

Security and Privacy of Assistive Technologies for People with Visual Impairments

James M Clarke, Supervisor Dr. Ehsan Toreini

University of Surrey, United Kingdom

Abstract

This work investigates the accessibility of cookie notices on websites for users with visual impairments (VIs) via a set of system studies on top UK websites (n=46) and a user study (n=100). We use a set of methods and tools – including accessibility testing tools, text-only browsers, and screen readers, to perform our system studies. Our results demonstrate that the majority of cookie notices on these websites have some form of accessibility issue, including contrast issues, not having headings, and not being read aloud immediately when the page is loaded. We discuss how such practices impact the user experience and privacy and provide a set of recommendations for multiple stakeholders for more accessible websites and better privacy practices for users with VIs. To complement our technical contribution we conduct a user study, finding that people with VIs generally have a negative view of cookie notices and believe our recommendations could help their online experience.

Introduction

- Visual impairment (VI) is a term used to describe any type of vision loss, ranging from partial vision loss to someone who cannot see at all.
- People with VIs have various assistive technologies (AT) available to help them use technology.
- Screen readers are installed on users' computers or phones to read information by outputting it as sound.
- Content is spoken aloud in a linear order, which can differ from the visual order on the screen and make it harder to get an overview of the page.
- There has been limited research looking at security, privacy and VIs [1, 2, 3].

Methodology

- We ran experiments on 46 popular UK websites (according to Alexa) and reported a wide range of accessibility issues with their cookie notices.
- We used various techniques and tools to check the website's accessibility, including automated accessibility testing tools, a non-graphical browser, and screen readers.
- The overall design of our experiments and the tools used in each part are presented in the table below.

Table: Overview of website accessibility evaluation.

Experiment	Tools	Website Accessibility Assessment	Cookie Notice Assessment
Cookie notices & Tracking Evaluation	Google Chrome & Brave	NA	Yes (General)
General Automated Accessibility Tools	WAVE & Google Lighthouse	Yes	Partial (Accessibility)
Manual Testing via Text-only Browser	WebbIE	Yes	Yes (Accessibility)
Manual Testing via Screen Reader	JAWS & NVDA	Yes	Yes (Accessibility)

- In addition to the system studies, we conducted user studies with 100 UK participants who use AT.
- Our questionnaire comprises five sections—Internet and AT, Privacy-enhancing technology usage, Cookie notices, Suggestions, and Demographics.

Results

- We discovered that at least one accessibility error was present in 93.3% of the websites we tested.

Table: Number of websites which passed and failed each criterion of the manual testings via NVDA and JAWS.

Criteria	NVDA		JAWS	
	Pass	Fail	Pass	Fail
Readable	29	6	34	1
Immediately read	20	15	22	13
Keyboard navigable	27	8	29	6
Link or button purpose	5	30	11	24
Abbreviations are explained	0	7	0	7
Page titled	46	0	46	0
Cookie notice titled	19	16	19	16
Headings useful for navigation	0	35	2	33
No timing	35	0	35	0

- The majority of websites failed at least one of our tests.
- When using a screen reader or viewing cookie notices non-graphically, cookie notices were often not at the start of web pages.
- We found that users with VIs have a negative view of cookie notices overall.

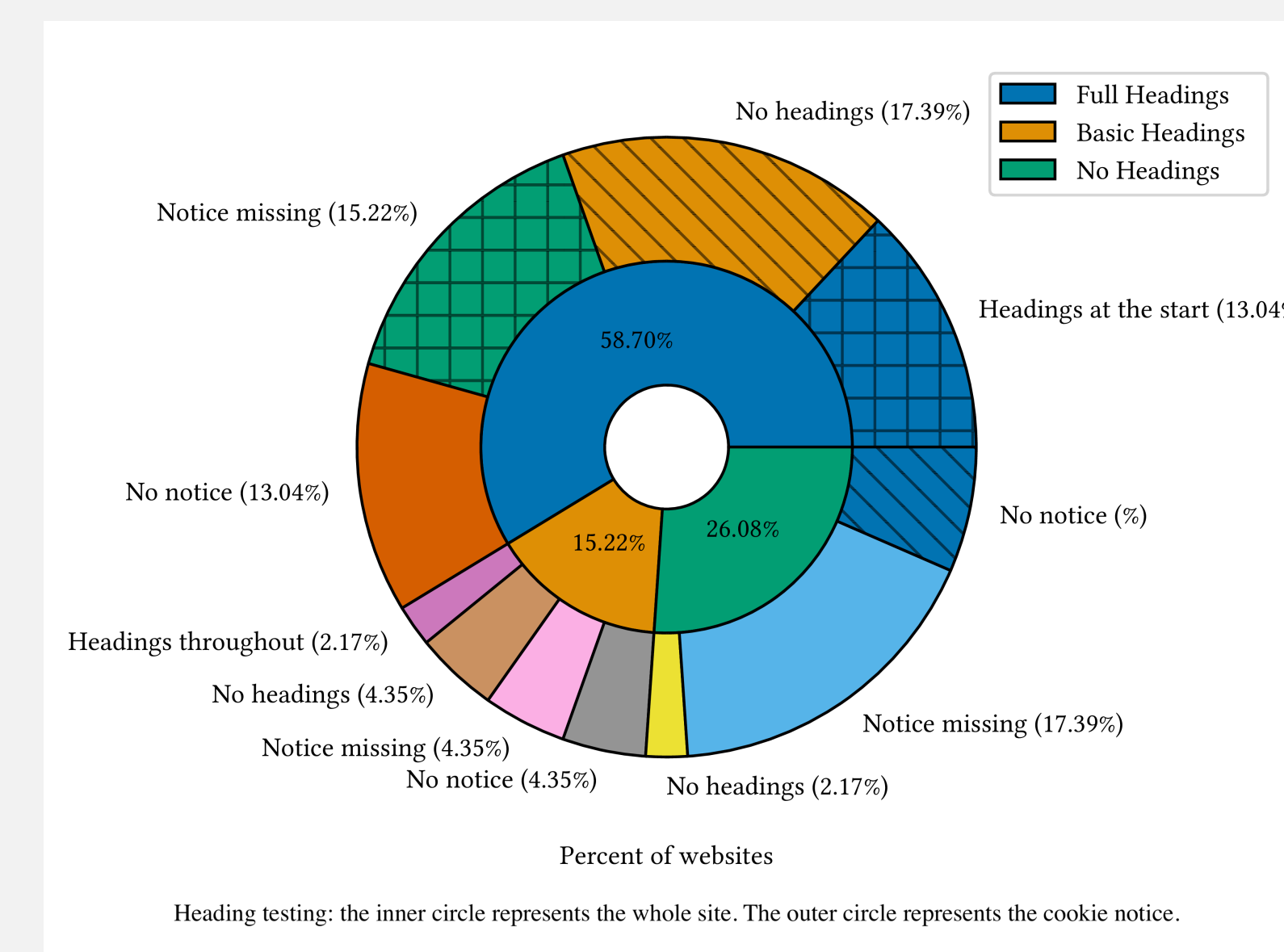


Figure: WebbIE accessibility testing; inner circle: the whole site, outer circle: the cookie notice.

Conclusion

This work investigated the interaction between AT and cookie notices via a set of system studies of 46 top UK websites and a user study of 100 users with VIs via Prolific Academic. We found that 22 of these websites had at least one issue with the accessibility of their cookie notice when manually tested using a screen reader. We also observed websites which did not have issues with their cookie notices when using AT but did include issues such as low contrast when viewing them graphically. These practices often created accessibility issues when trying to read and respond to cookie notices. The results of our user study revealed that users with VIs overall have a negative view of cookie notices. We also found that all users believe that at least one of our recommendations would help improve their experience online. These recommendations are outlined in our paper.

Table: How did participants feel about cookie notices?

Category	Examples	N
Strongly negative	Don't trust, Intrusive Very bad, Frustrating	24
Negative	Dislike, Don't understand Confusing	19
Neutral	Okay, Not bothered Don't care	31
Positive	Important, Essential Useful	26

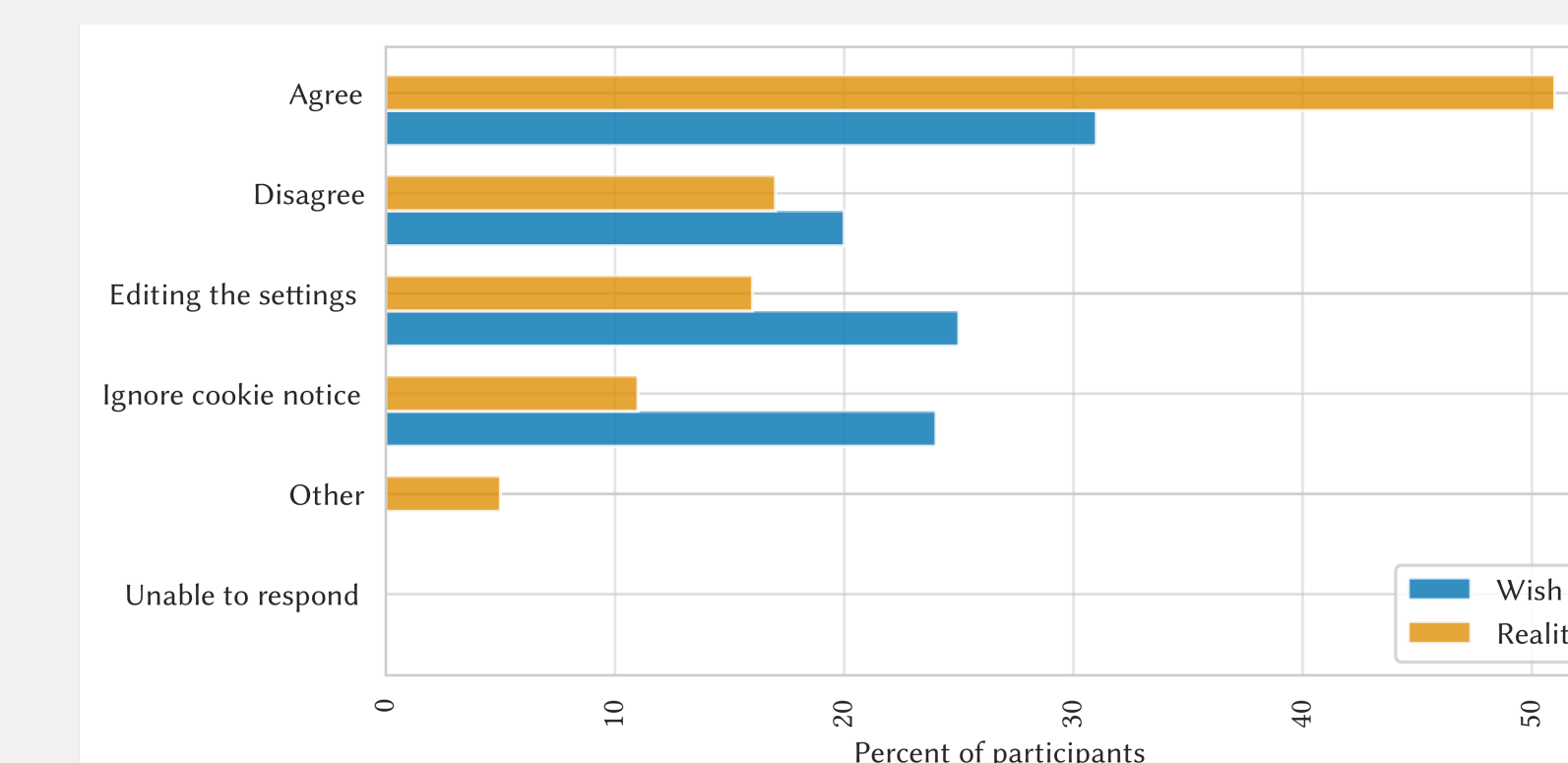


Figure: How did participants want to respond to cookie notices versus how they do in reality?

Future Work

- We are planning to directly look at the security and privacy of the screen readers themselves.
- We are planning to look at the security and privacy of other technologies used by people with VIs, including web extensions and mobile devices.
- The overall goal is to develop a privacy enhancing solution to the issues we find.

References

- [1] Fethi A. Inan, Akbar S. Namin, Rona L. Pogrund, and Keith S. Jones. Internet use and cybersecurity concerns of individuals with visual impairments. *Journal of Educational Technology & Society*, 19(1):28–40, 2016.
- [2] Karen Schnell and Kaushik Roy. Website privacy notification for the visually impaired. In *2021 IEEE Symposium Series on Computational Intelligence (SSCI)*, pages 1–6, Orlando, FL, USA, 2021. 2021 IEEE Symposium Series on Computational Intelligence (SSCI).
- [3] Farhani Momotaz, Md Ehtesham-UI-Haque, and Syed Masum Billah. Understanding the usages, lifecycle, and opportunities of screen readers' plugins. *ACM Transactions on Accessible Computing*, 16(2):1–35, 2023.

Contact Information

- Web: JamesMClarke.co.uk
- Email: J.M.Clarke@Surrey.ac.uk

