the implemented systems (Burton-Jones and Straub, 2006). Finally, researchers study the positive characteristics of system usage
that leads to better decision making. In other words, in this domain, IT is a tool to improve and reach better informative decisions.

Although such extensive research is found in the conceptualization of system use in different IT domains, there is little known on the IS use pattern behaviors and the impact of these behaviors on performance (Ortiz de Guinea and Webster, 2013).

2.1.1 Information System Use Patterns and User Adaptation

Responding to Burton-Jones and Straub (2006) calls for more in-depth research to re-conceptualize the IS use construct, Ortiz de Guinea and Webster (2013) conducted a study to conceptualize IS use patterns. They developed their conceptualization drawing on coping, affect-object and automaticity theories. Their main objective was to postulate how different use patterns appear/disappear as a result of different IT events, and how these use patterns influence performance. Based on changes in three pattern components; emotions, cognition and behavior, they were able to identify two IS use patterns, automatic and adjusting. In the automatic IS use pattern the user interacts with the system during expected events to perform straightforward tasks. Whereas in adjusting IS use pattern the user employs adaptive behavior when faced with unanticipated (negative) IT event.

In a similar vein, Beaudry and Pinsonneault (2005) extended the coping theory to IT context and proposed a Coping Model of User Adaptation (CMUA). The authors argued that user adaptation behavior is very similar to the concept of coping and
defined it as the “cognitive and behavioral efforts exerted by users to manage specific consequences associated with a significant IT event that occurs in the environment.”

Beaudry and Pinsonneault (2005) postulated that a combination of primary appraisal (assessment of expected consequence of IT event) and secondary appraisal (user control over the IT event) will lead to different adaptation strategies (different levels of problem- and emotion-focused adaptation). They identified four adaptation strategies (benefits maximizing, benefits satisficing, disturbance handling, and self-preservation) that result in three different individual-level outcomes (restoring emotional stability, minimizing the perceived threats of the technology, and improving user effectiveness and efficiency). Based on this research, Fadel (2011) explored the effect of different adaptation behaviors employed by IS users on IS infusion. The result of this research illustrated that problem-focused adaptation behaviors promote infusion while avoidance-oriented emotion-focused adaptation behavior reduce infusion.

When it comes to the adaptation behavior of users in web environments a smaller number of studies investigated online user adaptation. Drawing on the technology acceptance model (TAM) and adaptive structuration theory (AST), Bhattacherjee and Harris (2009) proposed a high-level abstraction of user adaptation in an online environment (MyYahoo). The authors proposed adaptation usefulness, adaptation ease of use and IT adaptability as constructs predicting user-level IT
Adaptation. They further postulated that user IT adaptation will have an effect on subsequent IT usage.

Investigating user adaptation behavior at a deeper level, Tseng and Howes (2015) conducted a study on the visual search strategies that people choose during a search engine task. This research reported a computational model of adaptive strategies given the constraints by “the natural ecology of images of the web, the human visual system and the task demands.” The authors proposed computational parameters that result in optimal adaptation to the above mentioned constrains. The resulting strategic parameters that led to optimal adaptation were adjustments to gaze duration and number of fixations.

The above mentioned research focus on the individual user adaptation behavior; what, how and why users adapt themselves and/or their IS use to a specific IT event and/or environment, which is the scope of this dissertation. To make our scope better understood when it comes to IS adaptation, we adapt Goy et al (2007) distinction between adaptable systems and adaptive ones. In adaptable systems, the user decides the adaptation; she explicitly customizes the system to receive a personalized service. In adaptive systems, however, the system autonomously performs the adaptation without any direct user intervention. Adaptability and adaptivity may co-exist within the same system. For our research study we are focusing on the former.
In the adaptive systems literature, system adaptivity is approached in two research streams. First, the adaptive user interface studies, which focused on automatically adapting the interface based on user characteristics such as user preferences and history. To illustrate, Hawalah and Fasli (2015) introduced a set of methods to capture and track users interests and maintain dynamic user profiles within a personalized system. Zhou et al, (2014) proposed methods to adapt the interface colors to be more suitable for the color vision deficiency (for more examples see Kardara et al, 2013; Yang and Shao, 2007). Second, the adaptive interface across devices studies (e.g. from desktop to mobile phones). A very good example of this approach is Adipat et al (2010) who proposed a hybrid approach to adapting mobile web that integrates tree-view, hierarchical text summarization and colored keyword highlighting. (for more examples see Zhang et al, 2015; Ahmadi and Kong, 2012; Zhang and Lai, 2011).

2.2 Browsing Strategies for the Blind and Visually Impaired Users

This dissertation focuses on browsing behaviors and not searching behaviors of people with vision impairments. According to Marchionini (1995), a fundamental distinction exists between searching (or analytic) search strategies and browsing search strategies. “Analytical strategies depend on careful planning, the recall of query terms, and iterative query reformulations and examinations of results. Browsing strategies are heuristic and depend on recognizing relevant information.” Since we are looking at
different daily browsing behavior of people with disability while surfing the Internet, we also focus on “browsing” behaviors; analytic information searching strategies require a user to be more active than does a “browsing” strategy (Cothy, 2002).

Many studies have covered the behaviors of individuals while browsing the Internet. These studies included different demographics, web settings, and motivations (Kumar & Tomkins, 2010; Torres & Hiemstra, 2011; Goel et al., 2012). Most studies used data logs as a data collection method. However, a smaller number of studies looked into the behaviors of blind and visually impaired individuals in the web setting. Most of the studies in Table 1A (Appendix A) discuss the navigational behaviors and strategies in circumstances where the visually impaired face a challenge or obstacle while navigating the web.

Harper and his colleagues conducted a series of studies concerning the browsing behavior and coping strategies of visually impaired users. Their earlier set of studies (Harper et al., 2000; Goble et al., 2000; Yesilada et al., 2003; Harper et al., 2003) employed the real-world travel metaphor to define the web mobility of the visually disabled. They identified browsing pattern, cues in the web that aid travel, and obstacles that hinder travel for the visually impaired. In other studies (Vigo & Harper, 2014; Vigo & Harper, 2013a, b; Lunn et al., 2011), the researchers focused on the challenges the visually impaired faced while browsing websites and identified coping tactics such as impulsive clicking, exploration tactics, re-doing, and giving up. These
studies used coping theories and considered the visually impaired adaptive strategies as coping mechanisms.

A few other researchers also explored the coping strategies blind and visually impaired users employ when faced with a challenging situation while browsing a website. Bigham et al. (2007) conducted a wide-ranging remote study using a proxy to record the web pages visited and the keystrokes users made to determine their coping strategies compared to sighted users. They found that when coming across accessibility barriers, some blind users make use of cursor keys, which is the functionality that simulates the use of the mouse by reading aloud the area of the page hovered. Visually impaired users were less likely than sighted participants to visit pages that contained either dynamic content or which issued AJAX requests. Similarly, Borodin et al. (2010) provided a detailed overview of existing web accessibility problems and described the coping strategies employed by screen reader users to overcome these problems. Browsing strategies identified in this study include increasing the speech rate of the screen reader, exploring the visual interface with a keyboard-driven mouse, and falling back to external help.

Other studies explored the general navigational behavior of blind users who use screen readers. Takagi et al. (2007) investigated the navigability of E-commerce online shopping sites (30 sites), evaluated their accessibility status, and identified blind users’ behavior. Two key browsing behavior they identified were exhaustive scanning (a
scanning tactic by listening to content in a sequential fashion) and gambling scanning (by jumping forward and skipping a determined amount of lines until bumping into content that draws their attention). Trewin et al. (2010) described information seeking strategies observed in people with visual impairment using screen reading software for web navigation tasks and identified user strategies when using familiar and unfamiliar websites. Vigo et al. (2009) conducted a user test with 16 users to observe the strategies they followed when links were annotated with scores that indicate the conformance of the target web page to blind user accessibility and usability guidelines. They found that with annotated links, the navigation paradigm changed from sequential to browsing randomly through the subset of those links with high scores. The different browsing behaviors of blind and visually impaired (BVI) users identified by previous studies are listed in Table 1.

**Table 1. Browsing Behaviors of BVI**

<table>
<thead>
<tr>
<th>Identified Behaviors</th>
<th>Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heading Level Navigation</td>
<td>Borodin et al., 2010); Trewin et al (2010); Goble et al. (2000)</td>
</tr>
<tr>
<td>Probing/Previewing</td>
<td>Lunn et al (2011); Goble et al. (2000)</td>
</tr>
<tr>
<td>Increasing Speech Rate</td>
<td>(Borodin et al., 2010); Goble et al. (2000)</td>
</tr>
<tr>
<td>Re-doing/Re-starting</td>
<td>Vigo and Harper (2013a,b); Shinohara and Tenenberg (2007)</td>
</tr>
<tr>
<td>Asking for assistance</td>
<td>Vigo &amp; Harper (2014); Vigo &amp; Harper (2013), Goble et al (2000); (Borodin et al., 2010)</td>
</tr>
</tbody>
</table>
A small number of studies compared the browsing behavior of sighted and blind users. Brinkley and Tabrizi (2013) conducted a pilot study on the online behavioral habits of 46 Internet users, 26 of whom self-identified as having a visual impairment (either blind or low vision). Their findings showed differences exist between the online behavior of sighted users and users with visual impairments. These differences suggest the presence of a visual impairment may have a significant impact on information seeking and online exploratory behavior. Visually impaired participants indicated significant difficulties using websites of this type and were most severely challenged by social networking websites. Also, Michailidou et al. (2008) conducted an eye tracking study to investigate the browsing behavior of sighted users on nine web pages. They concluded that understanding how sighted users browse web pages would improve web accessibility for visually impaired users.

One key idea that emerges from this section of the literature is that adaptive strategies are shaped based on the constraints imposed by interface design, human visual system, cognitive styles and priorities of the users (Teseng and Howes, 2015; Belk et al, 2013). It is apparent that analyzing the structure of the environment and the resulting IS use patterns is an important addition to the IS use literature. We suspect these concepts are linked to the ecological rationality framework that focuses on the fit between decision strategies applied by minds in different environmental circumstance. Gigerenzer and his colleagues studied in details the notion of “ecological rationality”,
which involves analyzing the structure of the environment, the structure of heuristics (strategies), and the match between them. They proposed the *adaptive toolbox* concept. The adaptive toolbox contains a collection of fast and frugal heuristics (intuitive judgments and decision rules) that help human deal with their social and physical environments. In each environment, the adaptive toolbox uses simple rules for search, stopping and decision as building blocks. Heuristics that are matched to particular environmental structures allow the agent to be ecologically rational. Gigerenzer has identified a number of heuristics that work in a set of different environments, including but not limited to the recognition heuristic, fluency heuristic and take the best heuristic. (Todd and Gigerenzer, 2012) We believe that these concepts can be extended to the web environment context and BVI users. We predict that different browsing and decision strategies will be used in different environment constraints (e.g. website categories/layout, visual impairment level, challenges)

2.3 Web Accessibility: Guidelines and Measures

World Wide Web Consortium’s (W3C, 2005) Web Accessibility Initiative (WAI) views web accessibility as a circumstance whereby people with disabilities can effectively perceive, understand, navigate, and interact with the web. However, this is not a definition but rather an outcome of web accessibility. Moreover, the literature views web accessibility as an attribute of web design, as perceived by potential users, rather than a user attribute.
The most commonly used accessibility guidelines to help web developers make their web pages accessible for users with disabilities are the Web Content Accessibility Guidelines (WCAG) proposed by W3C’s WAI. Government as well as private companies and organizations use these guidelines. The proposed guidelines claim to cover the interface needs of most users with disabilities. However, they do not yet address the needs of users with cognitive impairment.

The first version of WAI guidelines was WCAG 1.0. Web accessibility is categorized and measured in terms of three levels of website feature priorities (W3C, 2008):

- Priority 1 (A): features that must be satisfied by the web content developer, such as providing text equivalent for non-text elements (e.g. images, graphical representations of text, video, etc.).
- Priority 2 (AA): features that should be satisfied by the web content developer, such as providing information about the general layout of a site (e.g., a site map or table of contents).
- Priority 3 (AAA): features that may be addressed by the web content developer, such as expanding each abbreviation or acronym in a document where it first occurs.

For a website to be considered accessible, it only needs to be in compliance with Priority 1 guidelines; it need not to be in compliance with Priority 2 and 3 guidelines.

WAI kept working on the proposed guidelines and updated them to WCAG 2.0. The new guidelines consist of four major guidelines: perceivable, operable, understandable, and robust. Perceivable means that an interface must provide suitable
alternatives for the different types of media presented. Operable means that all users can read and use the content, even from a keyboard alone, have enough time to read content, and be able to know where they are. Understandable means that content should be readable and easy to understand, and have predictable operation. Robust means that regardless of the technology used to access an interface, it should be able to be accessed (WC3, 2008). For each of the four guidelines, 18 checkpoints are defined. For each checkpoint, definitions, benefits, and examples are provided. Checkpoints are classified either as core or extended. To conform to WCAG 2.0, the core checkpoints must be satisfied; the extended ones are additional optional checkpoints. Table 2 demonstrates the differences between the two versions of guidelines.

<table>
<thead>
<tr>
<th>WACG 1.0</th>
<th>WCAG 2.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>Four Principles</td>
</tr>
<tr>
<td>14 Guidelines</td>
<td>12 Guidelines</td>
</tr>
<tr>
<td>67 Checkpoints</td>
<td>61 Success criteria</td>
</tr>
<tr>
<td>Three priority levels per checkpoints</td>
<td>Three priority levels per success criteria</td>
</tr>
<tr>
<td>Three levels of conformance</td>
<td>Five requirements for conformance</td>
</tr>
</tbody>
</table>

2.3.1 Evaluating WAI Guidelines and Accessible Websites

Many studies have empirically tested and evaluated the degree of accessibility of various websites, web accessibility guidelines, and their effectiveness when used by the visually impaired. A number of studies have evaluated the accessibility of different websites, ranging from federal websites to E-commerce websites. For example,
Loiacono et al. (2005) evaluated 417 federal websites and federal contractor websites using the Bobby tool⁴, and found only 23% of websites were compliant with section 508. White et al. (2005) evaluated the government websites of the 50 states and the District of Columbia and found that nearly a third did not meet the most fundamental requirements for web accessibility. Jaeger (2006) evaluated 10 federal websites, and they all had issues related to 508 web accessibility compliance. Olalere and Lazar (2011) recently evaluated the accessibility of 100 federal websites and their results show only 8% home pages were free of accessibility violations, and the 100 home pages had an average of 2.06 guidelines violated per site. Other examples of similar studies include Jackson-Sanborn et al. (2002) and Ellison (2004).

Moreover, Loiacono et al. (2005) evaluated the accessibility of the top online product/service sites in eight sectors and found that, from the 44 websites, only 15.9% were accessible based on the WAI Priority 1 guidelines. Another research examined the accessibility of 10 of the top E-commerce web sites, which offer online-only price specials. The results revealed multiple section 508 accessibility violations (Lazar et al., 2011). Fortune 100 companies were evaluated and only 27% were free from Priority 1 errors and user checks (Loiacono et al., 2005). Koutsabasis et al. (2010) tested 10 scientific E-Publishing homepages and found their accessibility was not satisfactory. In

---

⁴ The original Bobby was a free online tool used to validate websites for WAI and Section 508 compliance.
addition, Hackett and Parmanto (2005) evaluated 45 university websites and concluded that complex web designs increase barriers; higher education websites become progressively inaccessible as complexity increases.

Moreover, many studies have evaluated the effectiveness and the efficiency of the WAI guidelines. For example, Di Blas et al. (2004) evaluated WCAG 2.0 for visually impaired users and found these guidelines do not guarantee accessibility for visually impaired users. They argue the proposed guidelines only guarantee “technical accessibility.” They address problems related to bad use of technology. Moreover, automated tools evaluation and design guidelines fail to create fully accessible sites; there is no significant relationship found between WCGA conformance and disabled users performance and satisfaction (Disability Right Commission, 2004) and no significant agreement between users and researchers regarding the importance or priority rating provided by guidelines (Mankoff et al., 2005; Petrie et al., 2007). In general, there is too much focus on compliance instead of real usability.

From all these studies, we can conclude that despite the existence of these guidelines as benchmarks and despite the government policies encouraging accessibility, not all federal websites are fully compliant and most non-governmental websites do not follow these accessibility guidelines. For example, Harper and Chen (2011) conducted a longitudinal study comprising approximately 6000 home pages and found the adoption rate of accessibility guidelines over a 10-year period is only 10%.
Moreover, it is possible to build a website that follows the WAI guideline and is yet not accessible to visually impaired users. WAI guidelines are necessary but not sufficient in meeting the needs of this population.

The analysis of the literature review revealed several limitations and gaps. First, most current studies on IT adaptation tend to be exploratory rather than explanatory and they do not have any theoretical basis (Bhattacherjee and Harris, 2009). More research is needed to find theories specializing on not only the adaptive behavior of the general IS population but also this special group rather than trying to fit their behaviors into existing non-disabled theories and frameworks.

Second, most previous studies focused on improving the technology rather than on understanding the disabled users’ needs when interacting with the web. There have been experimental attempts to develop better technology to assist visually impaired individuals to access online content and propose alternative approaches to deal with web accessibility (Takagi et al., 2004; Askawa, 2005; Petrie, Weber, & Fisher, 2005; Jeong, 2008; Vigo et al., 2009). However, most studies have overlooked how these design features may influence the usage behavior of people with disabilities.

Third, it is still unclear how browsing behavior varies based on the different website environments that are browsed, and the specific use pattern behavior used to navigate these environments. In a recent study, Vigo & Harper (2014) called for more research to explore human adaptation to Web environments. The notion of “adaptive
toolbox” would be helpful to better understand the fit between a certain strategy and a task in a web environment.

Finally, further research is needed to improve the concept of web accessibility and the design of accessible websites, especially for the visually impaired. It is evident the technical accessibility by following WAI guidelines is not sufficient in providing an efficient browsing experience to the blind and visually impaired.

To add to the body of existing knowledge, we aim to further explore and identify browsing strategies and behaviors of blind and visually impaired users in online environments. These strategies are not only limited to extreme, challenging, or coping behaviors that result from discrepant IT events but also include general behaviors and adaptation to positive unexpected events. Also, unlike most previous research focusing on blind individuals who use screen readers, one of our objectives is to identify the strategies of users with different levels of vision impairment and the use of different assistive technologies. We plan to achieve these objectives by conducting a qualitative interpretive study using the grounded theory approach.
CHAPTER THREE:

INTERVIEWS

This exploratory qualitative study looks into the behavior of people with vision impairment when browsing different online environments (social networks, E-commerce, information, and search engines). I used qualitative methods, inductive analysis, and a grounded theory approach. There are many reasons to conduct a qualitative study. (Creswell, 2013) In this study, I used the qualitative method to explore and understand the complex needs and behaviors of this special group without predetermined information from the literature. I also used qualitative research to capture the perspective of the visually impaired users directly with a view to developing unique explanation specific to this subgroup instead of trying to fit their behavior into existing frameworks and theories.

In this study, we use analytic inductive means to determine the browsing behaviors drawn directly from respondents with visual impairments. Thus, we attempt to reveal implicit insights regarding approaches, issues, and perceptions of visually impaired users’ browsing behaviors. We use a series of exploratory methods with three goals in mind: (a) to explore and identify the different browsing patterns of the blind
and visually impaired users in different web environments, including their adaptive behavior in web environments, (b) to identify differences in browsing strategies across various website categories and visual impairment levels, and (c) to develop a theoretical framework of visually impaired individuals’ IS use pattern behaviors. To achieve these goals, I conducted three studies. In the first study, I conducted and analyzed six face-to-face interviews of people with vision impairment to explore and identify browsing challenges and behaviors. To reach a larger sample of blind and visually impaired users, I used an online questionnaire with mostly open-ended questions as a second study. Lastly, I conducted an observational study to understand how individuals actually use and interact with the technology to get an in-depth understanding and validation of our interviews and surveys results.

3.1 Data Collection and Participants

We recruited participants through the assistance of the USF Student with Disability Services (SDS). Study information was distributed via email and contained a detailed description of the study, consent form, and contact information to schedule interview meetings with the principal researcher. We also made a request to forward the study information to others outside the USF mailing list to reach a wider network. Six people with different visual impairments who fit the study criteria agreed to participate. Participants received $15 Amazon gift cards as a token of appreciation.
The first round of emails sent by the Student with Disability Services did not yield any respondents. A second round of request generated six prospective respondents. However, two of the prospective respondents did not fit the criteria of our target sample. For example, one respondent had an eye strain condition that is not considered a visual impairment case based on the visual equity categories we identified in chapter 2. necessitating the solicitation of additional respondents. Overall, the final group consisted of six qualified, visually-impaired respondents.

3.2 Interview Questions

The principal researcher conducted six interviews privately, in homes, university, or at public meeting places, over a period of five months. On average, each interview lasted 45 minutes. Before starting each interview, the interviewer explained the purpose of the interview, read aloud an informed consent document approved by the Institutional Review Board at the University of South Florida and requested their oral consent to participate in the study (Appendix B). The researcher assured participants that their responses was confidential and that, although they would be quoted in the research report, their names would not be disclosed. Respondents had the option of having their interview recorded. The interviewer took written field notes to record key responses and personal observations such as facial expressions, non-verbal cues, and figures of speech.
Interview questions were categorized under six key areas based on the research questions and the reviewed literature: (a) demographic and visual impairment information; (b) general Internet use information; (c) assistive technologies needed to browse website (d) browsing behaviors and approaches; (e) problems and challenges; and (f) individual affects and satisfactions. Follow-up questions were asked to delve further into or better understand interviewee responses. The interview protocol is provided in Appendix C.

3.3 Data Analysis Methods and Procedures

The qualitative interview data were analyzed inductively using the grounded theory process. The goal of the inductive analysis was to identify patterns, themes, and categories of analysis that emerge from the data (Patton, 1980). Coding was done iteratively; with each iteration, the researcher adjusted codes and themes to fit the concepts better.

I used NVivo qualitative data analysis software for data organization and management. NVivo helped assign open codes (substantive “labels”), including in vivo codes (respondents’ exact words), as well as to create coding/analytical memos (analysis of codes and themes) (Bowen, 2003). Coding was performed at three levels: open coding, axial coding, and selective coding.

3.3.1 Open Coding. In this first analytical step of analysis, I coded the interview data into discrete parts and then conceptualized them in order to reduce largely textual
data into manageable groupings (Strauss & Corbin, 1998). To open code the data, the researchers initially used the six categories of items in the interview guide (demographic and visual impairment information; general Internet use information; assistive technologies used; browsing behavior and approaches; problems and challenges; and individual satisfaction) as “labels” for the interview transcripts. Further open coding involved assigning more specific substantive labels or preliminary concepts.

**3.3.2 Axial Coding.** At this level, I examined the relationship among generated concepts. I further organized them, pinpointed concepts that seemed to cluster together, and formed more precise and complete explanations (Strauss & Corbin, 1998).

**3.3.3 Selective Coding.** In this coding step, I identified the central category of the study and systematically relating this central category to other categories. After that, “new data is selectively sampled to validate the central category and its relationships to other categories. (Bhattacherjee, 2012, p. 114-115)” When additional data failed to uncover any new ideas about the developing theory the coding process ended because “theoretical saturation” is reached. (Beck, as cited in Bowen, 2003)
3.4 Results

3.4.1 Preliminary Open Coding

One of my research advisors, who is an expert in qualitative coding, and I developed a coding schema (a list of themes) to guide subsequent coding of interviews. This list was based on an initial coding of three interviews (coded independently) and the key themes of IT use by the disabled population, as suggested by the research literature. The researchers compared their independent coding schemes to reach a final agreement on code categories.

The initial codebook used in the data generated from actual interviews is presented in Table 3. The initial codebook shows that we are able to elicit needed information relating to our research questions. One of the six coded interview transcripts can be found in Appendix D.

Table 3. Initial Codebook

<table>
<thead>
<tr>
<th>Code</th>
<th>Code Name</th>
<th>Code Description</th>
<th>Relationship to other Codes</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Personal Characteristics (CHAR)</td>
<td>Personal characteristics of the individual e.g. age, exp, personality traits</td>
<td>This is a main code. Sub-codes include: AGE, GEN, EDU, OCCU, EXP, PTRAITS</td>
<td>“58 Female”</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&quot;I am a high school graduate with some college courses&quot;</td>
</tr>
<tr>
<td>2</td>
<td>Vision Impairment (VI)</td>
<td>Vision impairment—specifically mentions any information regarding the vision condition and causes</td>
<td>This is a main code. Sub-codes include: VI-L, VI-O</td>
<td>&quot;I am totally blind. I lost my vision when I was 2 years old from retinoblastoma&quot;</td>
</tr>
</tbody>
</table>
|   | Purpose (PURP) | Purpose of use- mentions any reason to use websites | This is a main code. | "I visit sites to shop or read articles/stories."
|---|---|---|---|---
| 3 |  |  |  | 
| 4 | Web Category (ENV) | Web environments- the different categories of websites e.g. social networks, e-commerce | This is a main code. Sub-codes include: SNS ECO INF SRCH | "I visit Facebook, Google search, amazon.com, other shopping sites, several store sites, newspaper sites."
| 5 | Web characteristic (WEB) | Any characteristic of the web environment | This is a main code. | "some sites have a link to a more accessible version of their site. It is more straightforward with fewer graphics."
| 6 | Web Useful Feature (WEB-U) | Any feature (existing or suggested ) that makes a website useful | This is a main code. | "They have graphics, but most of them are labeled and they don’t seem to interfere."
| 7 | Ease of Use (EOU) | Any feature of the website that makes it easy to use, or example of easy to use websites | This is a main code. | "It is sometimes easier because mobile sites are simpler to navigate."
| 8 | Frequency of Use (FREQ) | Any mention of the frequency of website use | This is a main code. | "I use the internet several times a day"
| 9 | Interface used (INTERF) | Specifically mentions the interface and device used, why it is used and how it is used | This is a main code. Sub-codes include: PC MAC MOB TAB BRWSR | "I use a PC, netbook, or mobile phone.”
| 10 | Challenge (CHALL) | Any challenges and problem faced during website use or mention of specific website that was difficult to browse | This is a main code. | "Graphics are a problem if they are not labeled.”
| 11 | Enjoyment (ENJOY) | Any expression related to feeling of enjoyment or it’s opposite | This is a main code. | "It is very frustrating"
Table 3 (Continued)

<table>
<thead>
<tr>
<th></th>
<th>Successful Use (SUCCESS)</th>
<th>Any mention of successful use where the individual was able to complete/achieve task/goals</th>
<th>This is a main code.</th>
<th>&quot;I can perform searches for products easily, shop, review, anything I need to do easily.&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>Browsing Behavior (BB)</td>
<td>Any mention or description of browsing behavior</td>
<td>This is a main code.</td>
<td>&quot;I can move around a page as far as it goes just fine&quot;</td>
</tr>
<tr>
<td>13</td>
<td>Browsing Strategy (BS)</td>
<td>Any mention or description of browsing strategies that needs higher cognition than a simple behavior</td>
<td>This is a main code. Sub-codes include: Settings Search Assistance Probing Avoidance Giving Up Shortcuts Familiar Env</td>
<td>&quot;I can look quickly through the links and do word searches.&quot;</td>
</tr>
<tr>
<td>14</td>
<td>Assistive Technology (AT)</td>
<td>Specifically mention they type of assistive technologies used to be able to browse websites</td>
<td>This is a main code. Sub-codes include: SCREAD MAGNI</td>
<td>&quot;I use JAWS for Windows. It is a screen reader.&quot;</td>
</tr>
</tbody>
</table>

3.4.2 Initial Conceptual Model

After reviewing the initial codebook, one of my research advisors and I were able to identify main constructs from the data. In this initial stage of the analysis, we only applied open coding and organized themes into higher order categories. As illustrated in Figure 2, we were able to identify six main categories: Information Technology, which refers to the web environment features; Disability, which refers to the level and onset of vision impairment; Task, which refers to the nature and purpose of using a website; Technology Use, which refers to the different adaptation strategies employed by blind and visually impaired users; Individual Differences, which refer to an
individual’s personal characteristics; and Use Outcomes, which refers to the different outcomes that resulted from an individual use of websites.

**Figure 2.** Initial Stages of developing the conceptual model

### 3.4.3 Coders Training

Two graduate students majoring in anthropology and psychology were hired as coders. Both students had prior coding experience by virtue of their fields and working on research projects that required coding of interview transcripts.

The coders were trained as follows. First, I explained the purpose of the study, the process of data collection, and walked through the initial coding schema with the two coders. However, coders were encouraged to add new codes as they emerged from their analysis of the interview and survey transcripts.
Next, coders were asked to practice coding using one interview transcript and one survey transcript from this study. Coders did this in my presence so that I could answer any questions that they might have about the coding process. Upon completion of this practice session, the coders compared their coding outcomes with each other, followed by a researcher-led walkthrough of the coding to discuss which codes captured the respondents’ opinions most faithfully. Lastly, coders were asked to maintain a reflexive journal, in which they could record their thoughts related to the content, the coding process, and/or the project. Coders were asked to write in their reflexive journals at least once a week. The purpose of this journal was to understand why coders might have disagreed on coding certain sections of the transcripts and to resolve those differences via discussion and consensus after the coding was complete.

After the training, coders were given a timeline to complete coding all 56 transcripts (6 interviews and 50 surveys). However, to make sure that they are on the right path, a small set of transcripts were given to them and reviewed by the primary researcher before coding the remaining transcripts. Coders completed this process in a span of two months. Coders were compensated for their efforts at the standard graduate assistant rate of $12.67 per hour.

### 3.4.4 Coding of Interview Transcripts

In this section, we first demonstrate the case of each of the six individuals interviewed. Summaries of participants are meant to give the reader a better idea on
how people with different level of vision impairment interact with technology, the challenges they face, and their strategies of adapting to accomplish their goals. Table 4 presents the profile of the interview participants, their visual impairment level, and assistive technologies they used.

Table 4. Interview Study Participants

<table>
<thead>
<tr>
<th>ID</th>
<th>Disability</th>
<th>Onset</th>
<th>Assistive Technology (AT)</th>
<th>Specific AT</th>
<th>Age</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>Blind</td>
<td>Early – 3 months</td>
<td>Screen Reader</td>
<td>JAWS, VoiceOver</td>
<td>27</td>
<td>Female</td>
</tr>
<tr>
<td>P2</td>
<td>Blind</td>
<td>Early – 2 years</td>
<td>Screen Reader</td>
<td>JAWS</td>
<td>58</td>
<td>Female</td>
</tr>
<tr>
<td>P3</td>
<td>Blind</td>
<td>Early –Birth</td>
<td>Screen Reader</td>
<td>JAWS, VoiceOver</td>
<td>60</td>
<td>Female</td>
</tr>
<tr>
<td>P4</td>
<td>Blind</td>
<td>Late – 28 years</td>
<td>Screen Reader</td>
<td>JAWS, NVDA</td>
<td>58</td>
<td>Female</td>
</tr>
<tr>
<td>P5</td>
<td>Blind</td>
<td>Early – Birth</td>
<td>Screen Reader</td>
<td>JAWS</td>
<td>24</td>
<td>Female</td>
</tr>
<tr>
<td>P6</td>
<td>Visually Impaired</td>
<td>Early –Birth</td>
<td>Screen Magnifier</td>
<td>Zoomtext</td>
<td>38</td>
<td>Male</td>
</tr>
</tbody>
</table>

3.4.5 Participants Overview

Participant 1

This participant is a 27 years-old female who completed three years of university, but has no degree, and is currently unemployed due to disability. She is totally blind (no light perception) due to Retinopathy of Prematurity (ROP) since she was three months of age. She has used computers for 20 years. When using computers, her main assistive technology is the screen reader (JAWS or VoiceOver).

This user is extremely experienced in and familiar with assistive technologies, including multiple screen readers and browsers. She mentioned several challenges that
could arise while browsing different websites, along with her strategies to overcome them. She is also extremely motivated to use computers for browsing and other activities and very insistent on doing what she needed to do online. For example, she would contact customer care when issues arise with captcha images or PDFs.

**Participant 2**

This user is a 58 years-old retired female. She is a high school graduate with some college courses. She lost her vision when she was two years old from Retinoblastoma, a childhood eye cancer, and has been totally blind since.

She uses the internet several times a day for social sites, shopping, research, e.g. Facebook, Google search, Amazon.com, other shopping sites and newspaper sites. When browsing websites, she uses different devices (e.g. PC, laptop, smartphone) based on the availability of the device at the time. She mainly uses Internet Explorer because it works well with the JAWS screen reader.

This participant is fairly computer-savvy. She takes pride in adapting to a web environment that is not always designed for users like her. Also, she is determined to use the web despite the frustrations, however she is not as resilient as Participant#1; there’s a possibility that she gives up. This user really stressed on the importance of following the ADA guidelines when designing websites. In multiple occasion, she mentioned that these accessibility guidelines made her browsing experience less challenging.
Participant 3

This participant is a 24 years old female, who is currently working toward her bachelor degree. She was born with Leber’s Congenital Amaurosis (LCA), a rare inherited eye disease that appears at birth or in the first few months of life.

Similar to the first two participants, this individual uses the Internet for search, e-commerce, social networks and information purposes. She often uses either her laptop, or smartphone. She believes that Safari and Firefox are more stable than Internet Explorer. She mainly uses JAWS as her default screen reader but have also used WindowEyes, and SaToGo.

Like Participant#1 and Participant#2, she critiques certain websites but overall has a determined attitude to work around challenges of the web environment, as is evident from such comments as “one just has to learn how to navigate the sites”. However, she is not as sophisticated in her browsing strategies as the previous participants.

Participant 4

This participant is a 58 years old retired female, who started a foundation for the blind and visually impaired individuals. This user’s impairment onset was late in her life as a result of a car accident in 1979; her optic nerves severed in that accident and her vision deteriorated gradually to no vision.
This participant was an experienced computer user. Like other participants, she uses the Internet for research, shopping, finance, grant writing, personal use, reading newspapers and employment search. She mostly uses a Windows PC with either JAWS or NVDA screen readers.

Despite her computer skills, she is often frustrated with the tedium of navigating websites with poor accessibility. She stressed that using the web efficiently was critical to her work. Unlike other participants, this user has no reservations in asking for sighted assistance when websites and assistance technologies failed or when otherwise needed.

Participant 5

Participant #5 is a 60 years old retired medical transcriptionist female. She is totally blind since birth. She’s familiar with different devices: PC, laptop, Apple iPod and uses the device that is most convenient for her at the time. The Internet is an integral part of her daily routine; she uses it daily in her work and for personal use and social networking. Her choice of the assistive technology depends on the device used: JAWS screen reader for computers and Apple VoiceOver for mobile handsets.

Like the other participants, this woman is determined to use the web properly, despite challenges. While she is occasionally frustrated and may give up if websites are not accessible, she stresses that she will persist if she is really interested in a website’s content.
Having used computers since the mid-80s, this user has a considerably amount of knowledge of web environments; she was familiar with terms like Java and Flash.

One interesting observation about this participant is that she consistently tried to explain the challenges she goes through in terms that a sighted user would understand: "It is comparable to if a sighted person was reading the screen with a piece of paper covering everything but one line. You read the line, then move the paper down a bit to get to the next line." Described in such a way, browsing sounds very frustrating.

**Participant 6**

This user’s condition is different from the other participants. He is a 38 years old male who works as a certified public accountant (CPA). He has Congenital Glaucoma that left him with low vision in one eye (less than 20/200) and no vision in the other eye. He has this illness very early in his life and his vision has slowly degraded since then. Unlike other participants, he uses a screen magnifier, Zoomtext or Windows Magnifier, on his 27” monitor PC. His web use ranges from work-related tasks to personal-related tasks.

This user’s website accessible needs are somewhat different than screen reader users since he has a limited range of vision. However, he prefers that websites have a logical layout with appropriate colors and fonts. He believes if websites improve their contents and navigation, he can be more efficient in web browsing.
3.4.6 Identified Challenges

After examining each interview transcript thoroughly and reviewing the coders’ results, the analysis revealed 13 main challenging situations in which the 6 users faced problems of different natures. Table 5 outlines the summary of the challenges faced categorized by disability and assistive technology.

Table 5. Summary of Blind and Visually Impaired Users Challenges

<table>
<thead>
<tr>
<th>Disability Level</th>
<th>Assistive Technology</th>
<th>Challenge</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Blind</strong></td>
<td>Screen Reader</td>
<td>Unlabeled web elements (No ALT)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Captcha</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Audio and video interference w/AT</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inaccessible PDFs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Flash and Image-based elements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>constantly refreshing screen</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No feedback when clicking on a link or button</td>
</tr>
<tr>
<td><strong>Visually Impaired</strong></td>
<td>Screen Magnifier</td>
<td>Websites constantly changing layout</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Poor color contrast</td>
</tr>
<tr>
<td></td>
<td></td>
<td>italic fonts</td>
</tr>
<tr>
<td><strong>Shared</strong></td>
<td>Screen Reader &amp; Screen Magnifier</td>
<td>Information Redundancy &amp; Overload</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pop-up windows &amp; advertisements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>poorly-designed websites and tables i.e. not Accessible to AT</td>
</tr>
</tbody>
</table>

3.4.6.1 Screen Reader Users Challenges

When looking at the five screen reader users, we find that all of them are totally blind with no light perception. Thus, the challenges they face while navigating websites is based on the extent to which the website is accessible to the assistive technology they
are using and the structure of the website itself. Such problematic situations are mostly raised because of poorly structured websites, e.g. poorly labeled images, buttons and links, information redundancy, constantly refreshed screens, audio and video interference with screen readers, Flash and JAVA elements. The identified challenges are discussed in more details below.

**No ALT Text for Graphics, Buttons, Links or Images**

As a blind user, proper labeling is crucial when navigating the web; it’s how screen readers can identify the element on the screen to the user. When a user comes across an image, a button, or a link that is not labeled, she is either confused or frustrated because this information cannot be translated in a form that the screen reader can capture. All five screen reader participants (P1-P5) mentioned this problematic feature when giving an example of a challenging situation they have faced. For example, P1 explained that screen readers cannot interact with unlabeled elements in a website: “the fact that a website has unlabeled buttons also means the screen reader cannot interact with those buttons, so even if clicking them would provide you with information you need or allow you to place an order that isn't an option.”, P3 confirmed this stating that “Graphics make my JAWS useless. Unlabeled buttons make navigation impossible.” P2 also stressed that lack of labeling or having alternative text for such elements could make it hard on her to fully capture the concepts of a webpage, she said “It could be hard to understand the contents if there are lots of unlabeled graphics.” It is
also important to note that proper labeling is needed for blind and visually impaired users to understand the functionality of buttons or the description of images and graphs. For example, labeling a button as “button” is not really helpful for the user to understand the functionality of a button. An example of a better labeling could be “Next”, “Previous” or “Done”. Also gibberish labels are considered a challenge similar to no labeling. P1 explained her frustration with such issues “properly labeled buttons which describe what the button actually is/does instead of saying "button " are always a great help.... Websites whose links are labeled with "gibberish" for their link text (such examples are often found in image map links) could be greatly improved if text names for the links were provided. By "gibberish" I mean that a link might say something like 1234abcd.gif”

**Captcha**

Captcha is a visual and textual verification to determine whether or not the user is human. Over the years this verification method poses an accessibility challenge for blind and visually impaired individuals since it is image based. (May, 2005; Shea, 2015) All of the participant in this study, pointed out that captcha can be a real barrier when creating an account or completing a transaction. P2 explained “There was a shopping site where I wanted to buy something. I had to sign up for an account, and when I got to the end, there was a visual picture of numbers and letters that I would have had to type in in order to complete the transaction. Obviously, I couldn’t do that, so I couldn’t
accomplish my buy. These come up often and make posting, shopping, commenting, lots of things, impossible.” P1 confirmed this struggle “I still feel that websites which require interaction with captchas and provide no alternative ways of solving them are by far the most difficult. They can stop you from creating an account, changing a password for an existing account, chatting with a representative, or sending an online form with an inquiry related to the website or some product.”

Audio and Video Interference

When using a screen reader, any interfering voice can cause confusion to the user. Some websites when opened will automatically display a video, audio or play music. These sounds increase the cognitive load of blind and visually impaired users since they need more effort to distinguish between what the screen reader is reading from other sounds heard. P2 explained his frustration “Audio is horrible if it just starts playing when you open a page. It makes it impossible to hear the screen reader. It’s even hard to turn it off because you can’t hear the screen reader. It is very frustrating.” P3 confirmed “loud audio makes it so that I can’t hear my screen reader.” Similarly, P1 expressed the same inconvenience: “I find this an unpleasant and difficult process sometimes.” So did P4: “Too much audio is annoying while trying to hear speech output to navigate.”
Inaccessible PDFs

Many websites use PDF documents to deliver information or content to the user. For screen reader users not all PDF files are accessible to them. In an inaccessible PDF document, only an image scanned into a PDF document is represented inside the PDF file. These scanned documents are not accessible because screen readers are unable to recognize the text. Also, some PDF files do not include tags so that screen readers can distinguish between headings and identify content. (WebAIM, 2014) P1 avoided the use of a local transportation company explaining: “the timetables for its buses are not accessible at all since they are provided in an all but unreadable PDF document. Websites that use PDF documents to convey information are frustrating.”

Flash-Based Elements

It is known that “nearly all Flash content on the web poses notable accessibility issues for many users with disabilities.” (WebAIM, 2013) A screen reader user can only access flash content in liner manner based on how the developer has laid it out. In other words, those users cannot read through Flash content. Another reason that makes flash content difficult for screen readers to scan/read is the constant changing content of flash-based websites. (WebAIM, 2013) P1, P3 and P5 all expressed their difficulty in navigating such websites. P1 said: “websites full of flash elements are not usable at all” and P3 confirmed: “Facebook is a nightmare to operate. It’s flashed based.”
Constant Refreshing

Another problematic situation encountered by screen reader users is the constantly refreshing screen, “which makes it impossible to read anything before the screen switches content” as P2 explained. P1, also explained facing this challenge with certain stock-related websites and news websites especially when such websites “present you with no way to stop the auto-refresh.”

No Feedback

One of the situations that causes uncertainty and confusion to the blind and visually impaired users is when they perform an action and nothing happens; no warning or confirmation messages to indicate the result of their actions. P2 expressed such uncertainty as “Sometimes, a link or button does nothing when clicked on. Sometimes, it does something, but there is no feedback to let us know.” Also, while P4 was exploring a page and was not able to find what she was looking for, she commented: “if I misspell [a word] then I get nothing returned for my search argument”, when performing a word search to find desired information.

3.4.6.2 Screen Magnifier Users

Screen Magnifier users are individuals with a form of vision loss. However, they need content to be extremely enlarged for them to be able to see and read. Thus, the challenges they face when browsing websites is somewhat different from those of
screen readers. The challenges are not limited to the extent of which the website is accessible to the assistive technology, but also the design and layout of the webpage. Issue related to website colors, content fonts, and over all layout were all mentioned.

**Colors and Fonts**

Websites colors and fonts are one of the key features that can define an accessible website for visually impaired individuals who use screen magnifiers. When it comes to color contrast “Contrast is the visual effect caused by the difference between the brightness (luminosity) of adjacent foreground and background regions of a display. If either region (foreground or background) is bright and the other is dark, then we have high contrast. If the levels of brightness are close like light grey on white, or black on navy blue then the contrast is low.” (W3C, 2016) Another feature related to color is the website brightness. Some people with visual impairment such as those with blurred vision, often experience difficulty recognizing text with too much light. On the other hand, individuals with peripheral field loss cannot see well without light. Thus the balance of brightness is crucial for websites to be accessible to a wider range of people with visual impairment. (W3C, 2016) P5 explained his issues with website color schemes “when I invert the colors, [I want them] not to be very bright and unpleasant. I always invert the colors where the white becomes black and the black becomes white. However, some colors are looking very bright or a different color when I use the
inverter tool of my software.” Some visually impaired people invert color to create a greater contrast so they can distinguish the various element in the webpage.

In a similar vein, some font families are more accessible than others. It is known than san-serif fonts are much easier to read and seen by people with visual impairment [W3C]. Also, as P6 confirmed he doesn’t like “some italic fonts” and believes that to help this special group in having a better browsing experience “colors and font should be appropriate for visually impaired people.”

3.4.6.3 Shared Challenges

We found some overlapping challenges that we could identify for both Screen Reader and Screen Magnifier Users. These challenges are more focused on the presentation of information, general web accessibility features and icons/buttons functionalities.

Websites Layout

In general screen magnifier users do not see the entire webpage at once. Rather, they see enlarged segments of the page one at a time. When browsing unfamiliar websites, users first encounter with the website is learning the different functions, locations, layout, and over all navigation. On the other hand, with a familiar website users are more confident browsing and achieving their goals. One challenge that faces this group of users is the constant change in websites’ appearance and layout. This
creates an issue because users have to relearn where to look at the screen as P6 puts it “some of the websites are very difficult to navigate. It is very difficult to find the information and/or the link where I need to go. Often, they change their appearance and that creates issue for me because I have to relearn where to look at the screen. I do magnify the screen, so I see a small portion of the screen. I have to move around and look for items. If they often change their appearance, it will discourage me to go to that website.”

Screen reader users also believe that a familiar website and webpage layout is easier to navigate. P4 explains her struggle with websites that keeps altering its layout “sites constantly evolving like Facebook. I use the m.facebook.com because easy to navigate. But then I learn it and then it totally changes again and again.”

**Information Overload and Information Redundancy**

Some of the situations that illustrate overwhelming situations are too much information in a page and having the same information repeated makes browsing tiring and frustrating. P1, P2 and P6 all confirmed their frustration of information overload and redundancy. For example, P6 expressed his frustration: “they are getting more crowded and crowded. They should be easier to navigate... when it is too crowded and everything is placed illogically, it is annoying. When I cannot find info it is annoying.” In addition to frustration P4 expressed uncertainty: “Sites are cluttered with so much information that unsure if reading information correctly.”
Advertisements & Pop-up Windows

Any distractions from the content that the website present is unpleasant to sighted users. To blind and visually impaired users this irrelevant information such as advertisements and pop-up widows, hinder their use of websites as they interspersed with the text and cause confusion. An example of a confusing situation is the one faced by P1 when a webpage was full of advertisements: “The information I seek on sites can sometimes be a little more difficult to find if a website's pages are covered in advertisements.” Another frustration situation was explained by P6 when navigating the affordable care act website: “[this website] is awful. Windows do pop up to ask you to enroll when I need other thing to do and just look for information. When unwanted pops up come it is annoying.”

Poorly-Designed Websites

In general, both groups of assistive technology users mentioned that having an accessible website that follows the accessibility guidelines of the WAI or section 508 would be a tremendous help for them. Although the most updated guidelines have been available for designer and web developers since 2008 (W3C, WAI), some blind and visually impaired users’ challenges are related to the basics of the what these guidelines recommends. [11] In addition to the lack of accessibility features, poorly designed websites (e.g. no proper headings, no logical flow of information, broken links, … etc.) makes it more challenging for this population to grasp the full potential of what the
internet can offer to enhance their personal and professional lives. Moreover, the increased use of graphics and images in websites increases the challenge of screen reader users to navigate and/or accomplish web-related task. All six participants mentioned that graphics and images could hinder their web experience, for example P2 confirmed that “graphics make JAWS useless.”

Throughout the interviews users stressed on a number of enabling features that would make their web experience more efficient, successful and enjoyable. Most of these features are the solutions of the challenges they are faced with. They include: clearly labeled links, buttons and images, proper page headings, well-structured tables, content that isn't interrupted with advertisements, logical layout, appropriate color and font formats, and less graphics

3.4.7 User Adaptation Strategies

As a result of the challenges and problematic situations the blind and visually impaired users encounter while browsing websites, they employ certain strategies and tactics to overcome them or work around the present obstacles. Based on the interview transcripts we were able to classify such strategies into technology-related and behavioral-related. We refer to these strategies as adaptation strategies since the user “adapts” to the problematic situation presented and each adaptation strategy is triggered by different challenges, personality traits, and choice of assistive technology.
Table 6 summarizes the different adaptation behavior discussed in the following sections.

**Table 6. Summary of BVI users’ adaptation strategies**

<table>
<thead>
<tr>
<th>Adaptation Type</th>
<th>Adaptation Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technology Adaptation</strong></td>
<td>Force load mobile version</td>
</tr>
<tr>
<td></td>
<td>Use Safari &quot;reader mode&quot;</td>
</tr>
<tr>
<td></td>
<td>multiple AT at disposal</td>
</tr>
<tr>
<td></td>
<td>Use of extensions and Plugins</td>
</tr>
<tr>
<td></td>
<td>Change AT settings</td>
</tr>
<tr>
<td></td>
<td>Invert Colors</td>
</tr>
<tr>
<td><strong>Behavior Adaptation</strong></td>
<td>Using Hot Keys (shortcuts)</td>
</tr>
<tr>
<td></td>
<td>Search Functions</td>
</tr>
<tr>
<td></td>
<td>Use Familiar Environment</td>
</tr>
<tr>
<td></td>
<td>Probing/backtracking</td>
</tr>
<tr>
<td></td>
<td>Asking for Assistance</td>
</tr>
<tr>
<td></td>
<td>Avoidance</td>
</tr>
<tr>
<td></td>
<td>Giving Up</td>
</tr>
</tbody>
</table>

### 3.4.7.1 Technology Adaptation

To overcome some of the challenges, blind and visually impaired users alter certain aspects of the technology to cope with the presented obstacle. Such strategies include: using functionalities that some browser offers, changing settings of the assistive technology used and of webpage appearance and using web extensions. We consider these adaptation techniques as high-level knowledge that only experienced users are familiar with.
Force Loading Mobile Website Version

When participants are faced with a cluttered website or one that is difficult to use, they tend to force the website to switch to the mobile version. Mobile websites tend to be simpler and less cluttered than the desktop version, which help the blind and visually impaired to find the information they are looking for faster and more efficiently. For example, P1 mentioned using this strategy when websites are crowded with information and when it is difficult to navigate a website: “mobile versions of websites are less cluttered with unnecessary information (or advertisements) than are their desktop counterparts.” Adding “In the case of certain social networking sites, such as Facebook, I will force a laptop computer to load the mobile version of the site because the desktop version is not easy to use. It is more difficult to find the information I want on the desktop version of Facebook.”

Safari “Reader Mode”

Another strategy to strip away all unnecessary extraneous information that act as added noise to the user is to use the “reader mode” functionality offered by Safari Apple browser. P1 explained “I can tell the Safari browser to put the page into ‘reader mode’ which allows me to see only the article or forum posts that I want to see.”

Multiple Assistive Technology

More experienced blind and visually impaired users tend to have more than one assistive technology software at their disposal. The reason is that when they are faced
with general accessibility challenges, such as poorly designed websites, or web browsers that do not support a particular version of the assistive technology used, they can try different ones to explore and learn what software work where and when. P1, a screen reader user, explained that because of using more than one screen reader software, every website is accessible to her to some degree. Also, P6, who is a screen magnifier user, switches between assistive technologies used to suits his browsing needs; “I had an issue when the Zoomtext did not display correctly the screen so I had to turn it off and use Windows Magnifier in order to be able to read.”

Change Assistive Technology Settings

Another strategy related to assistive technologies used is modifying the settings of the software. P4 explains a situation where she had to alter JAWS settings: “the other day I was on US Rowing site and it has mouse overs. When I used the keystroke for mouse overs it did not work. I went into JAWS settings for web and changed some settings and then it worked. But most people don’t know how to change settings.”

Use of Web Extensions

As explained above, Captcha is one of the main challenges that screen reader users face, especially when there are no alternative methods to solve Captcha such as Audio Captcha or NoCaptcha. One way to overcome the difficulty of Captcha is by installing specific web extensions. P1 faced a situation where she had to use a Mozilla Firefox extension called Webvisum: “If one wishes to consider captcha images, in some
cases this can be gotten around by using Mozilla Firefox and an extension called Webvisum. However, this is only an option if you use a Windows computer. Users of Macintosh computers or mobile devices have nothing comparable to Webvisum.”

**Invert Colors**

This strategy is exclusively used by visually impaired individuals who are not totally blind. When these users cannot navigate websites because of poor color contrast or light brightness, they tend to invert colors or change the brightness settings of a website either through functionalities provided by the website or an inverter tool.

**3.4.7.2 User Behavior Adaptation**

The second category of adaptation is the user behavior adaptation, meaning that the user will employ different behaviors to interact with the website to accomplish her goals. This includes browsing techniques and shortcuts, search behaviors, use of familiar setting among others. The different users’ adaptation behavior resulting from the interviews analysis are discussed below.

**Using Hot Keys**

Totally blind users who use screen readers rely mainly on the keyboard to use computer technologies in general and to navigate websites in specific. Thus, they employ different “hot” key strokes, which might be considered keyboard shortcuts, to reach and activate different elements in the webpage. This strategy does not necessarily
result from challenging or problematic situations, however, it is the default behavior of users using screen readers. Although accessible websites would make it much easier for screen users to browse the websites, they would still use this strategy with poorly designed websites. As P1 explains: “websites are often easier to navigate if portions of the website are divided up by headings. The only reason this makes website navigation easier is because screen readers offer a hot key which allows one to quickly jump from heading to heading.” Such keyboard shortcuts are used to jump through headings, look for links, highlight content and perform copy and paste functions as P2 confirms: “The screen reader has keys to enable navigation by headings, combo boxes, and check boxes. You can also find edit fields and buttons easily with 1 key.” P4 gives more specific examples of key strokes used while navigating different aspects of the web: “I like to use ‘e’ for edit boxes, ‘b’ for buttons, ‘F7’ for links, ‘h’ for headings and ‘n’ for next, F8 key to highlight table and copy it to clipboard.”

**Search Function**

It seems like search strategies is one of the most convenient strategies for blind and visually impaired users. It allows them to reach their desired link or page without necessary going through the webpage hierarchy. From our analysis we were able to identify two distinct search strategies that user perform, the first is Google searches and the second is within a website keyword search. When using the google search, the user is hoping that the resulting links will lead them directly to the web target they are
aiming. P6 explains: “I use Google search and the name of the same website hoping that
the search engine will penetrate through the hoops and find what I was looking for.”
And P4 conformed: “I google my question and then enter on the link that was returned
so I go right to content.”

On the other hand, other users go to the desired website then perform a search
there. P4 says; “It would be helpful to enter specific search term that might yield
positive results.” and P2 illustrates how such option might be extremely helpful when
purchasing products online “I can perform searches for products easily, shop, review,
anything I need to do easily. I can look quickly through the links and do word searches.
I can do a screen reader search though to find a word or number that will bring me
right to a spot.” P3 clearly stated that search is her primary strategy to reach her desired
goals: “[I] just has to search through the information to find what they need.”

Use of Familiar Environments

An interesting strategy that we noticed is that when it is difficult for the blind
and visually impaired individual to understand certain content or when they feel
confused when reading tables, they tend to copy the information from websites and
paste in a familiar setting (e.g. notepad, excel) because it too complex to read on
website. For example, P4 was attending a US rowing convention and the schedule of the
event in a table on the site. When she found difficulties reading the table on the website:
“I press F8 key to highlight table copy it to clipboard and open excel and paste in table.
Sometimes I use notepad to paste and read information. [Tables are] too complex to read on website.”

**Backtracking**

Users sometimes lose their orientation within a webpage and through different webpages. As a result, they might not able to locate where they are within a webpage or what website they are in if they visited more than one websites. In such cases, the blind and visually impaired users use backtracking strategies to get a better understanding of what could led them to that spot. Users usually employ this tactic not only when they are disoriented but also when they are confused. When we asked P6 if he could locate where he is on a page, he said “Sometimes I have to click back or forward button to make sure where I am.”

**Exhaustive Scanning**

Exhaustive scanning is the act that users read the entire web page left-to-right top-to-bottom with a screen reader. Based on previous research this is usually an exploratory tactic that blind people use when they are not familiar with a website (Virgo and Harper, 2013) For example, P5 explained that sometimes she needs to read line by line to get acquainted with the website.

**Avoidance**

Some users mentioned that they would completely avoid websites that to their knowledge are not accessible to them or those that raised certain challenges that
prevented them from achieving their browsing goals. When trying to read the timetables of a local transportation company, P1 stressed that she tries “to avoid [this website] because the timetables for its buses are not accessible at all.” Similarly, P2 and P5 confirmed that they “don’t visit sites that are not accessible.”

**Asking for Assistance**

Many participants asked for assistance as a last resort when they fail to accomplish their goals after employing a few strategies on their own. Our analysis finds that this strategy is not only employed by novice users as believed in prior research (Harper et al, 2013), but also very experienced users employed this strategy when encountering problems. The forms of assistance varied; they would ask for assistance from a sighted person such as a peer or family member. An example is how P1 asks for sighted help “[when some] information tends to be laid out as it is presented visually, I need a sighted person's assistance. I can tell them that what I wish to show them or the thing with which I need assistance [with].” Also P4 showed the same behavior when reaching a state where she cannot operate on a website “sometimes I cannot get passed the first page so I get sighted assistance.”

Another channel that the blind and visually impaired ask for assistance when facing obstacles is contacting their online communities. Many blind and visually impaired users enlist in online communities to get support, help and feedback on anything related to their condition. For example, P4 was able to learn a strategy that is
related to her screen reader settings when faced with a challenge after asking support email lists that she is on.

The third assistance method that we observed is emailing customer care or support team of the website. P1 explained her frustration when she couldn’t read a table in one of the websites because it was an inaccessible PDF image: “I ended up having to email their customer care team and have someone type out the information I needed and send it to me in an email.”

**Giving Up**

Giving up is a strategy by which blind and visually impaired users surrender to trying to overcome a problematic situation or a challenges. We found in our analysis that this strategy is employed when the users couldn’t complete a purchase or an account setup or when they are faced with different accessibility challenges and information overload. It is important to note that we found that this strategy is not the first strategy the blind and visually impaired individuals use when encountering a browsing problem. However, users tend to employ it in an extreme state of frustration or failure in achieving their browsing goals. For instance, P2 explained that when she wanted to purchase a product online, she had to sign up for an account that required her to solve a Captcha image in order to complete the transaction, “obviously, I couldn’t do that, so I couldn’t accomplish my buy. These [Captcha images] come up often and make posting, shopping, commenting, (lots of things) impossible.” Similarly, P4 could
not complete a transaction in a brokerage website because buttons were not accessible to the screen reader.
CHAPTER FOUR:

ONLINE SURVEYS

The objective of this second study is to reach a larger sample of blind and visually impaired users. In order to achieve this, I used an online questionnaire with a series of mostly open-ended questions.

4.1 Data Collection and Participants

To reach a larger pool of people with visual impairment, we used targeted participants through the panel service offered by Qualitrics. Data were collected based on specific quotas regarding vision impairment levels and resulted in 50 participants. Table 7 illustrates the non-proportional quota-sampling used. Each participant received a monetary incentive of $25.

Table 7. Online Survey Sampling-Quota

<table>
<thead>
<tr>
<th>Vision Impairment Level</th>
<th>Quota</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blind/Near Blind</td>
<td>20</td>
</tr>
<tr>
<td>Visually Impaired</td>
<td>20</td>
</tr>
<tr>
<td>Color-Blind</td>
<td>5</td>
</tr>
<tr>
<td>Sighted with vision condition</td>
<td>5</td>
</tr>
</tbody>
</table>
Unlike the interview data, the survey data quality was poor in comparison. Many respondents filled answers with gibberish texts or irrelevant words. There were also some fraudulent responses. For example, a person claimed that she was legally blind but used no assistive technology to navigate the web. After examining the data carefully and eliminating bad responses, we ended with a sample of 38 responses\(^5\).

### 4.2 Survey Questionnaire

The questionnaire consisted of two broad sections relating to (1) demographic and visual disability information and (2) Internet usage behaviors, assistive technology use, and online browsing behavior. The first section consisted of questions regarding the age, gender, occupation and educational background of the participants. The following questions focused on the details of the respective visual disability of the subjects. Since prior research highlighted the need for more data concerning the disability status, as different disabilities entail different types of limitations and barriers towards access to ICT (Vicente and López 2010).

The second part of the questionnaire contained variables obtained from the interview study findings that reflect use patterns behaviors and perceptions with respect to four different categories of daily online activities: self-representation, procurement, information search, and search engines. The representatives that were

\(^5\) These 38 responses also had questionable data quality and missing data.
selected with respect to the activity categories were: Social Networks (e.g. Facebook), e-commerce websites (e.g. Amazon), online news sites (e.g. CNN.com), and search engines (e.g. Messenger). A sample of the survey questionnaire is in Appendix E.

4.3 Data Analysis Methods and Procedures

Similar to Study 1, I used a qualitative method approach with two goals in mind: (a) to explore and identify additional visually impaired user browsing challenges and behavior, and (b) to build on the conceptual research model that resulted from the first interview study. To achieve these goals, I conducted the same coding process identified in section 3.3 to identify additional themes and relationships related to the visually impaired and their behavior across the different web environments.

4.4 Results

In this section we show the online survey results. We first provide descriptive analysis of the participants then we build on our findings from the interviews results.

4.4.1 Descriptive Analysis

As discussed in Chapter 3, the online survey data didn’t provide the richness of the interview data. However, we were able to reach a broader range of participants with various vision impairment levels. The sample of 38 participants included sighted individuals with common vision problems (near sightedness, far sightedness,
stigmatism, ...etc.), color blind, visually impaired and blind individuals. Table 8 illustrates the descriptive analysis of this study sample.

Table 8. Summary statistics of survey participants

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Range</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>18 to 24</td>
<td>7</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>25 to 34</td>
<td>9</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>35 to 44</td>
<td>8</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>45 to 54</td>
<td>11</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>55 to 64</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>≥65</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Gender</td>
<td>Male</td>
<td>17</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>21</td>
<td>55</td>
</tr>
<tr>
<td>VI</td>
<td>Blind</td>
<td>11</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>Visually Impaired</td>
<td>12</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Color Blind</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Sighted</td>
<td>11</td>
<td>29</td>
</tr>
<tr>
<td>Onset</td>
<td>Early</td>
<td>21</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Late</td>
<td>17</td>
<td>45</td>
</tr>
<tr>
<td>AT</td>
<td>Screen Reader</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Screen Magnifier</td>
<td>8</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Both</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>NA</td>
<td>22</td>
<td>58</td>
</tr>
<tr>
<td>Web skills</td>
<td>Excellent</td>
<td>14</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>Very Good</td>
<td>9</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Good</td>
<td>9</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Poor</td>
<td>6</td>
<td>16</td>
</tr>
</tbody>
</table>

4.4.2 Identified Challenges

Since the survey questions were structured differently than the interviews, we were able to identify challenges that a wider group of sighted and visually impaired users face. Participants were asked to identify the challenges they believe would have an impact on their web experience when shopping online, reading news, using search
engines and connecting through social networks. We discuss the identified challenges of the different user groups below. We first illustrated the unique challenges that the visually impaired and blind people, including color blind individuals, have identified then we demonstrate the shared challenges between sighted and visually impaired individuals, and finally we list the challenges that sighted individuals mentioned.

### 4.4.2.1 Visually Impaired and Blind Users Challenges

#### Color Contrast

As mentioned earlier, color contrast and brightness are crucial design features for users who are visually impaired and use screen magnifiers. Our survey data also shows that color blind individuals are extremely effected by the color choices of websites. For instance, S24 is red-green colorblind and he finds it extremely challenging when web elements are distinguished using only colors; he gives an example of a challenge he faced: “when colors on maps are used to show weather and I can’t tell shades of color enough to see differences.” Also, S18 who is a visually impaired individual user commented on how challenging the website is when poor contrast of colors is presented: “colors that are too close for the background and the text.”
Assistive Technology Issues

Another obstacle faced by blind users using screen readers and magnifier is when the website doesn’t support the assistive technology they use. S46 explains: “[for example] Tumblr. It’s hard for me to get my software to read it aloud.” Perhaps the reason for this specific website not to work with a screen reader for example, is because it is heavily graphic based, therefore there is no content for the screen reader to read aloud.”

4.4.2.2 Sighted Users’ challenges

Challenges that are exclusive for sighted individuals, who have some common vision problems, prove to be very different in nature than those experienced by the blind and visually impaired individuals. It seems to be that the challenges they mention relate more to their convenience in accessing technology in general and the internet in specific and their digital privacy. For example, sighted participants mentioned that slow internet speeds, loss of internet signal, broken websites and links are some of the challenges they face when browsing the internet. Another concern was the potential security breach that might result from their browsing behavior.

4.4.2.3 Shared Challenges

In this section we discuss the challenges that were mentioned by both sighted and visually impaired participants.
Font Size

Webpage font size appears to effect a larger group of sighted and visually impaired users. Sighted users, who need reading glasses, finds small text to be frustrating. Similarly, visually impaired individuals, who sometimes do not use a specialized magnification software and rely on the zooming capability of their devices and/or the website itself, express their frustration of small font size. For example, S26 complained about her online shopping experience when items’ description is “not big enough” for her to read.

Web Elements and Layout

Another shared challenge is related to some elements on websites and page layout. However, the nature of these challenges is different for both groups. For example, pop-ups and ads may be frustrating or bothersome to sighted individuals, yet for visually impaired users they hinder their web experience. Moreover, moving elements in screen tends to be challenging for both groups since the chance of clicking something by mistake is probable. Once again, for sighted individual this might be an inconvenience, however for visually impaired users this might redirect them to a new space that they are not familiar with and it takes them more time and cognitive effort to overcome this challenge. Also, crowded websites with not so clean layout pose a problem. When participants were asked to give example on a challenging design feature, they mentioned various features that relate to the web layout. For example, S15
mentioned “messy and confusing layout”, S18 stated that “There is sometimes too much going on [on a website]”, S19 expressed frustration “I hate the way pages like Facebook are set up”, and others stated other features such as the inability to find the search function and too many images in a webpage.

### 4.4.3 User Adaptation Strategies

The results of the survey data show that this user group only mentioned behavior adaptation strategies. We believe that the nature of the survey questions and the survey method, unlike interviews, do not allow for more detailed behaviors to be exploited. The identified user behavior adaptations were similar to the ones identified in the interview analysis.

Blind and visually impaired users demonstrated similar behaviors to the one mentioned in the interview analysis; using search functions, keyboard shortcuts, exhaustive scanning, and asking for sighted assistance. The one additional strategy captured is to re-start, re-do and refresh the task/page they were performing. For example, S24 explained that when faced with a challenge such as too many pop-ups; “I quit and start over if I can't leave [that] page.” It is important to note that this behavior is not exclusive to the blind and visually impaired; we detected that even sighted individuals might use this strategy when faced with a problematic situation that they cannot escape or solve.
4.4.4 Final CodeBook

The results of the interview and survey data coding were consistent with the initial coding presented above. Both external coders followed the same logic and added only a few new emerging codes. The newly identifies codes and/or sub-codes are listed in Table 9 (bolded and underlined).

**Table 9. Final Codebook Addition**

<table>
<thead>
<tr>
<th>Code Name</th>
<th>Code Description</th>
<th>Relationship to other Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 AFFECT</td>
<td>Any emotions or feelings that participants express,</td>
<td>This is a main code.</td>
</tr>
<tr>
<td>2 ENV</td>
<td>Web environments- the different categories of web sites e.g. social networks, e-commerce</td>
<td>This is a main code. Sub-codes include: SNS ECO INF SRCH EML ENT</td>
</tr>
<tr>
<td>3 WEB</td>
<td>Any characteristic of the web environment</td>
<td>This is a main code. Sub-codes include: AUD GRPHC</td>
</tr>
<tr>
<td>4 FREQ</td>
<td>Any mention of the frequency of website use</td>
<td>This is a main code. Sub-codes include: DLY+ OCCSN</td>
</tr>
<tr>
<td>5 INTERF</td>
<td>Specifically mentions the interface and device used, why it is used and how it is used</td>
<td>This is a main code. Sub-codes include: PC MAC MOB APPS TAB BRWSR UNSP PREF</td>
</tr>
<tr>
<td></td>
<td>AT</td>
<td>Specifically mention they type of assistive technologies used to be able to browse websites</td>
</tr>
<tr>
<td>---</td>
<td>----</td>
<td>-------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Specifically mentions the different places participants have access to the internet</td>
</tr>
</tbody>
</table>
CHAPTER FIVE:

OBSERVATIONAL TASKS

To obtain a better insight of the browsing behaviors and strategies of the blind and visually impaired users and validate our findings from Study 1 and Study 2, we conducted an observation study. The study was a think-aloud exercise where blind and visually impaired users had to accomplish a number of web-related tasks. According to Vigo and Harper (2013, p. 1015), such observation studies “allow us to recognize emergent behaviors, identify the sources of user frustration and enable a better understanding of when, why and how users employ determined tactics.” In our analysis, this study can be considered as a confirmation of our results in the first two studies.

5.1 Data Collection and Participants

Similar to the interview study, we reached out to the USF office of Students with Disability Service. Study information was distributed via email and contained a detailed description of the study, consent form (Appendix F), and contact information to schedule interview meetings with the principal researcher. Two individuals with different visual impairments who fit the study criteria were willing to participate.
Participants were compensated using a $50 Amazon gift cards. As mentioned earlier, having access to this population is challenging. It took two months to recruit these two participants.

Because visually impaired users employ different strategies to overcome varied levels of disabilities (Vigo & Harper, 2013), to maximize the variation in behaviors, we chose two participants with different disability level, one blind and the other is visually impaired, and who used different assistive technologies; screen readers and screen magnifiers.

5.2 Observational Setting and Tasks

The goal of this study was to analyze the interaction of blind and visually impaired users on the Web. A think-aloud protocol was employed so that the observer could record what users verbalized jointly with interaction data i.e. the observer’s comments on the different key commands used by the participant and the actions resulted from the participant’s command.

Participants were given seven different tasks to complete with no time constraints. These tasks required interaction with different websites: (a) e-commerce, (b) information, (c) search, and (d) social networks websites. Moreover, the tasks were selected carefully to address some of the challenges identified in the first two studies. They also varied in the type and level of challenges faced. To illustrate, there are two e-commerce related tasks; in Task 1 participants were asked to purchase a book on
Amazon. This task was selected because Amazon is known to be one of the more accessible websites to the blind and visually impaired. On the other hand, to compare their performance in a less accessible website, in Task 2 participants were asked to purchase tickets for a concert and select their seat from ticketmaster.com. This task was chosen because of the difficulty that might arise when interacting with the seats map as shown in Figure 3.

![Figure 3. Observational Task 2 example](image)

Task 3 is a search engine task, where participants were asked to search for the weather in a particular weekend. Moreover, there are two information sites tasks (Task 4 and Task 6); in Task 4 participants were asked to subscribe on webMD.com newsletters to
examine how would they behave when a pop-up window interfere with completing the
task. In task 6 they were asked to try to read one of CNN.com news articles to test how
the blind user deal with the overlay of the auto-displayed video and the screen reader
in comparison to the visually impaired user. To examine the challenges that users
pointed out in the first two studies when using Facebook.com, in Task 5 participants
send a friend request to a particular account. Finally, to observe how users would
behave in a high complicity time-consuming task, they were required in Task 7 to plan a
full trip to Washington, DC including airfare and hotels reservations. Table 10 is a
summary of the different tasks and rationale behind selecting these specific tasks.

Table 10. Observational Tasks

<table>
<thead>
<tr>
<th>Task</th>
<th>Difficulty</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task 1: Amazon book purchase</td>
<td>Low</td>
<td>Highly structured, known to be more accessible than others</td>
</tr>
<tr>
<td>Task 2: Concert ticket purchase and seat selection</td>
<td>Medium</td>
<td>Visual comprehension intensive when selecting seats using map</td>
</tr>
<tr>
<td>Task 3: Find weather in weekend</td>
<td>Low</td>
<td>Exploratory, possible search engine problems</td>
</tr>
<tr>
<td>Task 4: Newsletter Subscription</td>
<td>Low</td>
<td>Pop-up window challenge possible</td>
</tr>
<tr>
<td>Task 5: Send a Facebook friend request</td>
<td>Medium</td>
<td>Website layout interaction with AT</td>
</tr>
<tr>
<td>Task 6: Read a CNN news article</td>
<td>Low</td>
<td>Video overlap with AT</td>
</tr>
<tr>
<td>Task 7: Plan a trip to Washington, DC</td>
<td>High</td>
<td>High complexity, multiple challenges expected</td>
</tr>
</tbody>
</table>

During the observation session, each task was read aloud to the participant. After
the participant indicated that the task was complete, the observer had some follow-up
questions to clarify certain observed behavior and to understand the participants’ browsing decisions. The observational tasks transcript is provided in Appendix G.

5.3 Data Analysis Methods and Procedures

To confirm the results from the first two studies, I analyze the observational data following the same qualitative inductive method mentioned in the first two studies. New data obtained from the observation sessions was selectively sampled to validate the themes and the relationships. Thus, the conceptual model was further refined and relationships were confirmed.

5.4 Results

In this section the case of the two individuals (P7 and P8), who participated in the observational tasks study is presented. I explain in details the challenges they faced while completing their tasks, the strategies they used, and their overall impressions. Table 11 shows the profile of the study participants and table 12 shows a comparison of the task completion and task time for both participants.

Table 11. Observation Study Participants

<table>
<thead>
<tr>
<th>Participant</th>
<th>Disability</th>
<th>Assistive Technology (AT)</th>
<th>Specific AT</th>
<th>Onset</th>
</tr>
</thead>
<tbody>
<tr>
<td>P7</td>
<td>Blind</td>
<td>Screen Reader</td>
<td>JAWS</td>
<td>Late- 21</td>
</tr>
<tr>
<td>P8</td>
<td>Visually Impaired</td>
<td>Screen Magnifier</td>
<td>Zoomtext</td>
<td>Late- 16</td>
</tr>
</tbody>
</table>
Table 12. Task Completion and Time Comparison

<table>
<thead>
<tr>
<th>Task</th>
<th>Task Complete</th>
<th>Task Time (in Minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P7</td>
<td>P8</td>
</tr>
<tr>
<td>Task 1</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Task 2</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Task 3</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Task 4</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Task 5</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Task 6</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Task 7</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

*These times represent the time the participant tried to accomplish the task but didn’t not succeed

As mentioned earlier, a think-aloud method was employed so that the observer could record what users verbalized jointly with interaction data i.e. the observer’s comments on the different key commands used by the participant and the actions resulted from the participant’s command. For example, a selection of the interaction of P7 in this dataset looks as follows:

Used e key to look for the search field in the website [the first thing user did]
[the cursor is in the search field bar]
Typed artist name and clicked enter
[the browser took her to a previous page] (it clicked, so it went somewhere else)
[user closed browser] (let me start from the beginning, because it keeps going back to Amazon)

6 The square brackets are the comments made by the observer and the round brackets is the verbalization of the user. This method of documentation is adopted from Vigo and Harper (2013)
[Clicked on Internet Explorer, then pressed Control O to open a new dialog where user can enter the targeted website]
[Page brings up Ticketmaster.com window]
Enters e for search field [repeat previous step]
[Page brings up search results but JAWS does not read it out and takes the user to the side bar links]

5.4.1 Participants Overview

Participant 7

This user (P7) is a legally blind female who uses screen reader to navigate computers. The onset of her impairment was late as a result of optic nerve damage due to the unknown. She describes what she sees as television-like static in the whole of her visual field: “black and white spots all over what you normally see.” When it comes to computer screens she’s completely blind.

When completing the tasks, P7 faced a number of problematic situations. Some she could overcome and led her to complete tasks successfully, and others she could not, which resulted in her quitting.

All identified challenges were consistent with our findings from the previous two studies: no feedback or status indication, unlabeled heading and links, video interference, changing layouts, and web elements not accessible to the screen reader. In addition to identifying the challenges, we were able to record and gain in depth insights on how the user encountered the problem and what was actually happening in the computer screen. The challenge that seemed to hinder P7 the most from completing
some of the observational tasks and give her great confusion in others is the invisibility of web elements to the screen reader. For example, in Task 1, when she was creating an Amazon account at checkout, there was an input field that asked her to enter a “security access code”. Although the field gave an example of what is meant by this term (see figure 4), JAWS did not read it out to her. “I don’t know what it means. It should give me more details” she complained.

![Additional Address Details](image)

**Figure 4.** Task 1 challenge example.
*The “Security access code” field explanation was not visible to the AT and wasn’t read out to the user causing confusion.

In Task 2, P7 also faced another example where the screen reader didn’t read out what was actually on the screen. She was trying to purchase concert tickets on (ticketmaster.com). When the user search result was displayed, JAWS did not read out the middle section where the result was (see Figure 5).
Figure 5. Task 2 challenge A example.

*JAWS, the screen reader, read out results starting from 1 – the header of the page, then 2- further results drill down options, and finally 3- where the results actually are.

The user was not aware that the search result was there so she narrowed down the search attributes by city. By doing so, she was able to find the concert, however, the “See Tickets” button was not visible to the screen reader (see Figure 6). Thus, she quit the task.

Figure 6. Task 2 challenge B example.
*The highlighted “See Tickets” button was not visible to JAWS, the screen reader
Participant 8

This user (P8) is a visually impaired female. She was diagnosed with Stargardt disease, a form of juvenile macular degeneration, in 9th grade. Up until her vision began to decrease she had 20/20 vision. Today her visual acuity is 20/200 in one eye, and 20/150 in the other eye. When interacting with computers, she uses a magnification software to enlarge the screen or any font.

As mentioned earlier, the main challenges she faced as a screen magnifier user is the font style and size: “Times New Roman is a no no for me because there is so much creativity to the lettering. I like simple cut out like a Tahoma or an Ariel, those are easy to read.” As P8 explained, she is more comfortable reading san-serif fonts. She also pointed out that Italic and cursive fonts are harder to read: “Italic is a bit harder. Cursive is harder. It takes me longer to realize what I am reading.”

Another challenge we observed, is her inability to get a sense of the entire webpage: “I lose the sense of where everything is. I am really not seeing what this website looks like; I am looking at a little portion of it and not seeing it entirely.” Most times she seemed lost in the website, especially when it has blank spaces. Although she was able to successfully complete all tasks, it seemed hard on her to complete the task as directed. For example, in Task 1, she added 3 books instead of one to the cart.

Moreover, P8 pointed that some computer programs are not accessible to manual magnification, e.g. Control +. Thus, she needs a magnification software like Zoomtext to
force the magnification of the screen. She also, implicitly complained about the resolution of the screen when zoomed in. For example, when trying to read weather temperature with a high zoom strength, she could differentiate between a 1 and a 7: “this looks fuzzy. Some numbers are very hard to tell the difference between what they are.” Table 13 summarizes the challenges faced by both participants in all 7 tasks.

Table 13. Observational tasks challenges

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Participant</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P7</td>
<td>P8</td>
</tr>
<tr>
<td>Inaccessible web elements</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Pop-up</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>No Feedback</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Lack of Page Context</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Audio/Video interference</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>No Labeling or structure</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Inaccessible PDF</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Font size &amp; style</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>

5.4.2 User Adaptation Strategies

Table 14 demonstrates the strategies employed by both participants in the observation study. As shown, P7 used only behavior adaptations strategies most of them are identified in the previous two studies. However, the random clicking tactic, was first observed with this user. When P7 felt trapped, or when JAWS kept taking her in loops, she randomly clicked on any button or link she found to take her out of the current problematic situation.
P8, on the other hand, used both technology and behavior adaptation strategies. In each task, she kept zooming in and out – changing the magnification strength. As she explained; she needs to zoom out (decreasing the magnification strength) so that she can see the overall layout of the screen. After she finds what she’s looking for, she zooms back in (increasing the magnification strength) to be able to read that segment of the screen and interact with the website content. P8 also exhibited behavior adaptation strategies in some situations. For example, when she zooms in and lost the sense of the screen, she tends to scan the page vertically and horizontally as if the page is divided into columns and rows. P6, a screen magnifier user in the interview study, mentioned that he browses segments of the screen, however, he didn’t describe how he actually does it.

**Table 14. Observation participants’ user adaptation strategies**

<table>
<thead>
<tr>
<th>Participant</th>
<th>Behavior Adaptation</th>
<th>Technology Adaptation</th>
</tr>
</thead>
<tbody>
<tr>
<td>P7 (Screen Reader User)</td>
<td>Use hot keys/shortcuts</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>Heading and Links Navigation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Search Function</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Restart Task</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Avoidance</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ask for Assistance</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exhaustive Scanning</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Random Clicking</td>
<td></td>
</tr>
<tr>
<td>P8 (Screen Magnifier User)</td>
<td>Search Function</td>
<td>Change Magnification SW setting</td>
</tr>
<tr>
<td></td>
<td>Exhaustive scanning</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Backtracking/probing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ask for Assistance</td>
<td></td>
</tr>
</tbody>
</table>
The findings and implications of the research are discussed in this chapter. The discussion focuses on interpreting the research results and discussing the study conceptual model; the relationship of the research results to the reviewed literature; the implications of the study for practice, and research; and the limitations and conclusions of this study.

6.1 Discussion

6.1.1 Building the Conceptual Model

After obtaining the complete set of codes, concepts and themes generated through the data coding process from both the interview and survey data, the specific findings of the study are analyzed further to reach a conceptual model of the blind and visually impaired adaptation behavior in online environments.

The study researchers built on the open coding results and applied the axial and selective coding on each theme until the final conceptual model was reached. Figures 7 - 12 illustrate how we analyzed main prominent themes showing the coding stages that
resulted in the main themes. Moreover, Table 15 illustrates examples on how the relationships between themes were identified through direct quotes from participants and the observation results.

**Table 15. Axial Coding Examples**

<table>
<thead>
<tr>
<th>Relationships</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1 Disability Level → Assistive Tech</td>
<td>“I am totally blind, …, I use the JAWS for Windows screen reader”</td>
</tr>
<tr>
<td>P2 Individual Differences → User Adaptation</td>
<td>“I have used a computer for around twenty years … it is helpful to have multiple screen readers”</td>
</tr>
<tr>
<td>P3 Design Features → User Adaptation</td>
<td>“In the case of Facebook, I will force a laptop computer to load the mobile version of the site because the desktop version is not easy to use. It is more difficult to find the information I want on the desktop version of Facebook.”</td>
</tr>
<tr>
<td></td>
<td>“If they often change their appearance, it will discourage me to go to that website.”</td>
</tr>
<tr>
<td>P4 Assistive Technology → User Adaptation</td>
<td>“I use Zoomtext…I always invert the colors where the white becomes black and the black becomes white.”</td>
</tr>
<tr>
<td>P5 User Adaptation → Use Outcomes</td>
<td>“I went into Jaws settings for web and changed some settings and then it worked.”</td>
</tr>
<tr>
<td></td>
<td>“I had to sign up for an account, and when I got to the end, there was a visual picture of numbers and letters that I would have had to type in in order to complete the transaction. Obviously, I couldn’t do that, so I couldn’t accomplish my buy.”</td>
</tr>
</tbody>
</table>

* These relationships were detected during the observation study through the recording of participants’ behaviors.
I have been red-green colorblind for as long as I can remember.

my visual acuity is 20/200 in one eye, and 20/150 in the other eye.

I have Marfan Syndrome and dislocated lenses, and several eye surgeries

I am totally blind due to Retinopathy of Prematurity (ROP)

Figure 7. Coding process for the theme of Disability
I’ve used it for many years, it is helpful to have multiple screen readers at your disposal, because sometimes one screen reader can’t navigate a certain website as well as another.

If I want the information a website contains, I am willing to work around any obstacles that may present themselves in order to have that information.

I will visit websites if the products they sell, information they contain, or items of entertainment I can derive from them interest me.

**Figure 8.** Coding process for the theme of Individual Differences
<table>
<thead>
<tr>
<th>Participants Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>blogs are easily navigated because each blog entry is found under headings</td>
</tr>
<tr>
<td>it is important that on the page there are not many links and everything is logically located</td>
</tr>
<tr>
<td>[websites] change their appearance and that creates an issue for me because I have to relearn where to look</td>
</tr>
<tr>
<td>website is a little difficult to read because advertisements are interspersed with the text</td>
</tr>
<tr>
<td>Websites that use PDF documents to convey information are frustrating</td>
</tr>
<tr>
<td>some colors are looking very bright or different when I use the inverter tool of my software</td>
</tr>
<tr>
<td>constantly refreshing screen makes it impossible to read anything before the screen switches content.</td>
</tr>
<tr>
<td>Sites are cluttered with so much information that unsure if reading information correctly</td>
</tr>
<tr>
<td>loud audio makes it so that I can’t hear my screen reader</td>
</tr>
<tr>
<td>Facebook is a nightmare to operate. It’s flashed based</td>
</tr>
<tr>
<td>Graphics are a problem if they are not labeled</td>
</tr>
<tr>
<td>a link or button does something, but there is no feedback to let us know.</td>
</tr>
<tr>
<td>don’t visit sites that are not accessible; many are not to screen reader software.</td>
</tr>
<tr>
<td>captcha in the creation of an account might as well be considered inaccessible</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level 1 Open/In Vivo Codes</th>
<th>Level 2 Categories</th>
<th>Level 3 Construct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear Heading &amp; Labeling</td>
<td>Enabling Features</td>
<td>Design Features</td>
</tr>
<tr>
<td>Structured Layout</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changing Layout</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pop-ups &amp; ads</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inaccessible PDFs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Color &amp; fonts issues</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant Refreshing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Info redundancy/overload</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Audio/video Interference</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flash-Based</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No ALT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Feedback</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inaccessible to AT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Captcha</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 9.** Coding process for the theme of Design Features
Figure 10. Coding process for the theme of Assistive Technology

<table>
<thead>
<tr>
<th>Participants Data</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Open/In Vivo Codes</td>
<td>Categories</td>
<td>Construct</td>
</tr>
<tr>
<td>If I am using a Macintosh or iPhone, I use the built-in screen reader called Voiceover.</td>
<td>VoiceOver</td>
<td>Screen Reader</td>
<td></td>
</tr>
<tr>
<td>I use the JAWS for Windows screen reader.</td>
<td>JAWS</td>
<td>Screen Magnifier</td>
<td>Assistive Technology</td>
</tr>
<tr>
<td>[I use] Magnification - Zoomtext of Windows Magnifier</td>
<td>ZoomText</td>
<td>Screen Magnifier</td>
<td></td>
</tr>
<tr>
<td>Braille displays are the best tools available to browse websites.</td>
<td>Braille Displays</td>
<td>Braille Reader</td>
<td></td>
</tr>
</tbody>
</table>

93
Figure 11. Coding process for the theme of User Adaptation
<table>
<thead>
<tr>
<th>Participants Data</th>
<th>Level 1 Open/In Vivo Codes</th>
<th>Level 2 Categories</th>
<th>Level 3 Construct</th>
</tr>
</thead>
<tbody>
<tr>
<td>you can’t hear the screen reader. It is very frustrating.</td>
<td>Frustration</td>
<td>Affect</td>
<td>Use Outcome</td>
</tr>
<tr>
<td>Too much audio is annoying while trying to hear speech output to navigate</td>
<td>Annoyance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I enjoy having things under clearly labeled headings</td>
<td>Enjoyment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I went into Jaws settings for web and changed some settings and then it worked</td>
<td>Success</td>
<td></td>
<td></td>
</tr>
<tr>
<td>obviously, I couldn’t do that, so I couldn’t accomplish my buy</td>
<td>Failure</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 12.** Coding process for the theme of Use Outcomes
Figure 13 illustrates the conceptual model proposed by this study. As shown, I grouped themes into three major categories: Prior Conditions, Behavior, and Outcome. The Prior Condition includes four variables; Disability Level, Individual Differences, Design Features (Enabling and Challenging). Disability Level refers to the level of vision impairment the individual has. Individual Differences refer to the unique personal characteristics of individuals such as personal motivation or computer expertise. Enabling design features refers to the web design characteristics that makes the website easier to navigate with assistive technologies. Challenging design features refer to any problematic situation that arise as a result of the website design.

In the behavior category, we have the individual’s choice of Assistive Technology, and User Adaptation. Assistive Technology refers to any piece of equipment, product or system that is used to “increase, maintain or improve the functional capacities of people with disabilities. (WAI, 2010)” as illustrated in figure 10, the choice of the Assistive Technology used in the web context is dependent on the individual’s Disability Level i.e. blind individuals use screen readers and visually impaired individuals use screen magnifiers. User Adaptation refers to any high-level strategy (technology or behavior-related) that the user employ to achieve her browsing goals. This concept depends on Individual Differences, Enabling Design Features and challenging design features. For example, our analysis shows that Enabling Design Features trigger a different set of User Adaptation strategies than Challenging Design
Features. Also Individual Differences such as increased computer skills or high motivation usually trigger advanced and positive user adaptive strategies such as trying different assistive technologies, changing Assistive Technology’s setting, and using web plugins or extensions.

Moreover, we have observed that the choice of assistive technology impact the user adaptation strategy employed. For example, visually impaired individuals who use screen magnifier use a number of distinct adaptation strategies than those used by blind individual using screen readers.

Lastly, Use Outcome in this analysis entails a broad spectrum of affect-related and task-related outcomes. For example, positive affects can be satisfaction or enjoyment whereas negative affects can be frustration and annoyance, and task-related outcomes could be success or failure. The findings show that User Adaptation Strategy impacts Use Outcomes. For example, when a user chooses to avoid the website, similar to what P7 did in Task 7, this results in failure to achieve browsing goals.

Another unexpected finding of this research was that “Task Nature”, which was identified in the initial conceptual model in Chapter Three, did not make a difference in how this population browsed different website environments. One explanation could be that navigating and using websites either for work purposes or pleasure won’t change the design issues faced in a website; throughout the different studies presented
in this presentation, participants stressed more on the functionalities and design elements of the websites rather than the purpose of using the website.

6.1.2 General Discussion

The results of our study and the proposed conceptual model provide key findings in better understating the usage behavior and usage patterns of blind and visually impaired users. To address our first research question as to what factors that influence the blind and visually impaired users’ behavior in different web
environments, we conducted a series of studies to identify and classify the different individual personal factors (e.g. disability level, and individual differences) and the web design features (i.e. enabling and inhibiting) that influence the browsing behaviors of the blind and visually impaired users. The qualitative analyses of the interviews, online surveys, and observations revealed that one factor influencing the browsing behaviors were the visual impairment level, i.e. blind vs. visually impaired. We illustrated in our results that blind users, using screen reader, demonstrate different browsing behaviors than visually impaired individuals, using screen magnifier, or who are color blind. Another factor impacting the browsing behavior is the individual differences of blind and visually impaired users. Some users showed resilient motivation to achieve goals and overcome problematic situation, others were expert/advanced users, who know the technology and got used to browsing websites. These user groups exhibit different behaviors when interacting with the Web than those who are less motivated and less experienced with web technologies and websites. Also, the design features of a website impact the browsing pattern behaviors of blind and visually impaired users. Enabling design features such as well designed websites that follows the basic accessibility guidelines, trigger positive behaviors. Whereas challenging features could hinder this user population from having a successful browsing experiences. This finding is consistent with previous research. For example, Vigo and Harper (2013) classified challenges faced by visually impaired individuals into broad categories: uncertainty,
confusion, overload and reduced mobility. The challenges identified in this research study can be classified under these categories as well. For instance, the lack of feedback when an action is performed would be considered a case of uncertainty. Also, Cenfetelli and Schwarz (2010) explored the different inhibitors of IT use intentions for the general population, and their findings showed that information overload and process uncertainty, among others, hinder the use of systems. Raufi et al. (2015) also identifies that information overload, and lack of page context, which is an example of uncertainty and confusion, are two of the main challenges for blind and visually impaired users. Additionally, Lazar et al. (2007) conducted a study to explore the causes of frustration for blind users. The top causes reported were: confusing page layout; conflict between screen reader and application; poorly designed/unlabeled forms; no alt text for pictures; misleading links, and inaccessible PDF. Although most of the study challenges were identified in previous research, as technology evolves new challenges arise. Some of the challenges identifies in our research study that were not detected before include, dealing with CAPTCHA, constant refreshing of screen, changing layouts, and audio/video interference.

It is important to note that in our study we classified challenges based on the disability level of visually impaired individuals and thus were able to identify different set of challenges for different visual disability user group. In other words, with the legally blind users we were able to identify a different set of challenges than those faced
by the visually impaired users, including the color-blind. We believe that such distinctions and granulations are very important in building a complete understanding of this users group needs as they are not one. For example, the challenges faced by blind individuals are mainly related to the extent to which the website is accessible to the assistive technology used because screen readers are the main means to navigate websites. On the other hand, visually impaired users’ challenges rise from the actual visual design and layout of websites since they are able to see some portions of the screen to a certain degree. Although these two groups are affected differently by websites design features, they also share a number of challenges including Information redundancy/overload, pop-up windows and advertisements, and poorly-designed websites and tables i.e. not accessible to the assistive technology used.

Towards addressing the second question, as to understanding how the blind and visually impaired users adapt to web environments, we identified a number of user adaptation behaviors classified into technology adaptation strategies and behavior adaptation strategies. The reported behavior adaptation strategies in the literature are consistent with our findings; use of shortcut keys, backtracking, probing, avoidance, asking for assistance, and giving up (e.g. Vigo & Harper (2014, 2013), Lunn et al (2011), Borodin et al (2010); Trewin et al (2010), Takagi et al (2007), Shinohara and Tenenberg (2007), Goble et al (2000)). Also, we were able to capture a new adaptation behavior not mentioned in previous studies; the use of familiar environments. As explained earlier,
when blind individuals couldn’t read content such as tables, they would copy that table and paste it to a system environment that they feel comfortable working with e.g. Excel and notepad.

Moreover, most previous studies only reported the behavior adaptation strategies of blind users, however in our study we capture both technology-related and behavior-related adaptation strategies for both blind and visually impaired users. We observed in our findings that the technology adaptation strategies used by blind users are employed only by those with high expertise and who have been using the technology for a long time. On the other hand, visually impaired users use the technology adaptation methods regardless of their levels of computer and assistive technology knowledge. One explanation for this difference in the two user groups is the nature of the assistive technologies used. The default use of screen magnifiers by visually impaired users is focused on modifying the software settings, such as the magnification strength, screen colors, and color inversions options. Moreover, technology adaptation strategies continue to change with the evolvement of new technologies. For example, the ability to force the desktop version to load the mobile version, or put the screen on “reader mode” were results of technology advancements in recent years.

In this research study we also proposed a conceptual model that help explain the triggers of the adaptation behaviors as well as the influence of such behaviors on
desired outcomes. As illustrated in Figure 11 above, we identified different factors: (choice of assistive technology, individual difference and design features) that would influence the adaptation strategies used. Different combinations of these factors yield different adaptation strategies. For example, a screen reader user who is high motivated to achieve her browsing goal would employ a different adaptation strategy than another screen reader user who is less motivated. Observing these behaviors led us to the finding that adaptation behaviors can be categorized into positive and negative patterns. In other words, all behaviors that led to avoidance, and giving up could be considered negative adaptation strategies. Whereas, re-doing, backtracking, and asking for assistance, for example, are considered positive adaptation strategies that lead to solving the issue faced and achieving the browsing objectives.

6.1.3 Methodological Rigor

Qualitative research and interpretive paradigm have a different evaluation methods and terminology for evaluating internal and external validity, reliability and objectivity (Lincoln & Guba, 1985; Creswell, 2013; Bloomberg & Volpe, 2012). Lincoln & Guba (1985) proposed four criteria to evaluate the trustworthiness of the qualitative research: credibility, transferability, dependability, and confirmability.

Credibility refers to other researchers’ confidence in the reported findings (Lincoln & Guba 1985). Credibility was established in this study by triangulation of
methods, data sources and coders. Triangulation was obtained by combining face to face interviews, online surveys, and direct observations of individuals with various visual impairment levels. Multiple coders were employed to code the qualitative data.

Another strategy for ensuring credibility is ‘member check’ (Merriam, 2014), where feedback was solicited from respondents on the emerging findings from people I have interviewed in the first and second study.

Transferability in qualitative research refers to whether other researchers can apply the lessoned learned in other settings, but it does not mean that the findings are generalizable to all other settings (Bloomberg & Volpe, 2012). Researchers suggest that transferability can be facilitated by presenting findings with “thick” descriptions of the study. (Merriam, 2014) In this study I achieved this by providing highly descriptive, detailed presentation of the setting and the findings of this study with evidence presented in the form of quotes from study participants.

Dependability refers to the stability of the findings over time, and confirmability refers to the internal coherence of the data (Denzin & Lincoln, 1994). In this study, triangulation in data collection methods, data sources and investigators are used to accomplish both dependability and confirmability (Lincoln & Guba, 1985). I also involved research advisors in all phases of the study. They provided comments and critiques particularly on the research methods and data analysis. This has served to make the research process more transparent and rigorous.
6.2 Contributions of the Study

6.2.1 Research Implication

To the best of our knowledge, this is one of the first studies that use the grounded theory approach in understanding the blind and visually impaired population adaptation behaviors to web environments. Previous studies have focused on identifying the challenges faced, and tactics used to overcome such challenges, however, they did not investigate the links of such factors or how they impact each other. The resulting conceptual framework add to the body of existing research and fill a gap in identifying various factors (technological or personal) that results in user adaptation patterns. This contribution directly addresses our first research question.

Second, responding to calls for further research on IS use patterns (Ortiz de Guinea and Webster, 2013), this research explores and identifies adaptive use patterns of blind and visually impaired user in different web environments. By understanding the different IT events that result in adaptive browsing behaviors, we can better predict IS usage success and outcomes of this special population, which is what we aimed for in the second research question.

Moreover, this research complements the existing research on technology use, adoption, and continuous use (e.g. Bhattacherjee, 2001). According to Burton-Jones and
Straub (2006), “The concept of individuals’ IS use patterns represents a rich and descriptive view of IS use.” Therefore, this dissertation represents a key initial effort to our future work on usage patterns and IS development for people with disabilities.

Finally, this study will attract attention to disabled IT users, a population that has been largely ignored in prior academic research in general and IT usage research in particular, and how to better design websites that meets the needs of this underserved community. People belonging to this group can benefit a great deal from scientific research that can help them enjoy the benefits of modern technologies, which are an integral part of today’s communication, knowledge, and self-expression.

6.2.2 Practical Implication

The findings of this research study have three main practical implications. First it provides ideas and guidelines for enhancing the offered training for blind and visually impaired users to overcome possible challenges faced. Based on our results, we found that if participant had knowledge about some of the technology adaptation strategies, there is a better chance for them to overcome challenges and feel less frustrated.

Second, the research conducted and the resulting findings inform policymakers to better recommend regulations related to web accessibility regarding people with disability. In April 2016, the Department of Justice delayed the Notice of Proposed Rulemaking (NPRM) of web accessibility regulations arguing that proposed recommendation should be more current with the evolving technology. They also called
researchers and designers to provide more details information about the needs and benefits of people with particular types of disabilities to access public entities websites. (DOJ, 2016) I believe this research responds to such calls by addressing new current challenges that the blind and visually impaired population face on their daily interaction with websites.

Finally, the study offers insights of possible web design improvement that would make the browsing experience for this population less challenging. Although accessibility guidelines are available through the W3C’s Web Accessibility Initiatives (WAI), the main focus of the above mentioned guidelines (Chapter 2) concerns technical accessibility. Although this perspective of accessibility is important, it only guarantee the technical functionality of websites and it is not sufficient in ensuring effective interaction with the Web for people with vision impairments. This was evident during the observation session with Participant 7, for example. When this participant was completing an e-commerce Amazon task, she faced a number of navigational challenges although the website is following the default technical accessibility recommended by WAI. Thus, compliance with the accessibility guidelines, does not ensure that the blind and visually impaired users won’t face problematic situations that would hinder them for achieving their goals (Raufi et al., 2015). In order to overcome the navigational challenges, there should be more focus on the conceptual aspect of web accessibility, which addresses the design and usability issues. Many studies have called for the
integration of the proposed web technical accessibility published by WAI and the
usability of the web as the disabled view it (e.g. Di Blas et al, 2004; Yates, 2005; Subasi et
al, 2009; Babu et al, 2010). The literature referred to this perspective as usable accessibility,
which “defines the understanding of user-centered aspects of accessibility problems”
(Subasi et al, 2009). Moreover, other studies have advocated the inclusion of the
disabled user in building, evaluating, and testing proposed guidelines (e.g. Mankoff et
al, 2005; Babu et al, 2010).

6.3 Limitations

Some limitations of this research study have already been addressed, particularly
in relation to the sample size. Throughout the research process it was challenging to
find blind and visually impaired participants, even with an attractive monetary
incentive. We have contacted a number of organizations, but they seemed very
conservative and didn’t allow us to conduct interviews or observations with their
patrons. Thus, the finding of this study is considered and treated as exploratory
research and should not be viewed as a representative of the blind and visually
impaired population in general. Also the issue of a small sample size did not allow us to
explore the entire spectrum of vision impairment cases that could result in uncovering
different sets of challenges and thus new adaptation strategies. However, we believe
that the small sample size was compensated with the depth of our analysis.
Another limitation is the quality of data obtained from the online surveys. Although we have sought a known organization, Qualtrics, to help us conduct the survey study, the quality control for the sample wasn’t high. While analyzing the data we found missing data, fraudulent responses and irrelevant answers. Moreover, the nature of online survey studies does not allow for the depth of answers as interviews.

Furthermore, although, as mentioned earlier, validation in qualitative research is different in nature than quantitative statistical validation, the proposed model can be enhanced by further statistical validation with a larger sample size.

6.4 Conclusions

The primary purpose of this qualitative exploratory research study was to identify different factors that impact the blind and visually impaired users when navigating website, and propose a conceptual model that explains their adaptation behaviors. We use interviews, online surveys, and observations with people with different levels of vision impairment to introduce a set of challenges, and adaptation strategies to better understand the navigational use pattern of blind and visually impaired individuals. Through an inductive and exploratory process, we proposed a conceptual model that shed some light on how the different factors (personal and technology) impact use patterns of this population in web environments; adaptation strategies were explored and discussed. Our findings support the idea that more
research and work need to be done to present website content in ways that fit people with disabilities needs, and mental models of how they approach a problem.

Moreover, the findings of this research study provide basis for further research related to people with disabilities interaction with computer technologies. Further studies could explore and explain the use pattern of a wide range of not only vision disabilities, but also other sensory and mental disabilities. Additional research could also focus on the aging population, who represent a large demographic in the United States. As their vision, hearing, memory and coordination changes, technology interfaces should take into consideration their needs. Accessibility features and building usable interfaces has shown to improve the web experience for all users.

The use of the web is no longer an optional extra as the Internet is becoming a central component in providing vast range of product and services. People with disabilities are a part of any society, and equipping them with better access to technology will have a positive impact on the society as a whole and adds to that society’s competitive advantage. Technology use in general and Internet use in specific should be promoted for the social inclusion of people with disabilities.
CHAPTER SEVEN: FUTURE RESEARCH

This chapter presents ideas of the future work related to design suggestions and experiments. I propose different ideas relating to enhanced design modifications, task-technology fit, and eye-tracking experiments.

Enhanced Design Experiment

The findings of this research study suggest the following design guidelines to enhance the user experience for the blind and visually impaired population:

• **Managing Flow and Content.** I identified issues with the linear flow in a website. In general, blind people rely on a keyboard for input. Thus, a user must be able to use the keyboard to complete all interactions. Designers must ensure that keyboard access is properly designed and clearly specify the exact order of how web elements should appear in for a keyboard user. For example, designers should specify the order for form interactions and paragraphs of content.

• **Recreating visual interaction.** Visual information must be represented in a non-visual way for those who cannot see or cannot see the entire screen at once. Someone that is blind or has low vision needs other text-based ways of representing this
information. This concept can apply for navigational wayfinding clues such as page title, headings on a page, and textual ways of specifying where the person is in navigation. This also can be applied to convey proper functionalities of elements in the screen. For example, designers must find other means to represent items distinguished by their colors.

- **Ensuring proximity in design.** Proximity is an important concept for everyone, especially for people with vision impairment. If two things are related, then they need to be close together in the interface and keystrokes should reflect that. To illustrate, when a blind user clicks on a “More information” link to get more information about content or forms, the screen reader should read out the pop-up window that appears instead of going through all the other links in the page and then the pop-up window content. In our observation study, we found that this happens repeatedly in web interfaces, and the impact is profound.

- **Setting expectations.** Meeting the expected functionality of a web items is very important to eliminate confusion and uncertainty to blind and visually impaired users. For someone with a visual impairment, designers need to come up with clear means to confirm to the user that an action has been made and that they are where they expect to be. For example, when a low vision user submits subscription form and the feedback content on this action is displayed in a dialog that disappears immediately, almost all the time, a screen magnifier user misses it. Because such
users are zoomed in, they are not aware of this action, therefore, their expectation of getting a confirmation of filling a form is broken. This causes confusion and the user might think she needs to re-do the action.

The above mentioned guidelines are suggested based on the repeated findings of the challenges that the blind and visually impaired users face. Although such challenges are also considered challenges for people without vision impairment, disability amplifies the severity of the issue. For someone who relies on assistive technology to navigate and use websites, the impact can be profound; the problem that might slow down a sighted person for a few seconds may slow a visually impaired person down for a few minutes. Designers role is always to strive for absolute clarity when creating websites; clarity in flow, content, functionality, and expectations of all web elements.

For future work, I plan to conduct a design experiment study that compares the performance of blind and visually impaired users on websites before and after implementing the above suggested guidelines. The study would test for user interaction across various websites that would range in accessibility challenges and capture users’ task completion, task time, and satisfaction. Table xx is an example of the potential experimental design of this study.
### Table 16. Potential Experimental Study Design

<table>
<thead>
<tr>
<th>Web Accessibility/Task Difficulty</th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low (pre-implementation)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High (post-implementation)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This study would also include reference to the task-technology fit (TTF) literature in selecting the different user tasks for the experiment. In other words, I plan to manipulate “fit” of websites in terms of usable accessibility features to examine performance outcomes and, thus, determine the ideal set of technology or software characteristics for blind and visually impaired users to perform task efficiently and effectively.

**Eye Tracking and Adaptive Interface**

Tracking the human eyes has been an interest to many fields and domains. The analysis and study of eye movement got a lot of attention in various disciplines due to the fact that eye movements are tied with the cognitive process of the human brain (Buscher et. al, 2012).

There are two broad applications for gaze data obtained from the eye tracking technology: diagnostic and interactive (Biedert et. al., 2010). Diagnostic applications cover a wide range of domains. This application focuses on understanding the behaviors of users and the way they use interfaces. The diagnostic domain has been used in various human-computer interaction applications (Biedert et. al., 2010). For
example, eye-tracking technology was used to enhance e-commerce websites designs. One of the studies focused on understanding how internet users perceive human images as one element of website design. It was concluded the human images in websites induced users to perceive the website as more appealing along with other positive characteristics. (Cyr et. al, 2009)

Interactive applications on the other hand are classified into two categories. The first address new ways of human–computer interaction using gaze input, which could alter the runtime behavior of the system. The second interactive application is to implicitly provide users with certain functionalities based on the observation of the eye movements. These functionalities are meant to assist users and provide them with their “inferred” needs (Biedert et. al, 2010).

From the literature related to disability and eye tracking technology, I found that most of the applications developed for and used by people with disabilities are active interfaces, which allow users with movement disabilities to interact with computers through eye movements and gaze input. The focus of future work in this area is on the use of passive applications in assisting people with vision impairment, specifically people suffering from low vision and reading difficulties. The first step in achieving this objective is determining the reading behaviors of online users with low vision. After learning and analyzing the reading behaviors of such users, the focus becomes in adapting the interface to their needs accordingly.
In order to achieve these objectives, I plan to propose an algorithm that extends previous reading detection algorithms\(^7\) by introducing a new behavior category, low vision. Once the algorithm detects the low vision users’ profile, the main objective is to enhance the reading experience for individuals with low vision. We define these enhancements as providing a few accessibility features that enables them to better read and browse websites such as font style and size, and background and foreground colors.

\(^7\) One example is the proposed algorithm for detecting normal users’ reading behaviors by Buscher et. al. (2008)
REFERENCES


May, Matt (2005). Inaccessibility of CAPTCHA. W3C.


National Center for Health Statistics (2010). National Health Interview Survey.


Union of the Physically Impaired Against Segregation (1976). Fundamental Principles of Disability. London: UPIAS and The Disability Alliance, 3-4


WebAIM Web Accessibility in Mind (2013). *Creating Accessible Flash Content*.

WebAIM Web Accessibility in Mind (2014). *PDF Accessibility*.


Appendix A: Table 1A Studies on BVI Behaviors

<table>
<thead>
<tr>
<th>Study</th>
<th>Objective</th>
<th>Identified Behaviors</th>
<th>Results</th>
<th>Methods</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vigo, M., &amp; Harper, S. (2014)</td>
<td>This study explored the adaptive behavior of novice visually disabled in the Web environment, and their coping tactics when faced with challenges.</td>
<td>2 main groups: last resort tactics and exploration tactics</td>
<td>As the sessions go on, last resort tactics are gradually replaced by exploration tactics: exploration, narrowing down, gaining orientation and redoing.</td>
<td>In situ observations</td>
<td></td>
</tr>
<tr>
<td>Vigo &amp; Harper (2013a)</td>
<td>Secondary analysis of 2 independent datasets containing the interaction of 24 users. They determine the situations in which coping occurs (uncertainty, reduced mobility, confusion and overload), and identify 17 tactics employed to overcome these situations (e.g. impulsive clicking, exploration tactics and re-doing).</td>
<td>17 tactics: 7 main categories</td>
<td>The analysis confirms that most of the problems encountered by visually impaired users are not caused by accessibility problems</td>
<td>• Think-aloud protocol,</td>
<td>• Each participant had to accomplish four tasks without any time limitation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Each participant had to accomplish four tasks without any time limitation</td>
<td>• Observation of free browsing</td>
</tr>
<tr>
<td>Study</td>
<td>Objective</td>
<td>Identified Behaviors</td>
<td>Results</td>
<td>Methods</td>
<td>Comments</td>
</tr>
<tr>
<td>------------------------------</td>
<td>----------------------------------------------------------------------------</td>
<td>----------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
<td>------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| **Brinkley & Tabrizi** (2013) | A pilot study on the online behavioral habits of 46 internet users; 26 of whom self-identified as having a visual impairment | NA                   | • Differences do exist between the online behavior of sighted users and users with visual impairments.; visual impairment may have a significant impact on information seeking and online exploratory behavior.  
• Additional research is needed to explore the usability difficulties that users with visual impairments encounter on SN websites specifically. | Online Questionnaire |                                                                          |
| **Vigo and Harper** (2013b)  | The study identified navigation coping tactics of screen reader users       | 3 tactics categories  | • Navigation is not driven by information scent or utility, but by the need of increasing autonomy and the need of escaping from the current web patch.  
• Navigation tactics were employed by users in a number of problematic situations  
• In situations of reduced mobility and overload (caused mainly by | 4 Tasks without any time limitation.; think-aloud | Observations     |
<table>
<thead>
<tr>
<th>Study</th>
<th>Description</th>
<th>Coping strategies/Patterns</th>
<th>Tasks on Web pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lunn et al (2011)</td>
<td>The study developed a coping framework for identifying strategies that users may employ when they face difficulties accessing the content. (Extreme conditions)</td>
<td>46 coping strategies; 6 abstract patterns of coping</td>
<td>Behavior-driven transcoding can improve access to Web content. Fig 10</td>
</tr>
<tr>
<td>Harper</td>
<td></td>
<td></td>
<td>Tasks on Web pages</td>
</tr>
<tr>
<td>Trewin et al (2010)</td>
<td>Describe information seeking strategies observed in people with visual impairment using screen reading software for Web navigation tasks. They outline one example strategy for approaching a new Web page that, guided by information foraging theory, may expose access barriers that current design tools miss.</td>
<td>Landmarks were important in familiar websites. In unfamiliar websites users tend to listened to the headings to get an overview of the page.</td>
<td>• 4 task: 1. Familiar site, 2. Google (# of ppl in a city), 3. Find a buy ticket link, 4. Encyclopedia search • Interviews • Observations</td>
</tr>
<tr>
<td>(Borodin et al., 2010)</td>
<td>The study provided a detailed overview of existing web accessibility problems and describe the coping strategies employed by screen-reader users to overcome these problems.</td>
<td>Different coping strategies</td>
<td>3 users</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No mention of methodology used, focused on screen reader users. Mention the task environment!</td>
</tr>
<tr>
<td>Study</td>
<td>Objective</td>
<td>Identified Behaviors</td>
<td>Results</td>
</tr>
<tr>
<td>------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>----------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Vigo et al (2009)</td>
<td>User test study with 16 users was conducted in order to observe the strategies they followed when links were annotated with scores that indicates the conformance of the target Web page to blind user accessibility and usability guidelines.</td>
<td>NA</td>
<td>• With annotated links, the navigation paradigm changed from sequential to browsing randomly through the subset of those links with high scores. Users found annotations helpful when browsing through links related to a given topic.</td>
</tr>
<tr>
<td>Michailidou, Harper et al (2008)</td>
<td>An eye tracking study where sighted users' browsing behavior on nine Web pages was investigated to determine how the page's visual clutter is related to sighted users' browsing patterns.</td>
<td>First Fixation: users expect to find the most important information in the main content area or the appearance of salient elements (such as eye-catching logos, pictures, and flashing images) attracts their attention first. Average Gaze Time Fixation Counts Gaze Order Salient Elements</td>
<td>The results show that salient elements attract users' attention first. Users spend more time on the main content of the page and users tend to fixate on the first three or four items on the menu lists. Common gaze patterns begin at the salient elements of the page, move to the main content, header, right column and left column of the page and finish at the footer area.</td>
</tr>
<tr>
<td>Study</td>
<td>Objective</td>
<td>Identified Behaviors</td>
<td>Results</td>
</tr>
<tr>
<td>------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Bigham et al. (2007).</td>
<td>They conducted a wide-ranging remote study using a proxy to record the Web pages that users visited and the keystrokes that they made to determine what coping strategies visually impaired users employed compared to sighted users.</td>
<td>Use coping strategies to overcome accessibility barriers</td>
<td>• Blind participants spent more time on average on each page visited than sighted participants.</td>
</tr>
<tr>
<td>Lazar et al. (2007)</td>
<td>In this study, 100 blind users, using time diaries, recorded their frustrations while using the Web. The top causes of frustration reported were (a) page layout causing confusing screen reader feedback; (b) conflict between screen reader and application; (c) poorly designed/unlabeled forms; (d) no alt text for pictures; and (e) misleading links, inaccessible PDF, and a screen reader crash.</td>
<td>Participants responded to the frustrating experience by restarting the program or rebooting</td>
<td>• Blind users in this study were likely to repeatedly attempt to solve a frustration, not give up, and not reboot the computer.</td>
</tr>
<tr>
<td>Shinohara and Tenenberg (2007)</td>
<td>The authors observed a single visually impaired user in her home for a total of twelve hours, spread out over six two-hour sessions. The aim of the study was to understand how technology can be difficult to use for visually impaired users and the workarounds users employ when difficulties arise.</td>
<td>Whenever thus user was lost, they go back to the start page</td>
<td>• The blind users reported losing, on average, 30.4% of time due to these frustrating situations.</td>
</tr>
<tr>
<td>Goble et al. (2000)</td>
<td>This paper presents the ground work for including travel into web design and usability metrics by presenting a</td>
<td>Blind users employed several mobility</td>
<td></td>
</tr>
<tr>
<td>framework for identifying travel objects and registering them as either cues to aid travel or obstacles that hinder travel for visually impaired users.</td>
<td>instruments in their journeys</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix B: Interview Informed Consent

Oral Informed Consent to Participate in Research
Information to Consider Before Taking Part in this Research Study
IRB Study # Pro00007362

You are being asked to take part in a research study called:

Exploring the Browsing Behavior of Blind and Visually Impaired Users

This research study is being conducted by Raneem Saqr, a PhD in the Information Systems and Decision Sciences at USF. She is being guided in this research by Dr. Anol Bhattacherjee and Dr. Rosann Collins.

The purpose of this study is to understand browsing behaviors of users with visual impairment. The research will identify your browsing strategies across different websites and suggest ways of improving user experience.

In this study, you will be asked to take part in interviews, and/or questionnaires.

For the first session, The interview may last around 40 minutes. The research will be conducted at USF campus or at a site that is convenient for participants.

The interview will be audio recorded with your consent. Your response will remain confidential and anonymous, and will not be disclosed to a third party.

If you have questions about your rights as a participant in this study, or complaints, concerns or issues, please call the USF IRB office at (813) 974-5638.

If you want to take part, please give your oral consent to take part in this study.
Appendix C: Interview Protocol

**Demographics:**
What is your age?
Are you a Male or Female?

What is your current occupation?
What is the highest degree or level of school you have completed or currently enrolled in?
How long have you been using a computer?
What’s your visual impairment level? May you please talk about when and how you had it more.

**Internet use:**
How often do you use websites? For what purpose? (work, pleasure, Social pressure, …etc.)
Which websites would you like to visit frequently?
Why do you visit or not visit websites?
What device do you use to browse websites? (PC, Laptop, Tablet, Mobile Phone)
  - Is there a particular reason to use this device
  - If you mention Mobile phones or tablets:
    ▪ How is your web browsing experience different in a mobile device?
    ▪ What difficulties do you experience when using mobile phones?
From Where do you browse websites? Is there a particular reason to browse from this location
What browser do you use to browse websites? Is there a particular reason to use this browser

**Accessibility:**
What tools do you use for reading websites (magnification, screen readers, etc.)?
What tools do you think will be useful to brows websites?
Is there a time that you wanted to use the website and it wasn’t accessible? Give an Example of a situation that prevented you from using a website
Can you give a good example of a good (accessible) website? Why is it good in your opinion?
Can you give an example of a poor (inaccessible) website? Why is it poor in your opinion?
In your opinion, what could have improved your using of the poor websites?

**Information Overload:**
Is it hard for you to read or understand website contents? Why?
Do you feel that the website is has too much information that makes it difficult for you to read? Example
Does it take you a long time to find specific information on a website?
What features on a website will make it easier for you to read or understand website contents?

**Effort:**
Do you find web browsing to be tiresome, frustrating, exhausting, annoying, time-consuming, …etc.? Why?
If the amount of effort in using a website is reduced, would you use it more/less/same?

**Navigation:**
Can you easily locate where you are on a website? Elaborate
Is it difficult to navigate through websites? Elaborate
Do you navigate different websites differently i.e. social network vs. e-commerce vs. content websites? Please elaborate

**Layout and Design:**
What aspect of the layout of web pages bothers you the most?(e.g. table, certain colors, graphics, …etc.)
Does too much images, audio or video hinder you from using the website? Elaborate
Would it be easier for you to view tables if they were converted to text or other form? Elaborate
Appendix D: An Open Coding Example

Interview Questions

Demographics:

- What is your age?
  58 female.
- What is your current occupation?
  I am retired.
- What is the highest degree or level of school you have completed or currently enrolled in?
  I am a high school graduate with some college courses.
- How long have you been using a computer?
  20 years.
- What’s your visual impairment level? May you please talk about when and how you had it in more details.
  I am totally blind. I lost my vision when I was 2 years old from retinoblastoma, a childhood eye cancer.

Internet use:

- How often do you use websites? For what purpose? (work, pleasure, social pressure, etc.)
  I use the internet several times a day for social sites, shopping, research, etc.
- Which websites would you like to visit frequently?
  I visit Facebook, Google search, amazon.com, other shopping sites, several store sites, newspaper sites.
- Why do you visit or not visit websites?
  I visit sites to shop or read articles/stories. I don’t visit sites that are not accessible; many are not to screen reader software.
- What device do you use to browse websites? (PC, Laptop, Tablet, Mobile phone)
  I use a PC, netbook, or mobile phone.
- Is there a particular reason to use this device
  I use a device that has either built-in speech (as in the iPhone), or a computer with screen reading software.
- How is your web browsing experience different in a mobile device?
  It is sometimes easier because mobile sites are simpler to navigate.
- What difficulties do you experience when using mobile phones?
  I do not really have trouble with my iPhone.
- Which browser do you use to browse websites? Is there a particular reason to use this browser
  I use internet explorer because it works with screen readers such as JAWS. Google chrome does not.

Accessibility:

- What tools do you use for reading websites (magnification, screen readers, etc.)?
  I use JAWS for Windows. It is a screen reader.
- What tools do you think will be useful to browse websites?
  I think that just having websites comply with ADA requirements would be most helpful.
- Is there a time that you wanted to use the website and it wasn’t accessible? Give an Example of a situation that prevented you from using a website
  There was a shopping site where I wanted to buy something. I had to sign up for an account, and when I got to the end, there was a visual picture of numbers and letters that I would have had to type in in order to complete the transaction. Obviously, I couldn’t do that, so I couldn’t accomplish my buy. These come up often and make posting, shopping, commenting, (lots of things) impossible.
- Can you give a good example of a good (accessible) website? Why is it good in your opinion?
  I like amazon.com. They have an accessible version, but I use the regular one. I can perform searches for products easily, shop, review, anything I need to do easily. They have graphics, but most of them are labeled and they don’t seem to interfere.
- Can you give an example of a poor (inaccessible) website? Why is it poor in your opinion?
  The Humana.com site is pretty bad. I find myself going around in circles. There are some parts I just can’t get anywhere with. I’m not sure why all the problems, I just know it is a challenge to get anything
• In your opinion, what could have improved your using of the poor websites? They just need to be designed to work with screen readers. Sometimes, a link or button does nothing when clicked on. Sometimes, it does something, but there is no feedback to let us know.

Information Overload:

• Is it hard for you to read or understand website contents? Why? I would say, no. It is not hard to read. It could be hard to understand the contents if there are lots of unlabeled graphics.

• Do you feel that the website is has too much information that makes it difficult for you to read? Example: Lots of repetition makes a site string to read but not difficult.

• Does it take you a long time to find specific information on a website? Not usually, I can look quickly through the links and do word searches. I’m quicker than lots of inexperienced people with sight.

• What features on a website will make it easier for you to read or understand website contents? Some sites have a link to a more accessible version of their site. It is more straightforward with fewer graphics. I appreciate the effort some companies put in.

Effort:

• Do you find web browsing to be tiresome, frustrating, exhausting, annoying, time-consuming, ...etc? Why? Usually, it is not frustrating just to browse. I can find the information I’m looking for most of the time without a problem.

• If the amount of effort in using a website is reduced, would you use it more/less/same? Of course, if a site is easier to use, I would use it over others.

Navigation:

• Can you easily locate where you are on a website? elaborate. As far as position on a page, no. Whereas someone will say, look at the top right, it’s hard to tell where that would be. Can do a screen reader search through to find a word or number that will bring me right to a spot. I just couldn’t then tell you the position of what I have found, i.e. top middle or bottom right side. Please.

• Is it difficult to navigate through websites? Please elaborate. With some sites, everything doesn’t show up to a screen reader. I can move around a page as far as it goes just fine, but there are times when I am told about a button or box that just isn’t there for a screen reader; therefore, I can’t click on it.

• Do you navigate different websites differently i.e. social network vs. e-commerce vs. content websites? Please elaborate. I attempt to navigate all sites the same way. With a screen reader, you navigate with arrow keys and tab. The screen reader also has keys to enable navigation by headings, combo boxes, and check boxes. You can also find edit fields and buttons easily with 1 key.

Layout and Design:

• What aspect of the layout of web pages bothers you the most? (e.g., table, certain colors, graphics, ...etc.) Graphics are a problem if they are not labeled. If a graphic is labeled, it’s not a problem; we know what the picture is if it’s labeled. With tables, I can miss things.

• Does too much images, audio or video hinder you from using the website? Audio is horrible if it just starts playing when you open a page. It makes it impossible to hear the screen reader. It’s even hard to turn it off because you can’t hear the screen reader. It is very frustrating. Another problem sometimes encountered is the constantly refreshing screen, which makes it impossible to read anything before the screen switches content.
Appendix E: Sample of Online Survey

**Default Question Block**

Q1. Browser Meta Info

This question will not be displayed to the recipient.

**Browser:** Safari
**Version:** 8.0.8
**Operating System:** Macintosh
**Screen Resolution:** 1440x900
**Flash Version:** 18.0.0
**Java Support:** 1
**User Agent:** Mozilla/5.0 (Macintosh; Intel Mac OS X 10_10_5) AppleWebKit/600.8.9 (KHTML, Like Gecko) Version/8.0.8 Safari/600.8.9

Q2. The purpose of this study is to identify the different browsing behaviors of individuals with various vision impairments.

By completing this survey you give your consent to be part of this study.

Q3. The following set of questions relate to you and your browsing behavior in general.

Q4. What is your age?

- Under 18 years
- 18 to 24 years
- 25 to 34 years
- 35 to 44 years
- 45 to 54 years
- 55 to 64 years

---

Q5. What is your gender?

- Male
- Female

Q6. What is the highest degree or level of school you have completed or currently enrolled in?

- Less than high school
- High school graduate (includes equivalency)
- Some college, no degree
- Associate's degree
- Bachelor's degree
- Ph.D.
- Graduate or professional degree
- Other, please specify

Q7. What is your current or most recent occupation?

---

Q8. What is your visual impairment level?

- Moderate Low Vision (your reading ability is near-normal with reading aids and you use low power magnifiers or large print books)
- Severe Low Vision (your reading ability is slower than normal with reading aids, and you use high power magnifiers)
- Profound Low Vision (your reading ability is slower than normal with reading aids, uses high power magnifiers)
- Near-Blindness (no visual reading must rely on talking books, Braille or other non-visual sources)

---

8 The presented survey is not the complete survey; to preserve space this is only a sample of some sections of the online questionnaire.
Q9. When was the onset of the vision impairment?

On Birth
Early, less than three years old
Late, please specify

Q10. May you please talk in more detail about your vision condition?

Q11. For how long have you been using a computer?

Less than a Year
1 to 3 years
4 to 6 years
7 to 9 years
10 years or more

Q12. Where do you usually use a computer and browse the Internet? Check all that apply

Home
Work
School
Library
Public Internet Cafes
Other

Q13. How would you rate your current Internet or Web skills?

Poor
Fair
Good
Very Good
Excellent

Q14. How often do you use the Internet?

Less than Once a Month
Once a Month
2-3 Times a Month
Once a Week
2-3 Times a Week
Daily

Q15. What do you usually use the Internet for? Pick top three

Work
School or Education
Social Networks
Pleasure and Entertainment
E-mail and communication

Q140. Do you use social media websites?

Yes
No
Q110. On a Scale from 1 to 10, how **challenging** is it for you to browse the mentioned websites - one being the least challenging and ten the most challenging?

<table>
<thead>
<tr>
<th>Least Challenging</th>
<th>Most Challenging</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td>NA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Social Network Sites</th>
<th>Online Shopping Website</th>
<th>Online Search Engines</th>
<th>Content-based Read Only Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

Q112. On a Scale from 1 to 10, how much **effort** do browsing mentioned websites require - one being least effort and ten most effort.

<table>
<thead>
<tr>
<th>Least Effort</th>
<th>Most Effort</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td>NA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Social Network Sites</th>
<th>Online Shopping Website</th>
<th>Online Search Engines</th>
<th>Content-based Read Only Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

Q111. On a Scale from 1 to 10, how **frustrating** is browsing the mentioned websites - one being least frustrating and ten most frustrating.

<table>
<thead>
<tr>
<th>Least Frustrating</th>
<th>Most Frustrating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td>NA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Social Network Sites</th>
<th>Online Shopping Website</th>
<th>Online Search Engines</th>
<th>Content-based Read Only Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

Q113. On a Scale from 1 to 10, how **easy** is it for you to navigate through the mentioned websites - one being extremely easy and ten extremely difficult.

<table>
<thead>
<tr>
<th>Extremely Easy</th>
<th>Extremely Difficult</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td>NA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Social Network Sites</th>
<th>Online Shopping Website</th>
<th>Online Search Engines</th>
<th>Content-based Read Only Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
Appendix F: Observation Informed Consent

Informed Consent to Participate in Research
Information to Consider Before Taking Part in this Research Study
IRB Study # Pro00007362

You are being asked to take part in a research study called:

Blind and Visually Impaired Users Adaptation to Web Environments

This research study is being conducted by Raneem Saqr, a PhD in the Information Systems and Decision Sciences at USF. She is being guided in this research by Dr. Anol Bhattacherjee and Dr. Rosann Collins.

The purpose of this study is to understand browsing behaviors of users with visual impairment. The research will identify your browsing strategies across different websites and suggest ways of improving user experience.

In this study, you will be asked to take part in observations tasks and follow up questionnaires.

For the session, the observation may last up to 90 minutes. The research will be conducted at USF campus.

The session will be video recorded with your consent. Your response will remain confidential and anonymous, and will not be disclosed to a third party.

If you have questions about your rights as a participant in this study, or complaints, concerns or issues, please call the USF IRB office at (813) 974-5638.

By accepting to participate, you give your consent to take part in this study.
Appendix G: Observational Task

You will be given 7 tasks to complete. There is no time limit to complete each task.

- Task 1: Go to Amazon.com and try to Purchase a book titled “A Web for Everyone: Designing Accessible User Experiences” by Sarah Horton and Whitney Quesenbery. Please proceed to checkout and stop right at the credit card information.


- Task 3: Find out if it is going to rain in Tampa, FL this weekend.

- Task 4: Subscribe to newsletters in webmd.com that might interest you. Note: If you don’t want to use your personal email, you can use this email: xxxxx@yahoo.com.

- Task 5: Send a Facebook friend request to “Rosann Collins” a faculty member at the University of South Florida.

- Task 6: go to cnn.com, and try to read one of the top news links for today.

- Task 7: You’re planning a vacation to Washington, DC from March 31 to April 4 to tour main attractions in the city including the White House. You need to buy both airfare and hotel. Go to one of the travel sites (Kayak, Priceline, Expedia … etc.) and book your stay. (you can stop right at the traveler information page).
Appendix H: IRB Study Approval

5/19/2015

Raneem Saqr  USF Information Systems & Decision Sciences 10420 N McKinley Dr Apt 12312  Tampa, FL 33612

RE: Expedited Approval for Continuing Review  IRB#:  
CR2_Pro00007362  Title: Usable Web Accessibility: A User-Centered Approach for People with Visual Impairment

Study Approval Period: 6/7/2015 to 6/7/2016

Dear Raneem Saqr:

On 5/18/2015, the Institutional Review Board (IRB) reviewed and APPROVED the above application and all documents outlined below.

Approved Item(s): Protocol Document(s): Research Proposal V1 5.24.13

The waiver of documentation of informed consent has been renewed.

The IRB determined that your study qualified for expedited review based on federal expedited category number(s):

(6) Collection of data from voice, video, digital, or image recordings made for research purposes.

(7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or
practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

As the principal investigator of this study, it is your responsibility to conduct this study in accordance with IRB policies and procedures and as approved by the IRB. Any changes to the approved research must be submitted to the IRB for review and approval by an amendment.

[Signature]

John A. Schinka, Ph.D.

We appreciate your dedication to the ethical conduct of human subject research at the University of South Florida and your continued commitment to human research protections. If you have any questions regarding this matter, please call 813-974-5638.

Sincerely,

John Schinka, Ph.D., Chairperson

USF Institutional Review Board