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The Use of Wayfinding Apps by Deafblind Travelers in an Urban Environment: Insights From Focus Groups

Amy T. Parker[1], Martin Swobodzinski[2], Tara Brown-Ogilvie[3] and Jenna Beresheim-Kools[1]*

[1] College of Education, Portland State University, Portland, OR, United States, [2] Department of Geography, Portland State University, Portland, OR, United States, [3] School of Special Education, University of Northern Colorado, Greeley, CO, United States

This brief report explores qualitative themes from focus groups with nine individuals who are Deafblind regarding their use of wayfinding apps to support orientation and mobility in an urban environment. Culturally responsive approaches to the design of the focus groups integrated the partnership with Deafblind communication facilitators and ProTactile approaches to solicit naturalistic inquiry on the experiences and preferences of Deafblind travelers. Thematic emergences suggest that participants benefit from various wayfinding apps for orientation and mobility in a densely populated city but they desire greater functionality, consistency of access, equity, and recognition of the unique travel demands faced by Deafblind travelers.

Keywords: Deafblind, orientation and mobility, wayfinding, technology, accessibility, ProTactile, Deafblind communication

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****Correspondence:***
Amy T. Parker
atp5@pdx.edu

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INTRODUCTION

Traveling in an urban environment is a complex process. Likewise, human wayfinding is an interaction between the navigator and the ever-changing world around them. It has long been recognized that having a disability often leads to diminished opportunities for participation in society, reducing access to services and amenities (Wilson et al., 2017). In the context of wayfinding, people with combined vision and hearing impairments face profound barriers in accessing environmental information, communication, and typical affordances that most travelers enjoy. People with concurrent vision and hearing losses are recognized internationally by the term "deafblind", a unique disability, because of the combined impact of sensory losses (Wittich et al., 2012). In the United States, the term is often used with a hyphen, "deaf-blind", and it is related to national statues and regulations for children and adults (Parker, 2014). In this article, we are intentionally using the term "Deafblind" to describe people who identify themselves as members of a cultural and linguistic community. Narrative inquiry research amplifies the voices of people who are Deafblind who describe their experiences in piecing together fragments of information while navigating unpredictable travel environments (Ellis and Hodges, 2013; Watharow, 2020).

Wayfinding tools, such as the now-ubiquitous smartphone apps, hold promise for people who are Deafblind to support navigation as well as supplementing inaccessible environmental information. Although prior survey studies have described the landscape of mobile technologies used by people with visual impairments (Kane et al., 2009; Griffin-Shirley et al., 2017), people

who are Deafblind were not overtly included in these studies. Broad investigations on the types of interventions that support Deafblind persons accessing the internet have linked connectivity to the World Health Organization's International Classification of Functioning, Disability and Health (ICF) in the domains of interpersonal relationships and interactions; social and civic engagement; and learning and applying knowledge (Perfect et al., 2018). Perfect and colleagues' investigation did not uncover internet technologies that explore mobility nor devices that support wayfinding through GPS.

Orientation and Mobility (OandM) is a discipline which emerged from the fields of rehabilitation, special education, and social work to support safe, efficient, and independent travel for persons with visual impairment, as well as those with deafblindness. OandM instruction includes the integration of primary mobility devices (a long cane or guide dog), as well as secondary mobility devices, such as assistive technologies to support static and dynamic orientation to the environment (Wiener et al., 2010). Persons who are Deafblind represent a heterogeneous, low-incidence population who benefit from support with wayfinding and OandM instruction in real-world contexts (Bourquin and Sauerburger, 2005).

Despite the fundamental need for congenitally or adventitiously Deafblind people to receive OandM services, there is scant research about what instruction, techniques, supports, or assistive technologies are most effective for helping people attain their travel goals (Wall Emerson and McCarthy, 2014). The population of people who are Deafblind is diverse and has been described in three broad categories: (1) people who are born with combined vision and hearing impairments, many of whom have additional health impairments or disabilities, such as Congenital Rubella Syndrome (CRS) or CHARGE Syndrome; (2) those who experience one sensory loss early in life while acquiring a second sensory disability, such as Usher Syndrome; and (3) those who acquire vision and hearing losses in late adulthood (Dalby et al., 2009; Wittich et al., 2012). Within this mosaic of Deafblind experiences, heterogeneity in communication needs, access to sensory information, experience of concomitant disabilities, and geographic spread all compound the challenges in developing a body of evidence about assistive devices that support OandM tasks (Parker, 2009).

From the available research on assistive mobility devices for individuals who are Deafblind, investigators have described the positive impacts of the use of guiding robots (Lancioni et al., 1993), vibratory prompting signals (Lancioni et al., 1997), and automated light sources for individuals with deafblindness and concomitant disabilities (Lancioni et al., 1994). While they clearly demonstrate innovations for individuals with complex needs, these studies were focused on indoor travel contexts and were crafted to explore highly individualized OandM interventions (Parker, 2009). Vincent et al. (2014) employed a single-subject investigation with 4 adults who are Deafblind on the use of the Miniguide for obstacle detection and the Trekker Breeze for landmark orientation in everyday travel tasks, and found that despite the devices' limitations, the participants found the supplemental information provided through vibratory feedback to be supportive of their mobility. Reviews of assistive technologies for individuals who are Deafblind describe many proof-of-concept devices that incorporate elaborate, wearable hardware for providing haptic feedback for communication and limited mobility in specific environments (Caporusso et al., 2014). While such designs illuminate future possibilities, the devices, such as wearable belts and gloves that provide haptic feedback, have not been widely tested with people who are Deafblind and do not currently provide scalable wayfinding solutions. In Hersh's qualitative inquiry on the travel experiences of 27 Deafblind participants from different countries, only a single participant described the intermittent use of a GPS device as a component of travel. The same participant noted that the technology increased his confidence in novel locations, but he preferred to collaborate with human guides when possible (Hersh, 2016). Finally, in a participatory design, Azenkot and Fortuna (2010) integrated information from interviews and field observations on the design of a braille interface, MoBraille, for an Android-based GPS device with an adult who is Deafblind. The researchers reported that because the individual was transitioning to reading braille, that they preferred concise messages delivered via refreshable braille to support OandM tasks (Azenkot and Fortuna, 2010).

In this article, we report on the lived experiences of adults who are Deafblind pertaining to the challenges and opportunities afforded by personal mobile phones and wayfinding apps for urban environments. While the overall findings from our study, including an inventory of wayfinding apps that participants identified, have been made available in the final study report (Swobodzinski and Parker, 2019), qualitative themes from our research activities with the Deafblind participants have not been explored in detail. Instead, these are conveyed in this paper.

Our research question further explored the ways that Deafblind adults describe their use wayfinding apps to accomplish travel tasks. As part of our study, we solicited naturalistic input using everyday language in the form of focus groups (Southall and Wittich, 2012). Within our outreach, we recognized that many individuals prefer to identify as culturally Deafblind and value nuanced linguistic, social, and spatial information provided via Tactile American Sign Language (TASL) and touch (Edwards, 2018; Granda and Nuccio, 2018). Close range visual or touch-based TASL is often used for conversation, in which the Deafblind person puts their hands over the signer's hands to feel the shape, movement and location of the signs (Wolsey, 2017). Rather than simply being a means for functional communication, leaders who are Deafblind articulate the cultural and linguistic strength of touch-based communication and learning as a ProTactile approach, one deeply connected with a resilient, self-determined Deafblind community (Granda and Nuccio, 2018; Bradbury et al., 2019). ProTactile communication encompasses physical touch to replicate visual and social information in one's environment (Edwards, 2015). For example, when two or more individuals who are Deafblind engage in direct conversation, they can set up a touch signal (such as tapping on the other person's hand, arm, or leg) to indicate that they are following along in the

FIGURE 1 | Non-participants in the study model small group Tactile ASL communication.

same manner as a person would nod their head to portray that they understand/actively listening (**Figure 1**). One of the principles of ProTactile expression relates to the way spatial information is conveyed via touch. While ASL uses the space around the body to relay spatial concepts, TASL uses the arms, legs and upper chest to designate travel trajectories, landmarks, object-to-person and object-to-object relationships (Edwards, 2015; Granda and Nuccio, 2018; Bradbury et al., 2019). These sensory, conceptual, spatial, and linguistic considerations informed our naturalistic focus groups with Deafblind adults incorporating approaches that acknowledge the autonomy and communication strengths of the Deafblind community (Arndt, 2011; Roy et al., 2018).

MATERIALS AND METHODS

Ethics

The Deafblind participants were recruited as part of a study on the utility of wayfinding apps in a prominent Northwestern city in the United States. Based on Portland State University's IRB-approved protocol (#174465), the lead author, who is hearing and sighted (but fluent in ASL) reached out to a non-profit agency that is governed by people who are Deafblind to recruit participants, explaining the goals and purpose of the study via email and in face-to-face meetings with the director and Deafblind communication facilitators.

Design

Considering the dearth of information about wayfinding for people who are Deafblind, we deemed a qualitatively descriptive approach to be the most appropriate mode of inquiry (Kim et al., 2017). This approach included culturally supportive research practices, participatory engagement, and Deafblind space in the focus group design (Parker et al., 2010; Arndt, 2011; Bruce and Parker, 2012; Granda and Nuccio, 2018; Roy et al., 2018). From a communication, cultural, and linguistic perspective, by employing naturalistic inquiry in a setting hosted by people who are Deafblind, we also sought to avoid traditional power-imbalances between researchers and participants in rehabilitation/medical settings (Roy et al., 2018).

Procedure

The agency director assisted in selecting the date and reserving the agency's community meeting room. Rather than engaging with sighted interpreters for focus group communication, the agency selected two people who are Deafblind to support group communication using TASL and ProTactile principles. The agency assumed the role of sending the IRB approved recruitment materials to its community listserv and encouraged people who were interested to ask further questions and to confirm their attendance. It is important to note that the physical space at the agency is designed by Deafblind people to support effective communication with specific types of directed lighting for individuals with residual vision; walls that provide contrasting backgrounds to reduce glare and focus attention on a signer or speaker's face and hands; and movable furniture to support ProTactile group communication. The agency director and lead researcher established a plan for seating with 2 participants paired with one communication facilitator so that ProTactile communication was available to participants. In a ProTactile approach, all group members remain in proximity and use tactually based linguistic markers and supports to foster meta-linguistic engagement, akin to facial or vocal expressions (Edwards, 2018). The agency director devised a staggered schedule for small groups of participants to arrive; meet with the researcher to discuss consent; and rotate into the group sessions. Please see **Supplementary Appendix 1** for a detailed focus group guide. The lead researcher was present to observe all groups and to respond to facilitators or participants. All sessions were recorded on video so that TASL could be transcribed.

Participants

Nine Deafblind adult participants, all of whom used TASL or modified visual ASL, participated in the groups (**Supplementary Appendix 2**). One participant used a closely held iPad device as a magnifier to view visually signing members of her group. Six were white, one was African-American, one was Latino and one was Middle Eastern. Four identified as female and five identified as male. Each focus group lasted 35 min to an hour. Participants were offered a $50.00 Amazon gift card for their time. Individuals

were not questioned on their diagnoses nor levels of vision or hearing. We avoided any medical, rehabilitation, or service-based jargon for the group interviews, constructing questions that were related to individual use of wayfinding apps.

Data Transcription, Coding, and Analysis

The recordings of the focus groups were subsequently translated and transcribed by three members of the research team, all of whom are fluent in ASL and are active in supporting people who are Deafblind. Faithfully translating a visual or touch based language system, like ASL and TASL, into a completely distinct written language, such as English, has been compared to crossing cultural boundaries (Arndt, 2011). In order to authentically represent the participants' ideas, focus group video clip were translated and transcribed independently by two of the three researchers fluent in ASL and then compared for conceptual accuracy, clarifying the participants' expressed meanings (Arndt, 2011). If there was any misalignment in the researchers' translation from the ASL to written English, the third researcher would also review the clip and the team would revise the transcript accordingly. In one instance when the research team could not see a participant's fingerspelling because of the position of the listener's hands on the speaker's hands, the lead researcher reached out to the participant via email, arranged to review the video clip section with the participant, and received confirmation of the participant's intended message.

After transcription, responses were analyzed using constant comparison techniques (Lincoln and Guba, 1985). In order to ensure confirmability and fidelity in conceptual translation, the research team employed member checks, asking participants to review transcripts for accuracy. The researchers encouraged participants to offer any additional insights via email after the focus groups. Three participants chose to share additional thoughts, and these were incorporated into the transcript analysis process. In alignment with constant comparison processes, the team parsed words, sentences and phrases from transcripts into categories iteratively. Once final code categories were assigned, the lead researcher re-coded transcripts, discussed any agreements or disagreements, and formulated responses/themes in tables. Quotes from participants were drawn out that reflected gestalt themes across participant groups.

RESULTS

Repeated themes were identified across researchers and quotes were selected that represent ideas of the group. Quotes within sub themes were made by different participants.

Gestalt Theme: Desire for Apps to Functionally Provide Greater Access to Information

Across the focus groups, participants conveyed a desire for wayfinding apps to increase one's sensory efficiencies for travel and access to environmental information in their everyday lives.

Sub-Theme 1: Desire for Better Visual Access for People With Low Vision

"The screens on the phones are so small. When I try to enlarge them, the scale is way off and I've lost where I want to look. I have to scroll around. This is especially important when I'm standing at an intersection. Anticipating the next intersection is also a challenge. Even the iPhone 6 which has a larger screen is not helpful for viewing intersections."

"Since I use visual information, I often have issues with glare on my screen, if there was a way for the app to adapt automatically (get darker for example) to compensate for that I think that would be helpful for people who are Deafblind."

"I typically know my way around familiar areas, but in unfamiliar areas I have a hard time getting around especially when it is really bright outside. It would be difficult for me in those conditions to look at a GPS app for directions."

Sub-Theme 2: Desire for Touch-Based, Vibratory Information for Wayfinding Apps

"I really appreciate the touch information on the phone. I keep it in my pocket. If I'm headed in the wrong direction, it will vibrate on my leg as a prompt."

"I wish that the app would notify me when it's time to get off the bus or train through a vibration. A vibratory signal to let me know – 'time to get off'. I get really tired of trying to scroll through complex written directions and process them."

Sub-Theme 3: Desire for Apps to Support Braille Output

"I'm not sure how easy it is to interface with braille using the apps. I think all apps should more easily interface with braille, that's what I would recommend."

"I would like more access for Deafblind via braille related to navigation information."

"It's really hard for me visually now because my vision is deteriorating. I am using braille to confirm what I see. A braille app with the GPS is supportive when I travel or navigate."

"Like, if I can't see the street names, reading it in braille would be easy."

Sub-Theme 4: Desire for Sound-Based Environmental Information to Be Made Accessible

"Sometimes as Deafblind people, we're easily startled by sudden traffic such as an ambulance speeding by or sirens blaring or a fire truck roaring past. That kind of situation can be dangerous for us when we're traveling. It would be really nice to have some kind of notification about what's going on in an emergency situation."

"It would be helpful to have technology that notifies people about the kinds of sounds from emergency vehicles to warn travelers, as well as to let them know when the danger has subsided."

Sub-Theme 5: Desire for Consistent Connectivity

"I want GPS underground for the trains/subway. GPS but it constantly disconnects. I'm really frustrated. I want the technology to improve."

"Suppose something happened and I lose connectivity, I still have to navigate through the community. I still want something that's easy to use and that continues to help me navigate."

Gestalt Theme: Desire for Equity as a Unique Disability Community

Sub-Theme 1: Desiring Equity and Recognition by App Designers

"I wish there was something called a Deafblind Guide that would help the app become easily findable in the app store."

"Instead of having to complain to the government or make recommendations to tech companies, I'd like to have a system where they are more responsive to us. They should include upgrades that we need automatically."

Sub-Theme 2: Desiring Equity and Recognition by Other Disability Groups

"I was at a recent gathering in the city and there were many hearing blind people who were having a great discussion. They described how they use wearable technology as they walk which gives them real-time, environmental information in both ears. This includes intersection information. I raised my hand and asked a question, "Oh what about the Deafblind?" The blind person responded 'I didn't think about that. Why don't you just use wearable earphones?' I laughed and I said "No, I'm not going to wear earphones! I'm Deafblind. That's ridiculous!"

Gestalt Themes: Independence and Interdependence

Independence

"Sometimes the bus driver makes a lot of mistakes and the app can tell me the correct way."

"My friend uses the GPS for driving directions. That worries me. I rather know where I am going. And one time the GPS sent my friend the wrong way. It's better to know where you are going."

"Really, I am pretty independent. If my family is unsure, I tend to take the lead, especially with the GPS. I tend to navigate for them."

"I continuously use apps on my iPhone. And through that process am constantly learning and improving in becoming familiar with those apps. Before I was learning how to use the apps with my OandM but now I'm used to doing that independently."

Interdependence and Communication

"If I can't see, I need help to know where my address is. I check the app, I go online/connect with people like cops, and my friends. When I don't know where I am, I can be found really easily."

"I use the smartphone screen to communicate with the bus driver to ask that they let me know when we are at my stop."

"My stepfather wanted to use this app to stay in touch with me when I was traveling. He wanted to know what street I was on and I thought that was a little bit invasive of my privacy. But he was just giving it to me to consider you know a way to stay in touch to stay in communication when I was traveling. That's one situation I've experienced."

"With my partner, if we're traveling together and using an app that has voice output, so I just turn it up and turn the phone towards her. (Laughing) I'm like here you go listen to this this is the way we're supposed to go. She's hard-of-hearing. If I'm having a hard time reading the small print I just turn the volume up and turn it towards her. Here, you figure it out where we're supposed to go!"

DISCUSSION

This brief report represents the experiences of a bounded group of participants living in an urban environment, who identify as Deafblind and use TASL or close range visual ASL for communication. The Deafblind group's responses on which particular wayfinding apps they used were captured as a part of a broader investigation on wayfinding apps (Swobodzinski and Parker, 2019). The perspectives of participants were further examined within this article to amplify the voices of individuals who consider themselves culturally and linguistically Deafblind, those who are not often included in OandM research. Because the focus groups were constructed with the research team's questions being presented by persons who are Deafblind within smaller clusters of people, there may have been more opportunities for participants to share their own perspectives as well as get a better sense of the responses of listeners that were positioned in physical proximity to them. ProTactile communication supported a conversational, non-medical line of inquiry without a need for mediation from sighted interpreters, a desire expressed by people who are Deafblind (Granda and Nuccio, 2018). From emergent themes, information about the environment may be interpreted or attuned to in different ways by travelers based on their access, preferences, memories, and specific travel demands (Davis, 1989; Davis et al., 1989; Venkatesh et al., 2003). Although participants differed in their reporting of preferred apps, shared desires about how apps may become more useful, consistent, or supportive to travelers coalesced. Findings from these expressed themes were in close alignment with recommendations for OandM practitioners that teaching wayfinding should be grounded in purpose within natural settings and based on an individual's needs (Parker, 2017).

One of the quality indicators for qualitative research inquiries is that themes may be confirmed from the available sources of literature about the experiences of members within a community (Brantlinger et al., 2005). Although it was not the intention of the researchers to recruit people with Usher Syndrome, eight of the nine participants shared that they experience Usher Syndrome Type I. For people with Usher Syndrome, the challenges in transitioning from a visual to a tactile modality for communication, literacy, and mobility have been noted in previous research and were evident in this investigation as evidenced by the expressed concerns with stress, glare, night travel, eye fatigue, and the need for non-verbal communication strategies with transit providers (Ellis and Hodges, 2013; Högner, 2015; Simcock, 2017). The analysis of these themes expressed by members of the Deafblind community supports other findings about the profound relationship between effective mobility and

communication (e.g., De Fiore and Silver, 1988; Gervasoni, 1996; Franklin and Bourquin, 2000; Surakka and Kivelä, 2006). An overall observation of the dynamics within the focus groups was that both the apps and their perceived utility were of great interest to those who joined the discussion, which support a community-based, participatory model of learning (Parker et al., 2010; Bruce and Parker, 2012; Wolsey, 2017).

Limitations of This Study

While the goal of naturalistic inquiry is not to create generalizable knowledge, there is a value in having prolonged engagement with participants to better understand experiences or phenomena (Brantlinger et al., 2005). The focus group sessions were relatively brief and practically focused on the aspects of using wayfinding apps for travel, by no means exhaustively describing the use of mobile technologies, nor fully describing OandM-related experiences. By hosting the focus group in a familiar community space with communication facilitation from people who are Deafblind, the research team sought to facilitate trust and honor the use of a ProTactile approach. Etiological and extensive travel behavior information was not gathered. Challenges around access to information due to changing vision or hearing access emerged from the shared narratives and conveyed perceptions about the app interface or travel context. Another limitation was that the focus group transcripts were the primary source of data which limited the research team's ability to triangulate themes from more than one source; however, the team's use of member checks, independent transcription of video data into written English with clarification and review by multiple researchers bolstered the method for analyzing the narrative data and distilling themes.

CONCLUSION

The importance of developing wayfinding and OandM skills for persons who are deafblind cannot be overstated. Like all people, individuals who are Deafblind may experience increased emotional and physical health through the development of travel strategies (Parker, 2009; Hersh, 2013a,b). Within the lives of Deafblind participants discussed in this article, wayfinding apps play an important role in supporting OandM; however, the functionality of these apps may be improved through a design partnership with app developers. Indeed, several innovations that were suggested by Deafblind participants within the focus groups may have universal benefit for all travelers, particularly those with age-related vision and/or hearing loss (Hersh, 2015; Simcock, 2017). Focus groups provided researchers with opportunities to observe human resiliency fostered by community connections and the affordances provided by touch for communication and technological access. In sum, insights on enhancing the development of wayfinding apps in urban environments across the spectrum of vision and hearing loss informs the field of OandM, transportation, inclusive technology, and all interested in universal design.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because of restrictions within the IRB. Requests to access the datasets should be directed to AP, atp5@pdx.edu.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Portland State University's Institutional Review Board. The patients/participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

AUTHOR CONTRIBUTIONS

AP is the primary author for this report and the lead on the focus group research with the participants within this report. MS is the principal investigator (PI) on the larger study that was funded by the National Institute for Transportation and Communities (NITC; grant number 1177), a U.S. DOT University Transportation Center, while AP was the Co-PI for this grant. TB-O and JB-K supported AP with the coding of the video data from sign language into written English and supported the thematic analysis of the Deafblind focus groups. All authors contributed to the writing and editing of this report, with AP writing the bulk of the report.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2020.572641/full#supplementary-material

REFERENCES

Arndt, K. (2011). Conducting interviews with people who are deafblind: issues in recording and transcription. *Field Methods* 23, 204–214. doi: 10.1177/1525822x10383395

Azenkot, S., and Fortuna, E. (2010). "Improving public transit usability for blind and deaf-blind people by connecting a braille display to a smartphone," in *Proceedings of the 12th international ACM SIGACCESS Conference on Computers and Accessibility*, Orlando, FL, 317–318.

Bourquin, E., and Sauerburger, D. (2005). Teaching Deaf-blind people to communicate and interact with the public: critical issues for travelers who Are Deaf-blind. *Review* 37, 109–117. doi: 10.3200/revu.37.3.119-117

Bradbury, J., Clark, J. L., Grossman, R., Herbers, J., Magliocchino, V., Norman, J., et al. (2019). ProTactile shakespeare: inclusive theater by/for the deafBlind. *Shakespeare Stud.* 47, 81–99.

Brantlinger, E., Jimenez, R., Klingner, J., Pugach, M., and Richardson, V. (2005). Qualitative studies in special education. *Except. Child.* 71, 195–207. doi: 10.1177/001440290507100205

Bruce, S. M., and Parker, A. T. (2012). Young deafblind adults in action: becoming self-determined change agents through advocacy. *Am. Ann. Deaf* 157, 16–26. doi: 10.1353/aad.2012.1607

Caporusso, N., Trizio, M., and Perrone, G. (2014). "Pervasive assistive technology for the Deaf-Blind: need, emergency and assistance through the sense of touch," in *Pervasive Health. Human–Computer Interaction Series*, eds A. Holzinger, M. Ziefle, and C. Röcker (London: Springer). doi: 10.1007/978-1-4471-6413-5_12

Dalby, D. M., Hirdes, J. P., Stolee, P., Strong, J. G., Poss, J., Tjam, E. Y., et al. (2009). Characteristics of individuals with congenital and acquired Deaf-Blindness. *J. Vis. Impair. Blind.* 103, 93–102. doi: 10.1177/0145482X09103 00208

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Q.* 13, 319–340. doi: 10.2307/249008

Davis, F. D., Bagozzi, R. P., and Warshaw, P. R. (1989). User acceptance of computer technology: a comparison of two theoretical models. *Manag. Sci.* 35, 982–1003. doi: 10.1287/mnsc.35.8.982

De Fiore, E. N., and Silver, R. (1988). A redesigned assistance card for the Deaf-blind traveler. *J. Vis. Impair. Blind.* 82, 175–177. doi: 10.1177/0145482x8808200504

Edwards, T. (2015). Bridging the gap between DeafBlind minds: interactional and social foundations of intention attribution in the Seattle DeafBlind community. *Front. Psychol.* 6:1497. doi: 10.3389/fpsyg.2015.01497

Edwards, T. (2018). Re-channeling language: the mutual restructuring of language and infrastructure among Deafblind people at Gallaudet University. *J. Linguist. Anthropol.* 28, 273–292. doi: 10.1111/jola.12199

Ellis, L., and Hodges, L. (2013). *Life and Change with Usher: The Experiences of Diagnosis for People with Usher Syndrome*. Birmingham: University of Birmingham. Available online at: http://www.birmingham.ac.uk/Documents/college-social-sciences/education/projects/final-report-on-life-and-change-with-usher.pdf (accessed January 7, 2015).

Franklin, P., and Bourquin, E. (2000). Picture this: a pilot study for improving street crossings for Deaf-blind travelers. *Review* 31, 173–179.

Gervasoni, E. (1996). Strategies and techniques used by a person who is totally deaf and blind to obtain assistance in crossing streets. *Review* 28, 53–58.

Granda, A., and Nuccio, J. (2018). *Protactile Principles*. Seattle, WA: Tactile Communications.

Griffin-Shirley, N., Banda, D. R., Ajuwon, P. M., Cheon, J., Lee, J., Park, H. R., et al. (2017). A survey on the use of mobile applications for people who are visually impaired. *J. Vis. Impair. Blind.* 111, 307–323. doi: 10.1177/0145482X1711100402

Hersh, M. A. (2013a). Deafblind people, communication, independence, and isolation. *J. Deaf Stud. Deaf Educ.* 18, 446–463. doi: 10.1093/deafed/ent022

Hersh, M. A. (2013b). Deafblind people, stigma and the use of communication and mobility assistive devices. *Technol. Disabil.* 25, 245–261. doi: 10.3233/tad-130394

Hersh, M. A. (2015). Overcoming barriers and increasing independence: service robots for elderly and disabled people. *Int. J. Adv. Robot. Syst.* 12:114. doi: 10.5772/59230

Hersh, M. A. (2016). Improving deafblind travelers' experiences: an international survey. *J. Travel Res.* 55, 380–394. doi: 10.1177/0047287514546225

Högner, N. (2015). Psychological stress in people with dual sensory impairment through Usher syndrome type II. *J. Vis. Impair. Blind.* 109, 185–197. doi: 10.1177/0145482X1510900303

Kane, S. K., Jayant, C., Wobbrock, J. O., and Ladner, R. E. (2009). "Freedom to roam: a study of mobile device adoption and accessibility for people with visual and motor disabilities," in *Proceedings of the 11th International ACM SIGACCESS Conference on Computers and Accessibility*, (New York, NY: ACM), 115–122. doi: 10.1145/1639642.1639663

Kim, H., Sefcik, J. S., and Bradway, C. (2017). Characteristics of qualitative descriptive studies: a systematic review. *Res. Nurs. Health* 40, 23–42. doi: 10.1002/nur.21768

Lancioni, G. E., Bellini, D., and Oliva, D. (1993). A robot to provide multihandicapped blind persons with physical guidance and activity choices. *J. Dev. Phys. Disabil.* 5, 337–348. doi: 10.1007/BF01046390

Lancioni, G. E., Oliva, D., and Bracalente, S. (1994). An electronic guidance system for multihandicapped blind persons: evaluating its effectiveness and likeableness. *Behav. Interv.* 9, 93–103. doi: 10.1002/bin.2360090204

Lancioni, G. E., Oliva, D., and O'Reilly, M. F. (1997). Ambulation, object manipulation, and multiple disabilities: extending the applicability of a robot. *J. Vis. Impair. Blind.* 91, 53–60. doi: 10.1177/0145482x9709100109

Lincoln, Y. S., and Guba, E. (1985). *Naturalistic Inquiry*. Newbury Park, CA: Sage Publications, Inc.

Parker, A. T. (2009). Orientation and Mobility with persons who are Deaf-blind: an initial examination of single-subject design research. *J. Vis. Impair. Blind.* 103, 372–377. doi: 10.1177/0145482X0910300607

Parker, A. T. (2014). Deafblindness: growing a professional home with DVIDB. [Special issue]. *Vis. Impair. Deafblind Educ. Q.* 59, 5–10.

Parker, A. T. (2017). Considering a practical orientation and mobility framework to design communication interventions for people with visual impairments, deafblindness, and multiple disabilities. *Perspect. ASHA Sigs* 2, 89–97. doi: 10.1044/persp2.sig12.89

Parker, A. T., Bruce, S., Spiers, E., Ressa, S., and Davidson, R. (2010). Deaf-blind young adults in action: a participatory action research study. *AER J.* 3, 124–131.

Perfect, E., Jaiswal, A., and Davies, T. C. (2018). Systematic review: investigating the effectiveness of assistive technology to enable internet access for individuals with deafblindness. *Assist. Technol.* 31, 276–285. doi: 10.1080/10400435.2018.1445136

Roy, A., McVilly, K. R., and Crisp, B. R. (2018). Preparing for inclusive consultation, research and policy development: insights from the field of Deafblindness. *J. Soc. Incl.* 9, 71–88. doi: 10.36251/josi.132

Simcock, P. (2017). Ageing with a unique impairment: a systematically conducted review of older deafblind people's experiences. *Ageing Soc.* 37, 1703–1742. doi: 10.1017/S0144686X16000520

Southall, K., and Wittich, W. (2012). Barriers to low vision rehabilitation: a qualitative approach. *J. Vis. Impair. Blind.* 106, 261–274. doi: 10.1177/0145482X1210600502

Surakka, A., and Kivelä, T. (2006). A new method to train and measure 90° turns in visually impaired and Deaf-blind subjects. *Vis. Impair. Res.* 8, 41–47. doi: 10.1080/13882350601061968

Swobodzinski, M., and Parker, A. T. (2019). *A Comprehensive Examination of Electronic Wayfinding Technology for Visually Impaired Travelers in an Urban Environment*. Final Report No. NITC-RR-1177. Portland, OR: Transportation and Research Center (TREC).

Venkatesh, V., Morris, M. G., Davis, G. B., and Davis, F. D. (2003). User acceptance of information technology: toward a unified view. *MIS Q.* 27, 425–478. doi: 10.2307/30036540

Vincent, C., Routhier, F., Martel, V., Mottard, M. È., Dumont, F., Côté, L., et al. (2014). Field testing of two electronic mobility aid devices for persons who are deaf-blind. *Disabil. Rehabil. Assist. Technol.* 9, 414–420. doi: 10.3109/17483107.2013.825929

Wall Emerson, R. S., and McCarthy, T. (2014). "Orientation and mobility for students with visual impairments: priorities for research. In international review of research in developmental disabilities," in *Current Issues in the Education of Students with Visual Impairments*, Vol. 46, ed. D. D. Hatton (Cambridge, MA: Academic Press), 253–280. doi: 10.1016/b978-0-12-420039-5.00008-3

Watharow, A. (2020). Out of adversity can come opportunity: some observations on the different narrative spaces occupied by Deafblind patients. *Survive Thrive* 5:8.

Wiener, W. R., Welsch, R. L., and Blasch, B. B. (eds). (2010). *Foundations of Orientation and Mobility*, 3rd Edn, Vol. 1–2. New York, NY: AFB Press.

Wilson, C., McColl, M., Zhang, F., and McKinnon, P. (2017). Measuring integration of disabled persons: evidence from Canada's time use databases. *Can. J. Disabil. Stud.* 6, 105–127. doi: 10.15353/cjds.v6i1.335

Wittich, W., Watanabe, D. H., and Gagné, J. P. (2012). Sensory and demographic characteristics of deafblindness rehabilitation clients in Montréal, Canada. *Ophthalmic Physiol. Opt.* 32, 242–251. doi: 10.1111/j.1475-1313.2012.00897.x

Wolsey, J. A. (2017). Perspectives and experiences of DeafBlind college students. *Qual. Rep.* 22, 2066–2089.

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