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Assistive Technology Innovations: Perceptions, Adoption, and Desires

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Abstract

Assistive technology (AT) innovations for people who are blind or have low vision are occurring at a rapid pace, yet we know little about what this population thinks or knows about these innovations. This paper presents the results of a survey study with 329 employed people who are blind or have low vision regarding their perceptions about, adoption of, and desires for AT innovations. We found that many people were not aware of any recent technology advancements. A very small percentage of the participants adopted novel AT, as defined in the survey, during the 2-year period of the study, and only about one-third of the participants expressed an interest in adopting a novel AT. Key barriers to adopting new or novel AT were the high cost, the time required to learn the new technology, and the lack of training or support for learning and using the new technology.

Keywords: Blind, Low Vision, Assistive Technology, Adoption

Assistive Technology Innovations: Perceptions, Adoption, and Desires

Introduction

There is much potential for new and emerging assistive technology (AT) to enhance independence for people who are blind or who have low vision. There has been an explosion in assistive technology (AT) for this population in recent years (Bhowmick & Hazarika, 2017; Madake et al., 2023). This includes emerging technology, such as artificial intelligence (AI) and machine learning (ML), multi-line refreshable braille displays and tactile graphics, wayfinding technologies, and wearable technologies. However, research is needed to learn how people who are blind or have low vision perceive these innovative and novel technologies, their interest in adopting new technologies, and their desire for future technological advancements. The purpose of this study was to increase our knowledge about the lived experience of employed adults who are blind or have low vision with AT innovations, including their perceptions about, adoption of, and desires for these innovations.

Target Audience and Relevance

The target audiences for this paper are professionals who work with individuals who are blind or have low vision for AT-related assessments, training, and purchase requisitions, as well as manufacturers and vendors who develop accessible and assistive technologies for these same populations. The primary audience includes professionals who provide training, assessment, and purchasing decisions for AT, such as Certified Assistive Technology Instructional Specialists for Individuals with Visual Impairments (CATIS) and other AT instructors, Certified Vision Rehabilitation Therapists (CVRTs), Certified Low Vision Therapists (CLVTs), teachers of students who have visual impairments (TVIs), and Certified Rehabilitation Counselors (CRCs) and other professionals in vocational rehabilitation services. We believe this study's findings are

relevant to all blindness-field professionals and manufacturers because they provide novel information about what employed people who are blind or who have low vision perceive to be the best technology advancements, which new technologies they have adopted, their motivation for adopting new AT, and their interest in future AT innovations. This is especially pertinent to manufacturers and vendors as they continue to develop new and updated technologies. Additionally, it is relevant for CATIS, who must maintain knowledge within the core domain of exploration, which includes reviewing "…mainstream and AT hardware and software tools at every available opportunity…" (ACVREP, n.d.) to enable them to then teach these strategies.

Background

The increase in emerging technologies within the field of blindness and low vision has been apparent at recent AT conferences. More than one-third (49 of the 131) of the sessions labeled with the keyword "emerging technology" at the 2024 Assistive Technology Industry Association Conference (ATIA) were in the Vision & Hearing Technologies Strand (https://s3.goeshow.com/atia/orlando/2024/new_session_directory.cfm). Furthermore, at the 39th Annual California State University, Northridge (CSUN) Assistive Technology Conference in March 2024, 31.6% of the sessions (105 out of 332 sessions) included the topics of either "Artificial Intelligence & Machine Learning" or "Emerging Technologies" (https://www.csun.edu/cod/conference/sessions/index.php/public/conf_sessions/index_by_day). This represents an increase of approximately 150% from CSUN 2022, when there were 42 sessions on these topics (https://www.csun.edu/cod/conference/sessions/2022/index.php/public/conf_sessions/). Of the CSUN sessions on emerging technologies and AI/ML in 2024, one-third (35 sessions) included

the topic of “Blind/Low Vision.” This suggests an accelerating pace of AT innovation for those who are blind or have low vision in recent years.

Bhowmick and Hazarika (2017) determined that research and literature on AT for people who are blind or who have visual impairments has been doubling every four years since the 1990s. They discussed some emerging technologies highlighted in research, such as mobile phones, wearable technologies, biomedical enhancements, and the capability to extract information from visual images. These researchers projected that the extraordinary growth in the field would continue. This study also documented that potential AT solutions for this population are being developed across many different professional disciplines. Since this publication, several other authors have conducted literature reviews on the topic of AT for people who are blind or have low vision.

Mashiata et al. (2022) conducted a literature review to explore the evolution of AT for people who are visually impaired and classified the types of AT into four primary categories (i.e., portability, navigation, detection, and smartphone assistance), then further divided them into sub-categories. Madake et al. (2023) reviewed 140 research articles from 1946 to 2022 that focused on orientation and mobility AT for people who are blind or who have low vision. They evaluated the major types of mobility aids and provided a performance score for each major type. Muhsin et al. (2024) conducted a systematic review of 52 research articles and 18 literature reviews on AT for people with visual impairments published between 2018 to 2023. They determined that many technology advancements have not been developed in consultation with people with visual impairments, have poor usability or a high learning curve, and often focus on those with total blindness rather than those with partial sight.

Despite innovations and emerging technologies for people who are blind or have low vision, researchers have discussed the lack of adoption of innovative technologies, as well as themes relating to the adoption of new technologies. Through semi-structured interviews with 16 participants and a behavioral study that included 8 of those same participants, Turkstra et al. (2023) explored how blind adults use AT to perform instrumental activities of daily living and discovered that when participants could choose between low- or high-tech solutions, 75% chose a low-tech option. They reported that some participants would only use a digital aid if using their senses or tactile approaches did not work. Many demonstrated a preference for visual interpreting technologies, including those with integrated AI features (e.g., SeeingAI, Google Lookout); however, participants commented on issues with the accuracy of AI technologies. Barriers to the adoption of high-tech AT solutions identified by Turkstra et al. (2023) were a lack of awareness, including learning about newer technology; the amount of training and support needed to learn new AT; accessibility issues; and technical issues, including those related to compatibility with other technologies.

In a study of 20 older adults with visual impairments, Kim (2022) explored factors related to AT adoption, specifically the adoption of mobile apps. He reported the following themes: advance (whether the technology is better than other available technologies), compatibility (with participants' expectations, as well as with other technologies that they use), complexity (ease of use and need for training), observability of others who use the technology, and trialability. Comments within the "Trialability" theme indicated a desire for free and affordable technologies, as well as free trial versions. Similarly, participants in the Turkstra et al. (2023) study also discussed cost as a barrier to adopting new high-priced technologies.

While Turkstra et al. (2023) and Kim's (2022) studies provide valuable information about AT adoption and preferences, their conclusions are based on small samples. To increase our knowledge about blind and low vision adults' perceptions about, adoption of, and desires for AT innovations, we surveyed a large sample of employed adults living in the United States or Canada. This study was guided by the following research questions:

1. What do employed people who are blind or have low vision consider to be the best recent technology advancements?
2. What percentage of employed people who are blind or have low vision (a) have adopted new AT recently and (b) have adopted innovative AT?
3. What motivates people who are blind or have low vision to adopt a new AT?
4. What innovative AT are employed people who are blind or have low vision most interested in adopting and what factors influence whether they will adopt a novel AT?
5. What AT innovations do employed people who are blind or have low vision desire?

Method

Participants

Our sample consisted of 329 people who were participating in the the National Research and Training Center on Blindness and Low Vision's longitudinal *AT in the Workplace Study*. This study was determined to be exempt from oversight by Mississippi State University's Institutional Review Board. Participants were recruited via a blindness participant research registry, invitations distributed by blindness organizations (e.g., National Federation of the Blind, American Council of the Blind, American Foundation for the Blind), and notifications posted in email lists and websites for people who are blind (e.g., Top Tech Tidbits, Blind Bargains) and joined the study in 2021 or 2022. All participants were blind or had low vision, were currently

employed or had recently been employed, used AT for work, and resided in the U.S. (97.3%) or Canada (2.7%). Participants who resided in the U.S. came from 46 states. Demographic information about the participants is provided in Table 1. Surveys were completed either online (via Qualtrics) or by phone. We utilized participant responses from Survey 2 (conducted in 2022, *N*=313) and Survey 3 (conducted in 2023, *N*=246) for this study.

Variables

Data included multiple-choice and open-ended responses to the survey questions. *Best AT advancements* were determined by participant responses to the Survey 3 question "What is the best new technology advancement in the past year or two? This could be a new feature added to an existing product or a new AT." To determine *adoption of new AT*, we utilized responses to the question, included in both Survey 2 and 3, "Have you adopted any new AT since you completed the last survey in [month] of [year]?" with the participants' date of last survey completion included. Participants who answered yes specified what AT they had adopted, and they had the ability to report on up to three new AT adopted during the time frame. To determine *motivation for AT adoption*, we asked the participants who had adopted new AT to select from a list of eight options (e.g., Features of the AT appealed to me, Ease of use/convenience) as to their reason for adopting the AT ("What made you decide to begin using this AT?"). The eight multiple-choice options were developed based on participants' responses to an open-ended version of the same item in Survey 1. Once they selected all reasons that applied, they were asked to select the one reason that they considered their primary, or most important, reason for adopting that AT.

To determine *what influences innovative AT adoption*, all participants were asked in Survey 2 to rate the importance of six factors in their decision to adopt innovative, or novel, AT ("How do you decide whether to adopt a newly introduced, novel AT? Please rate the importance

of the following factors."). See Table 4 for a list of the factors. Participants rated importance on a 5-point scale, with 5 labeled "Very important" and 1 labeled "Not at all important." In the survey, we defined novel AT as newly introduced technology that is commercially available but has not been widely adopted yet. Participants were asked to share any comments they had about deciding whether to adopt newly introduced, novel AT. Then participants indicated whether there were any novel AT they were interested in adopting, and if so, what that novel AT was. To determine *desired AT innovations*, we utilized participant responses to the question, asked in both Survey 2 and 3, "Is there something you wish your AT could do that it currently doesn't do (but conceivably could do)?"

Data Analysis

We utilized descriptive statistics (frequencies, percentages, and means) to analyze our quantitative data. Most analyses utilized number of respondents (people) as the denominator to determine the reported percentage, but number of AT was utilized as the denominator for the new AT adopted analyses. We also utilized frequencies and percentages with the themes determined through qualitative analyses (described below).

Two researchers utilized content analysis to analyze responses to the five open-ended questions in Survey 2 and Survey 3 regarding what participants considered to be the best new technology advancement, comments about deciding whether to adopt novel AT, novel AT they were interested in adopting, and wishes for new AT innovations. Content analysis is an iterative qualitative research strategy used to analyze how participants experience a phenomenon through a four-step process of decontextualization (familiarization with the data and initial coding), recontextualization (reviewing the data to determine if changes to coding are needed),

categorization (creation of categories or themes and sub-themes), and compilation (analyzing the results and writing process) (Bengtsson, 2016).

The researchers first reviewed the responses while making notes about potential codes before initial coding began. Inductive coding was used to develop an initial set of codes after thoroughly reviewing and engaging with the open-ended responses (Bengtsson, 2016; Braun et al., 2019; Elliott, 2018). Each researcher independently coded the comments for each set of responses. We followed an iterative process as described by Elliott (2018), in which the two researchers reviewed the data and associated codes for accuracy and agreement, while considering new codes and revisions to existing codes. Through this process, the codes were updated, and any necessary recoding based on the updated codes was completed independently. Next, the researchers compared their assigned codes for each comment and reviewed any codes that were not in agreement and made changes, if needed, independently. The researchers then met to discuss all codes for which they were not in agreement and came to a consensus on the final codes assigned to each comment. Prior to the final analysis and writing process for this study, the researchers revisited the codes to review any needed changes or updates, including the recognition of previous stand-alone themes as a better fit as sub-themes under existing codes.

Results

Best AT Advancements

All 246 Survey 3 participants responded to the question about AT advancements, but 53 (21.5%) either did not provide a substantive answer (e.g., wrote N/A) or indicated they didn't know of any AT advancements. For example, one participant's response was: "Unfortunately, I am one of those people that does not keep up on the newest advances. I find that I simply don't have the time. I just need assistive technology that works to make things accessible for me in my

job and home life." Other participants provided one or more answers regarding their perceptions of the best AT advancements, and common response themes are provided in Table 2. The most common theme was related to AI, with 100 comments that named an AI-related AT advancement. In addition, we counted the number of people whose response was related to an AI advancement (even if AI was not named), and 102, or 41.5%, of the sample provided such a response. AI incorporated into remote sighted assistance, such as Be My AI, was the most commonly identified AT advancement (17.5%). For example, one person said "I love the Be My AI feature built into Be My Eyes. It is robust and provides a lot of description. I just saw today too that Seeing AI has built in a similar feature to their technology. The ability to ask questions and get AI clarification I think is invaluable and makes things easier and more efficient."

Twenty-one people (8.5%) commented on advancements in braille devices or features. For example, more than one respondent was excited about a soon-to-be-released braille device, as illustrated by this response: "The upcoming Orbit Optimum Laptop is a game changer in notetakers being that it is a full Windows 11 device with 40 cell braille internal. It comes out first quarter of 2024, but I have worked with it, and it is game-changing." Seventeen people (6.9%) indicated the addition of optical character recognition (OCR) or the availability of enhanced OCR in their AT was an important advancement. Twenty-seven people (11.0%) commented on improvements to specific AT or devices (only coded here if not captured in another code, such as OCR or AI), with several identifying new JAWS features or iPhone/iOS accessibility enhancements. Five people (2.0%) believed that the improved ability of AT to read handwriting was an advancement, with three specifically mentioning this feature in SeeingAI.

Many people (*n*=43, 17.5%) provided AT-related comments that did not fit under the other codes. Some of these comments were related to mainstream accessibility features, such as:

"Accessibility features being more and more mainstreamed into most devices, and with better quality (like dictation, or very natural-sounding voices for built-in screen readers)" and "Ease of use and implementation. If new things can be easily integrated into technology I already use then I'm much more likely to utilize them." Other comments were related to specific AT, without an indication that the respondent was referring to updates to that AT (e.g., OrCam, SeeingAI). Of note is that very few people mentioned new AT products; most identified new features added to existing AT as the best advancements. Also of note is that one-quarter of all comments referred to AT or features of AT that have existed for more than two years, although some of those commonly mentioned, such as OrCam, had features that were consistently evolving.

New AT Adoption

In the time frame between the first and second survey (2021 to 2022), 26.8% of the 313 participants adopted a new AT. Most adopted one AT (21.1%), a few adopted two AT (5.1%), and two people (0.6%) adopted three AT, for a total of 104 new AT adopted. The most commonly adopted AT were braille devices, which were 20% of all new AT adopted. Different types of apps were the other commonly adopted AT (46.2% for all types combined), including orientation, navigation, and wayfinding apps (14.4%); OCR or OCR+ apps (14.4%); and remote sighted assistance apps (4.8%). Screen readers (7.7%) and electronic video magnifiers (6.7%) represented a smaller percentage of the adopted AT. A relatively small number (n=12, 11.5%) of the adopted AT were novel AT (as we defined it in Survey 2), including Envision Glasses, OrCam device (adopted by two people), BrailleSense 6 (adopted by three people), and Soundscape (adopted by six people). Eleven people, or 3.5% of all participants, reported adopting novel AT between Survey 1 and 2.

In the time frame between the second and third survey (2022 to 2023), 17.5% of the 246 participants adopted a new AT. Most adopted one AT (14.6%), a few adopted two AT (2.4%), and one person (0.4%) adopted three AT, for a total of 51 new AT adopted. Braille devices were again the most commonly adopted AT, representing 35.2% of all new AT adopted. Remote sighted assistance apps were the only other common category of AT adopted, with 15.7% adopting Be My Eyes or Be My AI. Again, a relatively small number (*n*=7, 13.7%) of the adopted AT were considered novel, including braille devices (Monarch braille display, BrailleSense 6 mini, and BrailleNote Touch Plus – two people), Hable One (two people), and VoiceVista. Only seven people, or 2.8% of all respondents, reported adopting novel AT between Survey 2 and 3.

Motivation for Adopting New AT

Participants' reasons and their primary reason for adopting the new AT they obtained are provided in Table 3. The number of new AT adopted across the two surveys were combined and used as the denominator for these analyses (*N*=155). Results indicated that appealing features of the AT was the most important reason for adopting new AT, followed by the need to use the AT to perform a specific task and the need to use the AT for their jobs. Although ease of use/convenience and affordability/low to no cost were two reasons commonly identified for adopting an AT, they were not as often selected as the primary reason for adopting an AT. Even though only 15.5% of people selected the need to use the AT while at work as their primary reason for adopting it, 65.8% of the new AT was used on the job.

Novel AT Adoption

Participants rated the importance of six factors that may be associated with deciding to adopt newly introduced, novel AT. Their ratings, with factors sorted in order from most to least

important, are provided in Table 4. Functionality, defined as whether what the AT does would help more than the person's current AT options, was clearly the most important factor, with more than three-fourths of participants rating it as very important. Two other factors that were important to most participants were price/affordability and ease of use (whether it would be easier to use than the person's current AT). User reviews and whether friends or colleagues were using the novel AT were of moderate importance to most participants. Uniqueness of the AT (preference for being one of the first to try new products) was not an important factor for most people.

Participants were also given the opportunity to provide comments about their decision process regarding novel AT, and 174 of the 313 participants provided substantive comments. The most common themes identified in the responses (discussed by 4% or more of the total sample) are provided in Table 5. In accordance with the importance ratings, the most common theme was that the AT should be practical – useful in daily life, functional, or fill a need – as mentioned by 18.5% of the participants. A subgroup of these respondents (5.4%) specifically emphasized the importance of the usefulness of the AT: "It would need to really stand out in order for me to take the time to adopt, meaning extremely helpful/functional." Relatedly, several participants (6.1%) noted that the novel AT would have to improve their productivity or efficiency to be of interest.

The second most common theme was cost being an important factor, which included comments related to novel AT usually being prohibitively expensive (16.3%). As one participant commented, "There are always a lot of new and interesting products coming out, and adopting every one would be most costly and time-consuming. So, the decision about each specific product has to be made very carefully…." Another commented on the high cost not being

justified when there is a short lifecycle for technology, stating “Most AT is ridiculously overpriced because it is for such a small market, and it seems that hardware will become obsolete quickly.”

More than 10% of participants indicated excitement about or interest in using or learning about novel AT. For example, one participant stated: “I'm all about novel assistive tech, especially if it performs a new function I haven't previously been able to do without sighted assistance. Aira has been this novel AT in recent years, and I think the Braille/tactile tablet and/or the multi-line Braille display may represent the next revolutions.” Another participant indicated interest while taking a cautious approach: “I love new technologies but want to make sure they add value to me. Often new products are just enhanced versions of other applications or systems that are already available and that I'm familiar with.”

Conversely, some participants indicated a lack of interest in adopting novel AT (5.8%) for reasons such as not wanting to deal with potential bugs or use too many different technologies. Some indicated that their interest has waned with increasing age or career advancement. For example, one participant stated: “The older I get, the less zealous I am to try something novel unless evidence from users of significant ROI [return on investment] is overwhelming. Perhaps, when I retire, I will have more of an appetite to try new things just for the ‘adventure’ or ‘possibility’ of the effort. For now, however, as a husband, father, and family head, the prospect of carving out time and energy to invest in a new prospect is far less appealing than it was earlier in life.”

The time it takes to adopt new AT was a consideration for several participants, including some who indicated that novel AT must be easy to use, easy to learn, or both (6.4%) and some who specifically noted that there is often a big learning curve for new AT (4.8%). Lack of

support for learning new AT appears to be an issue for some participants: “I have big fears about the learning curve. Adding to the issue of training that is made available through AT provider is usually just an introduction and overview that I will forget shortly after.” Another participant explained his interest in novel AT, but lack of ability to typically integrate it into his daily life: “I enjoy the evolution of technology to provide access to things otherwise unavailable to me, but I'm not very patient about learning how to use it. It always seems like the learning curve is high and requires a lot of trial and error to figure out. So I learn about an app such as Soundscape, download and play around with it, but then don't usually implement it in daily use because I find it too cumbersome. If I had better access to learning these new apps, I'd probably use them more often.”

Interest in Adopting Novel AT

Although few participants reported adopting new, novel AT during the study, about one-third (*n*=101, 32.3%) expressed an interest in adopting a novel AT in Survey 2, and 20 people identified more than one novel AT they were interested in. The most common categories of AT participants expressed interest in were wearable devices/glasses (28.7%) and orientation/navigation aids (28.7%). Novel braille and tactile displays were of interest to 23.8% of participants. About one-fifth of participants mentioned an AT that was not a novel AT as defined in the survey. For example, several people mentioned remote sighted assistance apps such as Aira, electronic magnifiers, or refreshable braille displays. While these technologies have been available for many years and are in common use (and thus were not considered novel), innovative features may have been added to the AT.

Desired AT Innovations

Although 31% of participants in each survey could not identify a wish, or desired innovation, for their AT, most participants expressed one or more desires for what they wanted their AT to be able to do. Their responses were categorized into common themes, and themes mentioned by 2% or more of participants in either Survey 2 or 3 are provided in Table 6. Perhaps not surprisingly, the most common desire was for their AT to function better or offer additional functions or features, with 43.1% of comments in Survey 2 and 39.0% of comments in Survey 3 in this area. Some participants had specific wishes about AT functionality, such as this person: "I wish that screen readers, when in PowerPoint presentation mode, would only read the displayed content and not any that is displayed later by slide automation. For example, when presenting, some slides are designed to show partial content until the next click, where additional content is displayed. Screen readers currently read the whole slide at first transition." Other participants expressed broad wishes, such as being easier to configure or improved navigation of websites.

Participants desired better functioning in several common areas, which are listed in Table 6 as subcategories below the general category of function better/add functions or features. The most common subtheme was to be able to access information in images or tables, followed by improve (or add) OCR ability. For example, one participant stated: "I wish my AT was better at reading/deciphering data visualizations like charts, graphs, and tables, which I often have to interact with in the course of my work." Another participant said "If Seeing AI could display tables, charts, and/or documents with multiple columns in such a way that things could be read in the manner in which they are meant to be read (e.g. a page from a book with two columns would read down the first column, then move to the second, rather than reading the page straight across thereby mixing the information from the two columns)."

Some participants expressed a desire for their current AT to incorporate AI, and these comments were more common in Survey 3 (3.7%) than Survey 2 (2.2%). For example, several people wanted their screen readers to add AI features, as illustrated by this comment: “I would like to see JAWS and the other screen readers utilizing AI, deep learning and similar technologies to recognize commonly-implemented inaccessible code patterns in apps and websites and then add the necessary code to make them accessible on the fly.” Another participant said “Wish all screen readers built in AI capabilities similar to Be My AI when encountering inaccessible digital products. This would greatly assist with understanding and completing the digital products.” Other suggested incorporations of AI in existing AT were using AI to create scripts in JAWS, adding it to Blind Square to create better routes and improve navigation, and adding it to OCR software or apps to process text and resolve common OCR errors. A few participants commented on advanced uses of AI, not related to a specific AT, and again these comments were more common in Survey 3 (2.8%) than Survey 2 (0.6%). For example, one participant expressed their wish related to indoor navigation: “I'd love to see AT that allows for a blind/visually impaired person to take an already existing map of a store, train station, airport, etc. and be able to put it in an app and have the app (using AI) guide the user to a specific location.”

Another common theme was improving accessibility or usability of AT with software, websites, or digital elements (such as buttons or form controls), mentioned by 11.8% of participants in Survey 2 but only 6.9% of participants in Survey 3. For example, one participant stated “…I also wish JAWS worked more efficiently for advanced Microsoft Office tasks, and that commands were consistent from application to application (reviewing comments worked the same in Word, Excel, and PowerPoint). Learning different commands for every application starts

to feel like learning another language." Others wished that JAWS worked better or was accessible with specific software that they needed to utilize for work. A related theme was the lack of accessibility or usability of digital content, which some acknowledged was not the fault of the AT, mentioned by 3.5% of participants in Survey 2 and 4.5% in Survey 3. For example, one participant stated, "Most of the issues I normally find are external to the AT, for example inaccessible website or app; it would be great if all programmers/content designers were fully knowledgeable on WCAG guidelines."

Other common themes were for AT to read handwritten material (6.1% in Survey 2; 5.7% in Survey 3) and provide improved navigation, orientation, and wayfinding solutions (4.8% in Survey 2; 5.3% in Survey 3). A few participants provided unique ideas for new technology or features (6.1% in Survey 2; 2.4% in Survey 3). For example, in Survey 2 one participant stated "We need to make it so screen readers can display on multiple braille displays in the same way computers already do to multiple monitors. It would also be nice to have multiple focus points displayed on the same braille display as if it was split screen…." Other participants wished for advances in magnification options, such as: "Smart glasses that magnify quickly like the iPhone/smartphone camera - 4x - 6x minimum, something to help fine-tune magnify [to] read music notes while playing piano from music sheet." Others wished their head-mounted devices or smart glasses would add unique features, such as: "…add pictures of people on the fly…People I'd like to identify, like it should recognize that I am saying 'hi' to someone named Bill and then save a picture of that person for me to know that that person's name is Bill, or as I'm introducing myself to a client perhaps I could press a button on the device or do a hand gesture, which would let the device know that I am introducing myself or being introduced to a person. I would just like it to be more covert." and "It would be great if you could teach it to

locate a specific item. Example, I dropped my time clock fob, while trying to put it on my keyring. This item is not preprogrammed into Envision, but it would be nice if I could program it in myself." Others wanted their AT to help them effectively utilize the AT, for example: "Tell me when there is a better way for me to do something than what I am doing, so I can learn new things and continue to complete tasks. Occasionally, I have forgotten something if I haven't used it in a long time or if I rarely use a particular command or keystroke."

Discussion

Technology innovations, including AT innovations for people who are blind or have low vision, are occurring at a rapid pace. Many people from multiple disciplines are working to improve the quality of life of people who are blind or have low vision through technological advancements. Yet we know little about what people who are blind or have low vision know or think about these innovations, or what additional innovations they desire. This is the first study to collect data on thoughts about, desires for, and actual uptake of AT innovations from a large sample of this population who are currently using AT in the workplace.

The availability of generative AI was a recent major technology innovation. Generative AI became widely available during data collection for this study, between Survey 2 and 3, with the release of ChatGPT, and awareness of generative AI is very high in the U.S. (Pandya, 2024). The incorporation of ChatGPT into Be My Eyes, becoming Be My AI, was considered game-changing by many people who are blind or have low vision (McDonnall, 2024; Costabel, 2023). Despite this innovation and many others, more than one-fifth of our participants could not identify any technology advancements in the past two years, and many people identified technology advancements that were older (and, in some cases, much older) than two years. Our findings suggest a potential lack of awareness by a portion of the blind/low vision population of

the AT innovations that are being developed for them. Greater awareness of AT innovations may improve uptake and thus potentially improve efficiency, productivity, and even quality of life. Also of note regarding perceived AT advancements is that participants most often identified advancements within existing technologies (e.g., screen reader, mobile apps) rather than completely new or novel devices.

Very few participants actually adopted a novel AT during the more than two years of the study, and most indicated they were not interested in adopting a novel AT. Key barriers to adopting AT and particularly novel AT were the expense, time to learn the new technology, and lack of training or support, which coincide with findings from Turkstra et al. (2023) and Kim (2022). While AT innovations are exciting for some, many people are more interested in the practical aspects and the costs, both in terms of dollars and time and effort, of adopting new AT. The bottom line for most people in terms of adopting new AT (including novel AT) seems to be its features, functionality, and usefulness. Although ease of use/convenience and affordability were important considerations for most people, they were not primary reasons (or the most important reason) provided for actually adopting a new AT. However, price/affordability and ease of use were important or very important considerations for most participants when it came to deciding whether to adopt novel AT.

Innovation is needed to determine methods to lower the cost of novel AT, and one potential solution is to explore options, when feasible, to integrate into emerging mainstream technologies, which are often less costly than standalone AT products designed for those who are blind or have low vision. Examples of this are new head-mounted devices and smart glasses, which have varying features, such as cameras, built-in voice assistants and AI, and other accessibility features that can be enhanced by the integration of specific accessibility apps.

In terms of desired AT innovations, more than one-third of our sample could not or did not identify a wish for what their AT could do that it currently does not do. Most desires were specific to existing AT the person used and focused on (a) working with specific programs or elements, (b) functioning better, or (c) adding features, although a few participants did provide unique ideas for AT innovations they would like to see. Interestingly, some participants' desires for AT innovations have become available as of the time of this writing. For example, several people wished for their screen reader to recognize text embedded in images, and JAWS Picture Smart feature performs that function. Although Picture Smart was introduced in 2019, it is now much more robust with the incorporation of advanced AI through the enhanced Picture Smart AI feature (Freedom Scientific, 2024). One participant wished for a method for someone who is blind to remote into another computer to provide technical assistance. This wish became a reality in 2023: An updated version of Remote Incident Manager (RIM) made it possible to connect to and control Windows or macOS computers while using a screen reader on either Windows or a macOS computer (Pneuma Solutions, 2023). We anticipate that, given the rapid pace of technological advancements, more participant wishes will have been granted by the time of the publication of this paper.

While innovations such as these are fantastic and clearly meet a need, they are often initially introduced in only one brand. For example, JAWS is frequently a leader in screen reader innovations, and when a new feature is released, users of other screen readers may have to wait for it to be implemented in their software. Another potential challenge is lack of awareness and utilization of new features in current users' AT. While new and updated features are introduced regularly, with the expectation that even more will follow as AI is implemented in new ways, we do not know how many users are aware of and utilize the new features. Given the barriers of lack

of time and training opportunities, fewer people may be benefiting from these technological innovations than the number that could. Finally, although there are a large number of new, novel AT being developed for people who are blind or who have low vision, particularly new tools for orientation, navigation, or wayfinding, our findings suggest that encouraging the uptake of new devices such as these, particularly those that are not free, may be challenging for their developers.

Outcomes and Benefits

This study explored the lived experience of employed adults who are blind or who have low vision to gain insight into their perceptions about, adoption of, and desires for AT innovations. This research is timely given the large number of AT advancements and innovations for this population in recent years. Considering the ongoing evolution of technologies, such as AI and ML, multi-line refreshable braille displays and tactile displays, head-mounted devices, and smart glasses, this growth is likely to continue at a rapid pace into the future.

There are several outcomes of this study that are beneficial for AT practitioners and manufacturers of mainstream technologies and AT. The relatively high number of participants who did not know of any recent AT advancements suggests that they are not keeping up to date with the latest technologies. It is vital that practitioners, such as CATIS, AT instructors, TVIs, CVRTs, and others, not only stay current with emerging and innovative technologies themselves but develop strategies to provide instruction to consumers on how to remain current with innovative AT, including new features added to their existing AT. CATIS Certification through ACVREP (n.d.) requires certified instructors to be skilled in instruction for updating existing technologies, as well as teaching general exploration skills as appropriate for each student.

One potential model to counter the lack of awareness of new and innovative AT is technology clubs for people who are blind or who have low vision. Some community rehabilitation programs have computer or technology clubs designed to inform current or past students of updates in the field of AT, such as the Boot Up Club (founded in 2003) at the Lighthouse for the Blind of the Palm Beaches, and TechTime at the Conklin Davis Center for the Visually Impaired. Participants benefit from these technology clubs through ongoing collaboration with instructors and other participants to remain current with their existing technologies and to learn about innovative AT. Other agencies and AT instructors should consider how similar programs would be beneficial to current and former AT students.

AT manufacturers can benefit from the input by people who are blind or have low vision about barriers to innovative AT adoption (beyond lack of awareness) provided in this study, such as the high cost and time and effort it takes to adopt new AT. Having a product that is easy to learn, intuitive, and easy to use was of high importance to our participants. Many people cannot or do not want to take the time to learn to use a new product and will not adopt something that has a high learning curve. For most of our participants, new products need to function better than their current AT options to be considered. It is also vital that developers work to lower the high cost of specialized AT solutions. These high costs present a barrier for many people, which will result in limited uptake of new devices for which significant time and expense has been expended in development. In addition, specialized hardware can become outdated quickly, or even obsolete, with the rapid advancements in AI technology (e.g., Ctech, 2024). It would be beneficial for developers of high-cost AT to identify cost-reducing solutions or explore strategies to integrate their technology into existing or mainstream technologies.

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Table 1

Participant Characteristics

Characteristic	**Survey 2** ***(n)***	**Survey 2 (Percent)**	**Survey 3** ***(n)***	**Survey 3 (Percent)**
Gender				
Female	192	61.3	143	58.1
Male	121	38.7	103	41.9
Race				
American Indian or Alaska Native	1	0.3	1	0.4
Asian	18	5.8	11	4.5
Black or African American	16	5.1	13	5.3
Native Hawaiian or Other Pacific Islander	1	0.3	2	0.8
White	258	82.4	206	83.7
Other race or Mixed race	19	6.1	13	5.3
Hispanic Ethnicity				
Yes	25	8.0	20	8.1
No	288	92.0	226	91.9
Age Categories				
21-30	31	9.9	22	9.4
31-40	84	26.8	69	29.4
41-50	76	24.3	56	23.8
51-60	84	26.8	66	28.1
61 or older	38	12.1	22	9.4
Level of Vision				
Totally blind	190	60.7	143	60.9
Legally blind with minimal functional Vision	65	20.8	50	21.3
Legally blind with some functional vision	47	15.0	33	14.0
Low vision, not legally blind	11	3.5	9	3.8
Vision Loss Onset				
Preschool	214	68.4	171	69.5
Kindergarten-12th grade	47	15.0	36	14.6
Post school	52	16.6	39	15.9
Highest Education Level				
Less than a Bachelor’s degree	56	17.9	45	18.3
Bachelor’s degree	118	37.7	89	37.9
Master’s degree	112	35.8	80	34.0
Professional or doctoral degree	27	8.6	21	8.9
Additional disability				
Yes	112	35.8	90	36.6
No	201	64.2	156	63.4

Note. Survey 2 *N*=313; Survey 3 *N*=246.

Table 2

Perceptions About Assistive Technology Advancements

Advancement Themes	***n***	**Percent**
Artificial intelligence (AI) related		
AI incorporated into remote sighted assistance	43	17.5
AI that can describe images	25	10.2
Generative AI	24	9.8
AI improving accessibility	8	3.3
Braille device and feature advancements		
Braille devices	10	4.1
Multi-line braille displays or tactile displays	7	2.8
JAWS Split braille feature	4	1.6
OCR or enhanced OCR added to AT	17	6.9
Improvements to specific AT or devices (not captured in other codes)		
JAWS features/enhancements	9	3.7
iPhone/iOS accessibility enhancements	6	2.4
Updates/enhancements to other AT	12	4.9
Reading handwriting	5	2.0
Other AT-related comment	43	17.5
Not AT-related comment	15	6.1

Note. *N*=246. Data from Survey 3 (2023).

Table 3

Motivation for Adopting New Assistive Technology

Reason	**Select All (*n*)**	**Select All (Percent)**	**Primary (*n*)**	**Primary (Percent)**
Features of the AT appealed to me	110	71.0	42	27.1
Ease of use/convenience	92	59.4	15	9.7
Needed it to perform a specific task	88	56.8	29	18.7
Needed it for work	75	48.4	24	15.5
Affordability/low or no cost	63	40.6	11	7.1
It was recommended/had positive reviews	59	38.1	10	6.5
Needed to upgrade/update an existing AT I used	27	17.4	11	7.1
Needed due to vision changes or other disability	26	16.8	4	2.6
Other	8	5.2	5	3.2

Note. Overall *N*=155 AT adopted across Survey 2 and 3.

Table 4

Importance of Factors Associated with Novel Assistive Technology Adoption

Factor	**5**	**4**	**3**	**2**	**1**
Functionality (whether what it does would help me more than current AT options)	78.6	17.9	2.9	0.6	0.0
Price/Affordability	45.4	32.9	16.6	3.5	1.6
Ease of use (whether it would be easier to use than my current AT)	41.2	33.9	19.8	4.8	0.3
User reviews	12.5	27.5	34.5	19.5	6.1
Friends or colleagues are using it	10.9	28.4	30.0	16.6	14.1
Uniqueness of the AT - I like to be one of the first to try new products	4.8	7.7	15.3	24.0	48.2

Note. 5 was labeled as “Very important” and 1 was labeled as “Not at all important.” All numbers are percentages. *N*=313. Data from Survey 2 (2022).

Table 5

Themes Related to Novel Assistive Technology Adoption Decision Comments

Theme	***n***	**Percent**
Must be useful in daily life, functional, or fill a need	58	18.5
Cost is a factor/novel AT is usually expensive	51	16.3
Likes to use, learn about, or is excited about novel AT	33	10.5
Must be easy to use and/or easy to learn	20	6.4
Needs to improve productivity or efficiency	19	6.1
Lack of interest in trying novel AT	18	5.8
Desire to try out/see a demonstration of novel AT before buying	16	5.1
Comments on time/energy it takes to adopt new AT; the big learning curve for new AT	15	4.8
Talks to other blind users about novel AT or waits for reviews from others	14	4.5
Considers whether the novel AT offers new features or is unique/has unique features	14	4.5

Note. *N*=313. Data from Survey 2 (2022).

Table 6: Desired Assistive Technology Innovations

Theme	**Survey 2 *(n)***	**Survey 2 (Percent)**	**Survey 3 *(n)***	**Survey 3 (Percent)**
Function better or offer additional functions or features	42	13.4	33	13.4
Access information in pictures, photos, graphics, and/or tables	24	7.7	16	6.5
Improve (or add) OCR ability	22	7.0	15	6.1
Improve braille technology access and support	18	5.8	13	5.3
Formatting/layout	8	2.6	3	1.2
Improve the speed or process to complete tasks and access information	7	2.2	4	1.6
Improve image clarity and settings	7	2.2	3	1.2
Incorporate AI	7	2.2	9	3.7
Improve accessibility or usability with software, websites, or digital elements	37	11.8	17	6.9
Read handwritten material	19	6.1	14	5.7
Unique idea for new technology or features	19	6.1	6	2.4
Improved navigation, orientation, and wayfinding assistance and solutions	15	4.8	13	5.3
Mentions feature/technology that already exists	11	3.5	11	4.5
Lack of accessibility or usability of digital content (not the fault of the AT)	11	3.5	11	4.5
Need to reduce cost of AT	8	2.6	3	1.2
Color identification	3	1.0	8	3.3
Advanced AI solutions	2	0.6	7	2.8

Note. Survey 2 *N*=313 (2022); Survey 3 *N*=246 (2023).