

# A Research Framework and Initial Study of Browser Security for the Visually Impaired

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## ABSTRACT

In this paper, we describe ongoing work that investigates the accessibility of browser security warnings for the visually impaired. To date, this has been an ignored area of usability research, perhaps due to the unique challenges inherent in such research. The goal of the study is to ultimately understand visually impaired users' experiences with browser security warnings in a natural setting. Our approach leverages an embedded mixed methods research design that combines data from questionnaires and interviews. Broadly, this research aims to lay the groundwork for future usability studies on the accessibility of browser security so that a wider range of users can browse the web more safely.

## 1. INTRODUCTION

Browser security warnings are designed to protect users from possible network attacks, malware, and phishing scams. When the browser cannot distinguish between a benign situation and a true attack, the browser interrupts the user. The user can then decide to click through (i.e. ignore) the warning or return to safety [1].

The effectiveness of browser security warnings has been widely studied in the literature [8, 17]. Felt et al. described comprehension (a preferred goal) and adherence (a secondary goal) as measures of their effectiveness [9]. Wogalter et al. established research-based guidelines for warning design and evaluation that have since been put into practice [18]. Bravo et al. detailed a mental model of warning response behaviors for advanced and novice users, and found that novice users immediately pay attention to the warning's look and feel [3]. Felt et al. lowered click through rates (CTRs) in Google Chrome's SSL warnings by using opinionated warning design and reported that design only accounted for between a third and a half of the difference in CTRs between Chrome and Firefox, and suggested that other factors influence CTR [10].

But while the visual design of security warnings has been refined and tested in browsers, there has been little work

done to evaluate warnings with respect to accessibility. Hochheiser et al. identified accessibility concerns with anti-phishing tools, including the widespread use of color [12]. Implementing visual warning design guidelines and practices (e.g. style, color, symbols, some aspects of opinionated design) may promote safety for sighted users, but is ineffective for improving adherence with visually impaired (VI) users. The largely unsolved usability challenges with browser warnings are amplified for VI users.

While checklists to evaluate the accessibility of websites exist, Petrie and Khier found that there is little relationship between accessibility guidelines and the problems important to blind users [16]. To gain a complete understanding of warning effectiveness, the opinions and preferences of VI users need to be observed and measured, exposing possible accessibility problems that browser security warnings may present to this audience.

In this paper we consider the question: how do visually impaired users experience browser security warnings with a screen reader, and what research methodologies should be used to measure the same? The UN Convention on the Rights of Persons with Disabilities considers "access to information and communications technologies, including the Web" to be a basic human right<sup>1</sup>. In the spirit of disability inquiry and prioritizing basic human rights [15], the goal of the present work is to understand how VI users experience browser security warnings through a pre-usability study. In contrast to normative user studies, in which variables and expectations are well established, we believe a new approach that first establishes the "right" questions to ask, and identifies the themes common to VI users' experiences is necessary.

We aim to make two contributions: first, we identify a research approach that addresses many of the unique challenges when conducting usability research for VI users, and second, we propose a concrete initial study to be conducted in the Summer 2015. A full usability study for testing research-based accessibility metrics is a goal for future work.

## 2. A PROPOSED METHODOLOGY

The challenges inherent to addressing this problem include managing the differences in warnings for various browsers, browser versions, and operating systems. Every browser shows a different warning page and offers differing levels of accessibility since each browser has their own Accessibility API that is queried by the screen reader<sup>2</sup>. Screen readers

<sup>1</sup><http://www.w3.org/standards/webdesign/accessibility>

<sup>2</sup><http://www.ssbartgroup.com/blog/how-browsers->

are expensive and access to a variety of screen readers at universities is limited. Rigorous measurements of adherence and comprehension with ecological validity is another challenge with VI users. Previous studies have used screenshots [2, 11] or eye-tracking to study users' reactions and perceptions to security interfaces. These methods cannot be used with VI users.

To address some of these challenges, we propose using an embedded mixed-methods design approach with qualitative and quantitative components, a relatively new methodology originating in the late 1980s and early 1990s [6]. The advantage of a mixed methods approach is the ability to combine and integrate both forms of data into the analysis.

## 2.1 Data Collection

There are different types of mixed methods designs with varying approaches to data collection. In the embedded model of mixed methods research design, one data type provides a minor supportive role in a study based primarily on the other data type [4, 5]. The secondary data can either be collected before or after the primary data. In our proposed study, a questionnaire plays a supplemental role within the larger context of in-person interviews. This research design is useful as prior knowledge of the user's setup can help the researcher prepare for the in-person interviews, resulting in more meaningful qualitative results. Another advantage to this design is that it requires only one researcher [6].

Qualitative data is typically collected at the site that participants experience the problem under study [6]. For this reason, the in-person interviews should be conducted at the participant's home, work place, or other preferred natural setting using the operating system, browser, and screen reader that they are most comfortable with.

Both interviews and focus groups can be considered as approaches to obtaining qualitative data. The advantage of a focus group is that several participants meet at the same time to generate meaningful discussion and offer differing viewpoints [14]. However, it may be inappropriate to encourage differing viewpoints for sensitive topics such as those involving disabilities. Additionally, the researcher would not be able to carefully observe participants using their natural computer setup in a focus group. For these reasons, one-on-one interviews should be most appropriate.

## 2.2 Data Interpretation

To interpret the data collected from individual participants, key statements from text transcriptions and notes from video recordings should be combined with information about their setup to gain a holistic view of their experience. Users with disabilities often have intricate and personalized computer setups<sup>3</sup>. The questionnaires can reveal how the operating system, screen reader, and browser they typically use may affect their experience with the warnings. For instance, information about a VI user's screen reader from the questionnaire can shed light on possible difficulties with interactive components on a warning page that are discovered during the interview. These interpretations should lead to developing five to seven key themes common to all five participants [7].

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interact-with-screen-readers-and-where-aria-fits-in-the-mix/

<sup>3</sup><http://www-03.ibm.com/able/resources/ueplansessions.html>

## 2.3 Validity

To check the validity of results, the accuracy of the themes developed can be justified by triangulating multiple sources of data [6]. We can combine perspectives offered from different participants, for example. Themes extracted from one participant's interview alone is not sufficient to make conclusions about VI users due to differing operating system, browser, and screen reader preferences and capabilities. For example, it is possible that a button that can be accessed by one screen reader may not be accessed using a different one. We should also consider that the meanings of words may differ across participants. This makes it important to incorporate the data from questionnaires into answers to interview questions and examine the situations across all participants. Finally, a third source of data is video recording, addressing issues of uniformity across experiments: e.g. if a screen reader cannot access an element on the page, the participant cannot talk about it. Themes that emerge from notes on video recordings triangulated with the questionnaires and interview transcriptions can add validity.

## 2.4 Ethical Considerations

Kvale recognized that interviews for qualitative research carry an asymmetrical power relation between interviewer and interviewee, which can result in a "potential oppressive use of interviewer-produced knowledge" [13]. The researcher should strive to be aware of potential power imbalances at every stage of the study, from the formation of scenarios to the discussion of results.

Interviews can be stressful, invasive, and time consuming. Screen readers can be exhausting to use when the interface may not be accessible or have clear actions to take. We should minimize the steps involved to access the warning pages and limit the number of interview questions to what is necessary. Interview questions should also be left open-ended to allow for flexibility of the direction of the interview, instead of being too structured according to the interviewer's interests that can be based on false assumptions. The language used in constructing interview questions should avoid making assumptions about what is important to VI users as well. Privacy is also a major concern. Since VI users cannot know what the researcher is seeing on their screen, the researcher must respect participants' privacy at all costs. The researcher should also document their existing understanding of key concepts that may affect the interpretation of VI users' experiences. When interpreting answers to interview questions, the researcher should investigate what common terms might mean to VI users, instead of what the researcher supposes they mean.

## 3. AN INITIAL STUDY

This section describes an initial attempt at implementing the proposed methodology and the current status of this work.

### 3.1 Participants

Our target demographic is blind or visually impaired people who access the web using a screen reader. Nielsen recommended that five participants is sufficient to identify most usability problems, with respect to the iterative design process of improving projects<sup>4</sup>. Recruitment of five participants

<sup>4</sup><http://www.nngroup.com/articles/why-you-only-need-to->

will be carried out by e-mail requests to a BCC alias maintained by our university. In accordance with non-deceptive human subjects research, the purpose of the study will be fully disclosed to participants, and informed consent will be collected.

### 3.2 Research Protocol

The questionnaire distributed in the first phase of data collection will ask participants closed-ended questions about their operating system, browser, and screen reader settings. This questionnaire will be delivered to participants by e-mail. This questionnaire data will be collected prior to the interviews to inform and refine the interview questions.

In-person interviews in the second phase of data collection will involve task-based scenarios, a scenario for each warning type: phishing, malware, and SSL. For each scenario, the participant will be asked to navigate to a canonical example of a warning by performing one or more tasks. In the phishing warning scenario, participants will be asked to click a link inside a fake phishing email. The reason for this is to demonstrate to the participant a common phishing scenario. In the malware and SSL warning scenarios, participants will be asked to directly navigate to the respective example page using a shortened URL.

Eight to ten open-ended questions will be asked during the in-person interviews for each scenario, and participants will be encouraged to think aloud at appropriate times. Participants will be videotaped and notes will be taken during the interviews.

### 3.3 Current Status

The materials for this study are being prepared for submission to the IRB. The research protocol is also being refined by testing with sighted pilot study participants. The study with VI users is expected to take place in late June and July 2015, with preliminary results expected by late July 2015.

## 4. CONCLUSION

The field needs to establish a framework for studying the perceptions and experiences of browser security warnings for users with disabilities. This requires ideas for recruiting users with disabilities, shared experiences with conducting studies in participants' natural settings, and methods for establishing the validity of qualitative data with this demographic. We hope that a discussion on the accessibility of browser security will be of interest to the community of researchers in inclusive usability and security.

## 5. REFERENCES

- [1] D. Akhawe and A. P. Felt. Alice in warningland: A large-scale field study of browser security warning effectiveness. In *Usenix Security*, pages 257–272, 2013.
- [2] H. Almuhiemedi, A. P. Felt, R. W. Reeder, and S. Consolvo. Your reputation precedes you: History, reputation, and the chrome malware warning. In *Symposium on Usable Privacy and Security (SOUPS)*, 2014.
- [3] C. Bravo-Lillo, L. F. Cranor, J. S. Downs, and S. Komanduri. Bridging the gap in computer security warnings: A mental model approach. *IEEE Security & Privacy*, 9(2):0018–26, 2011.
- [4] V. J. Caracelli and J. C. Greene. Crafting mixed-method evaluation designs. *New directions for evaluation*, 1997(74):19–32, 1997.
- [5] V. L. P. Clark and J. W. Creswell. Designing and conducting mixed methods research, 2011.
- [6] J. W. Creswell. *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications, 2013.
- [7] J. W. Creswell and V. L. P. Clark. Principles of qualitative research: Designing a qualitative study. Office of Qualitative & Mixed Methods Research, University of Nebraska, Lincoln. Retrieved at <http://www.andrews.edu/leaderpart/roundtable/2004/workshops/2b/auqual-071504-jwc-vpc.pdf>, 2004.
- [8] S. Egelman, L. F. Cranor, and J. Hong. You've been warned: an empirical study of the effectiveness of web browser phishing warnings. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pages 1065–1074. ACM, 2008.
- [9] A. P. Felt, A. Ainslie, R. W. Reeder, S. Consolvo, S. Thyagaraja, A. Bettles, H. Harris, and J. Grimes. Improving ssl warnings: Comprehension and adherence. In *Proceedings of the Conference on Human Factors and Computing Systems*, 2015.
- [10] A. P. Felt, R. W. Reeder, H. Almuhiemedi, and S. Consolvo. Experimenting at scale with google chrome's ssl warning. In *Proceedings of the 32nd annual ACM conference on Human factors in computing systems*, pages 2667–2670. ACM, 2014.
- [11] B. Friedman, D. Hurley, D. C. Howe, E. Felten, and H. Nissenbaum. Users' conceptions of web security: A comparative study. In *CHI'02 extended abstracts on Human factors in computing systems*, pages 746–747. ACM, 2002.
- [12] H. Hochheiser, J. Feng, and J. Lazar. Challenges in universally usable privacy and security. In *Symposium On Usable Privacy and Security (SOUPS)*, volume 2008, 2008.
- [13] S. Kvale. Dominance through interviews and dialogues. *Qualitative inquiry*, 12(3):480–500, 2006.
- [14] J. Lazar, J. H. Feng, and H. Hochheiser. *Research methods in human-computer interaction*. John Wiley & Sons, 2010.
- [15] D. M. Mertens. *Transformative research and evaluation*. Guilford press, 2009.
- [16] H. Petrie and O. Kheir. The relationship between accessibility and usability of websites. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 397–406. ACM, 2007.
- [17] J. Sunshine, S. Egelman, H. Almuhiemedi, N. Atri, and L. F. Cranor. Crying wolf: An empirical study of ssl warning effectiveness. In *USENIX Security Symposium*, pages 399–416, 2009.
- [18] M. S. Wogalter, V. C. Conzola, and T. L. Smith-Jackson. Research-based guidelines for warning design and evaluation. *Applied ergonomics*, 33(3):219–230, 2002.