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Digital Privacy of Assistive Technology Users with Visual Disabilities

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As technology is advancing, accessibility is also taken care of seriously. Many users with visual disabilities take advantage of, for example, Microsoft's Seeing AI application (app) that is equipped with artificial intelligence. The app helps people with visual disabilities to recognize objects, people, texts, and many more via a smartphone's built-in camera. As users may use the app in recognizing personally identifiable information, user privacy should carefully be treated and considered as a top priority. Yet, little is known about the user privacy issues among users with visual disabilities, such that this study aims to address the knowledge gap by conducting a questionnaire with the Seeing AI users with visual disabilities. This study found that those with visual disabilities had a lack of knowledge about user privacy policies. It is recommended to offer an adequate educational training; thus, those with visual disabilities can be well informed of user privacy policies, ultimately leading to promoting safe online behavior to protect themselves from digital privacy and security problems.

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INTRODUCTION

The prevalence of visual impairment and blindness in the United States has been growing. For example, Varma et al. (2016) reported that over one million Americans were blind, and 8.2 million Americans suffered from visual impairment caused by uncorrected refractive error. Americans with visual impairment and blindness are anticipated to double to more than 8 million by 2050, while 16.4 million are expected to have poor vision caused by correctable refractive errors (e.g., myopia nearsightedness and hyperopia farsightedness) (National Institute of Health, 2016). According to the latest report from the Centers for Disease Control and Prevention (2020), among Americans aged 40 years and older, over 12 million had poor visual acuity, which include 1 million with blindness, 3 million with visual impairment after correction, and 8 million with visual impairment with uncorrected refractive error.

Further, the number of individuals with visual impairment and blindness tends to increase in the aging populations. For example, Colby and Ortman (2015) reported that 46.3 million Americans were aged 65 or older, the number of which is likely to reach 98 million by 2060. Nearly 67% of Americans with low vision are aged 65 and over (American Foundation for the Blind, 2013). Dillon et al. (2010) stated that one of every six older adults aged 70 and over had visual impairment, and its figure doubled in the aging populations aged 80 and over. A recent report (Chan et al., 2018) indicated that the prevalence and incidence rates of visual impairment and blindness in the United States is anticipated to more than double in 30 years.

As technology advances quickly, more and more people with visual disabilities obtain benefits from advanced technology in various domains such as healthcare, education, rehabilitation training, and Internet access (Kim, 2018). For example, a head-mounted visual assistive technology was introduced to improve the well-being of people with low vision (Lorenzini & Wittich, 2021). Kisanga and Kisanga (2020) emphasized the role of assistive technology to facilitate the participation and learning of students with visual disabilities in higher education. Various technologies are incorporated in rehabilitation programs for patients with visual disabilities, e.g., a mouse magnifier that is a computer mouse equipped with a small camera to magnify small texts, reserve contrast, and focus features (Şahlı & İdil, 2019). Other examples of using advanced technologies for people with visual disabilities include electronic walking aids (Faria et al., 2010), improved access to the World Wide Web (Szpiro et al., 2016), and easy shopping using mobile technologies (e.g., Radio-Frequency Identification, RFID and Near Field Communication, NFC) (López-de-Ipiña et al., 2011).

Today, a great number of users with visual disabilities take advantage of emerging assistive technologies (e.g., Microsoft's Seeing AI application [app]). The Seeing AI app is powered by an artificial intelligence technology that uses, for instance, a tablet PC/smartphone camera to scan environment, read texts, and identify people and then audibly describes them to users with visual disabilities. The Seeing AI app has multiple menus on the dashboard such as *Short Text, Document, Product, Person, Currency, Scene, Color, Handwriting,* and *Light*. The menus Short Text and

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Document serve as Optical Character Recognition (OCR) reading written information. The menu *Product* enables users to scan a barcode that is located on most products, such that users can identify what the product is and relevant details about the product. The menus *Person, Currency,* and *Scene* help users to recognize people (e.g., gender, age, hair color, and even emotion) and objects by taking a picture of a target, trying to recognize for a few seconds, and verbally describing what/who they are. The other menus *Color* and *Handwriting* help users to identify color and handwriting, while the menu *Light* describes the brightness of lights via non-speech sounds (e.g., beeps). The Seeing AI app supports various languages such as Dutch, English, French, German, Japanese, and Spanish.

Although AI is surely beneficial to many users and stakeholders, it is reasonable to be concerned about privacy. The Seeing AI users may take a picture of faces and objects containing private and personally identifiable information (e.g., home address, bank statements, medical bills, and so on), and the app company may store and/or share them with third-party organizations (e.g., consumer marketing campaigns). There have been voices warning of the malfunctions of AI-based technologies, especially associated with privacy issues (Arrieta et al., 2020; Stahl & Wright, 2018). For instance, Manheim and Kaplan (2019) argued that AI's processes of collecting, analyzing, and using a large set of user data could undermine privacy in that one of AI's primary features today is to harvest vast amounts of personal information, develop behavioral profiles/algorithms, and ultimately sell goods. Although user privacy should be taken seriously and considered as a top priority for all computer users, little is known about how users with visual disabilities perceive and understand the digital privacy policies of such AI technologies. To address the knowledge gap, this study conducted a questionnaire with the Seeing AI app users living with visual disabilities.

METHODS

A convenience sample of six individuals with visual disabilities living in North Carolina were invited to this study. The inclusion criteria included 18 years of age or older, visual acuity worse than 20/70 with the best possible correction, and the Seeing AI app user. As shown in Table 1, the research participants reflect well the diversity, taking into account gender, race, and household income – i.e., an equal number of participants for the sociodemographic category.

Table 1. Characteristics of the participants

Participants	
Visual acuity	
Between 20/400 and 20/1200	3
Less than 20/1200	1
No light perception at all	2
Duration of vision loss (years)	34.00±30.93
Onset of vision loss (years)	31.33±21.31
Age (years)	65.33±13.57
Gender	
Male	3
Female	3
Race/Ethnicity	
African American	3
European American	3
Occupation	
Employed	1
Unemployed	5
Education	
High school or equivalent	1
Associate	1
Bachelors	1
Masters	3
Household Income	
$0 – 25,999	2
$26,000 – 51,999	2
$52,000 – 74,999	2

Participants were instructed to complete a set of true-or-false quizzes about user privacy policies (i.e., seven quiz questions as shown in Table 2) that were extracted from the homepage of the Seeing AI app's manufacturer, Microsoft. After quiz, participants were educated on user privacy policies with correct answers.

Table 2. True-or-false quizzes to assess participants' knowledge level about user privacy policies for the Seeing AI app

Categories	**User privacy policies (*all true statements*)**
Personal data the app company collects	Q #1. Seeing AI is an artificial intelligence application developed by Microsoft. Microsoft collects data from you, through our interactions with you, and through our products. You provide some of this data "directly", and we get some of it by collecting data about your interactions, use, and experiences with our products. We also obtain data about you from third parties.
	Q #2. You have choices when it comes to the technology you use and the data you share. When we ask you to provide personal data, you can decline. Many of

	our products require some personal data to provide you with a service. If you choose not to provide data required to provide you with a product or feature, you cannot use that product or feature.
	Q #3. Where providing the data is optional, and you choose not to share personal data, features like personalization that use such data will not work for you.
How the app company uses personal data	Q #4. Microsoft uses the data we collect to advertise and market to you, which includes sending promotional communications, targeting advertising, and presenting you with relevant offers.
Reasons the app company shares personal data	Q #5. We share your personal data with your consent or to complete any transaction or provide any product you have requested or authorized. We also share your personal data with Microsoft-controlled affiliates and subsidiaries; with vendors working on our behalf.
How to access and control your personal data	Q #6. You can also make choices about the collection and use of your data by Microsoft. In some cases, your ability to access or control your personal data will be limited, as required or permitted by applicable law.
	Q #7. Not all personal data processed by Microsoft can be accessed or controlled via the tools available to you.

Note: The privacy policies are excerpts from www.microsoft.com/en-us/ai/seeing-ai.

The technology adoption life cycle typically ranges from initial use to long-term use (Liao et al., 2009). Thus, the technology adoption questionnaire was administered before and after quiz to assess the degree to which participants tend to change their tendency to use the app after being informed about user privacy policies. Seven inquiries about technology adoption, especially associated with trust issues, were extracted from the work by Gao et al. (2011).

RESULTS

Quiz

The ratio that participants answered correctly ranged from 66.67% to 100% for the seven quiz questions. The lower quartile of quiz scores (i.e., poor user understanding of privacy policy) was associated with the quiz #3 and #6. The quiz #3 was related to "personal data the company collects", and quiz #6 was related to "how users access and control their own data." Mann-Whitney tests were conducted to examine the quiz scores by sociodemographic backgrounds. Participants with early onset of vision loss showed a lower level of knowledge about quiz #2, as compared to their peers with late onset, $U = 0$, $z = -2.24$, $p = 0.03$. The quiz #2 was related to "personal data the company collects." Participants with household income lower than $52,000 showed a lower level of knowledge about the quiz #3, as compared to their peers with household income higher than $52,000, $U = 0$, $z = -2.24$, $p = 0.03$.

Technology adoption

A Wilcoxon signed-ranks test found that participants showed significantly increased tendency to adopt the app after the quiz-based education, $z = -2.03$, $p = 0.04$. The adoption tendency before quiz was 6.00 ± 0.51 while the tendency after quiz increased to 6.45 ± 0.39. Wilcoxon signed-ranks tests were also conducted to further examine the adoption tendency by sociodemographic backgrounds. Healthy participants were more likely to adopt the app after quiz, $z = -2.03$, $p = 0.04$. Their tendency was 6.00 ± 0.51 before quiz but 6.45 ± 0.39 after quiz. The same pattern was additionally observed in participants who exercised regularly, $z = -2.03$, $p = 0.04$. Their tendency was 6.00 ± 0.51 before quiz but 6.45 ± 0.39 after quiz.

Correlation between quiz and adoption

Spearman's rho correlation coefficient was employed to assess the relationship between participants' responses to the quiz questions and their adoption tendency. There was a positive correlation between the quiz #3 and adoption tendency, $r = 0.84$, $p = 0.04$.

DISCUSSIONS

Participants showed a lack of knowledge about several user privacy policies. The results suggest that although users with visual disabilities have been using the Seeing AI app, it does not necessarily mean that they are all well informed of user privacy policies. Similar results were also observed in the literature. Jones and Soltren (2005) found that 89 % of 390 college students using Facebook had never read the privacy policies, and 91% had not read the terms of service. Park (2013) conducted a survey study with 419 Internet users (aged 18 and over) and found that only eight respondents (1.9%)

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answered correctly all the quiz questions assessing the user knowledge level of privacy policies.

This study found individual differences in the knowledge level between participants with different sociodemographic backgrounds. For instance, participants with lower household income showed a lower level of knowledge about user privacy policies. It is consistent with the Pew Research Center's survey results (Auxier et al., 2019) in that Americans who earn $75,000 or over a year are more likely to pay attention to and follow privacy news closely, as compared to their peers with lower household income (less than $30,000 a year). However, it does not infer that those with visual disabilities are not concerned at all about privacy while using the AI app. There might be other reasons for their lower level of knowledge; for example, it might be difficult for those with visual disabilities to find the webpage containing the privacy policies, difficult to understand the policies due to the use of technical jargon, and so on. Further user study is required.

As compared to participants without health issues, their peers with poor health status were less likely to adopt the Seeing AI app although they were aware of the app's various useful features (e.g., recognizing products, texts, scene, people, brightness in the surroundings, and so on). This result is consistent with the findings of Schuster et al. (2022). They found that user adoption was positively correlated with users' education, income, and health status. There is also another report arguing that an individual's high levels of physical activities are likely to lead him/her to greater curiosity about using technology to keep track of daily living activities, which may contribute to technology adoption (Kononova et al., 2019).

Given the finding that the participants' tendency to adopt the app has increased after the quiz-based education, participants might have perceived more confident and/or felt safer to use the app after being educated on how their personal information and usage data were used and protected for privacy. Thus, this study hypothetically argues that an educational intervention may contribute to user's privacy awareness and trust in privacy, ultimately inducing users with visual disabilities to adopt the app. Positive effects of education on privacy has been well documented in the literature. For example, Noh (2020) empirically found that librarians increased their awareness of privacy for clients using their library services after completing a privacy education (e.g., privacy of digital library clients, personal information protection policies, and case studies of privacy infringement). Orgill et al. (2004) also argued that training about user privacy and security practices is effective; thus, they recommended that computer users should take such training.

As this study found evidence of a positive correlation between quiz scores and adoption tendency, it is recommended that users with visual disabilities make effort to find, read, and understand the user privacy policies in order to better protect themselves from inappropriately sharing personal information and usage data with the app company and/or third-party organizations. To further facilitate it, user privacy policy statements should be written to be self-explanatory such that those with visual disabilities can easily understand them and apply accordingly while using the app (i.e., digital privacy literacy).

Future research will focus on developing a complete set of education materials to teach users with visual disabilities how to safely use various assistive technologies. It will be ensured that the educational materials are user-friendly and accessible to those with visual disabilities.

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