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Orientation and Mobility Services for Students with Deafblindness: A Systematic Review

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Abstract

This study is a systematic review focusing on orientation and mobility services for individuals with DeafBlindness. It answers questions regarding the teaching strategies used with this population. Thirty articles provided thematic evidence under: instructional strategies, communication, assistance, assistive technology, and rehabilitation. 21 articles addressed one theme each while 9 addressed multiple themes each. This review identifies important guidelines for serving individuals with Deafblindness.

Keywords

Orientation and Mobility, Deafblindness, Systematic review

Introduction

Deafblindness (DB) is “concomitant hearing and visual impairment” [Individuals with Disabilities Education Improvement Act, 2004, IDEA§300.8(C)(2)]. Individuals with DB have varying degrees of vision/auditory loss, resulting in inadequate access to environmental information. Those with residual hearing or vision may not be able to use it as a primary source of access to information (Sauerburger et al., 2024). People with DB typically have “severe communication and other developmental and educational needs” and may not be adequately served by “programs solely meant for children with deafness or blindness” (Individuals with Disabilities Education Improvement Act, 2004, 34 CFR §300.8).In the United States, the Individuals with Disabilities Education Act (2004) mandated orientation and mobility (O&M) be provided to children with visual impairments (VI) as a related service to learn travel skills (Neal et al., 2004), concept development, and sensory skills (Fazzy & Barlow, 2017). O&M services provide individuals with DB safe and efficient travel strategies that compensate for limited vision/hearing (Fazzi & Barlow, 2017). However, many of these O&M skills need adaptations to benefit those with DB (McInnes & Treffry, 1982; Pogrund et al., 2012).

Research in O&M for individuals with DB is scarce (Okungu et al., 2020); therefore, this systematic review explores evidence-based studies from 1980

to 2022 concerning O&M services for individuals with DB. The research questions are:

- What does evidence-based research on O&M services for individuals with DB indicate?
- What teaching strategies used by O&M specialists are documented in such studies?

Methods

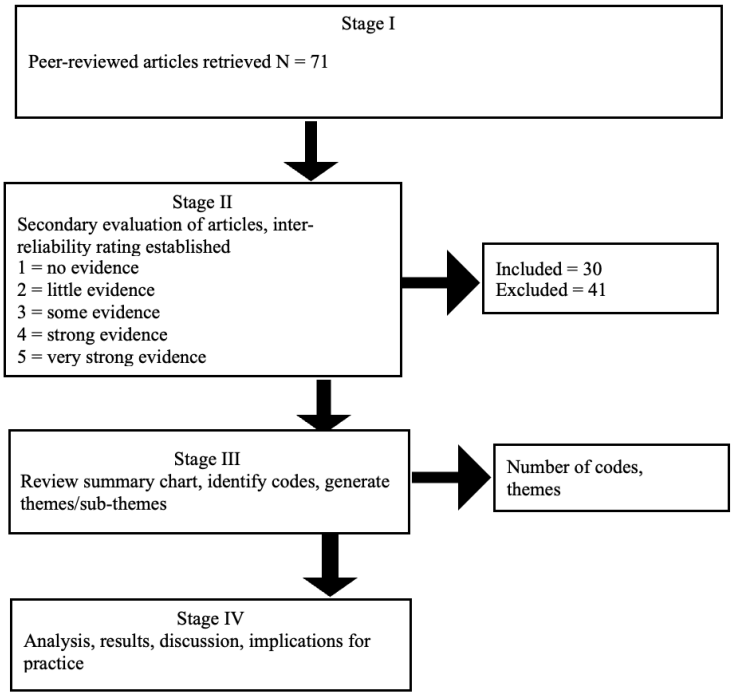
This systematic review adopted the PRISMA guidelines for systematic reviews, consisting of a four-phase flow diagram (identification, screening, eligibility, and exclusion criteria). The review process included framing the questions, identifying relevant studies, assessing the quality of the studies, summarizing the evidence, and interpreting the findings (Khan et al., 2003).

Articles were reviewed during February–November 2023. A Boolean search was performed in Google Scholar using the search terms O&M services, people with DB, dual sensory impairments, multiple impairments, low incidence disabilities, strategies for teaching O&M, and teaching O&M to individuals with DB and databases (e.g., EBSCO). Further searches included Journal of Exceptional Education, International Journal of Orientation and Mobility, Teaching Exceptional Children, Journal of Deafblind Studies on Communication, American Annals for the Deaf, and American Council for Rural Education, and the references from articles identified were mined.

Studies that were non-evidenced-based; did not appear in peer-reviewed publications; published prior to 1980; and where participants were solely deaf, blind, have multiple impairments were excluded. Once this criterion was applied, 71 articles had been identified. An 11-section Excel worksheet was used for encoding the following data for each article: the author/s, a complete article citation in American Psychology Association format, the research question, participants' description, data collection procedures, and results. We rated each article on a 1–5 scale based on how they addressed the research questions (1= no evidence, 2 = little evidence, 3 = some evidence, 4 = strong evidence, and 5 = very strong evidence). During weekly meetings, researchers discussed ratings, scores, and disparities and adjusted as needed. We then eliminated those with an evidence score of 3 or lower, which yielded a corpus of 30 articles. Figure 1 depicts this process and the characteristics of the 30 articles are shown in appendix 1.

Figure 1

Data-mining Process



Results

The following themes emerged from the review: instructional strategies (N = 8), communication (N = 1), assistance (N = 2), AT (N = 24), rehabilitation programs (N = 1). Twenty-one articles addressed only one theme each, and nine (Azenkot et al., 2011; Bourquin & Moon, 2008; Hersh, 2013; Lancioni et al., 1993; Lancioni & Mantini, 1999; Lancioni et al., 1992; Parker et al., 2020; Sauerburger & Jones, 1997; Warnicke et al., 2022) addressed more than one theme each.

Instructional Strategies

Thirteen articles addressed the importance of instructional strategies. To teach 90° turns, Surakka and Kivelä (2006) used heel reflectors, a camera, and software to provide feedback to participants and develop an effective training program. Parker (2009) suggested teaching in natural environments, while Warnicke et al. (2022) recommended training people with DB in auditory localization and visual tracking. Bourquin and Moon (2008) reported that the effectiveness of a larger size of communication

card is important for pedestrian assistance. Sauerburger and Jones (1997) found that cards with bold print, need stated first, followed by instructions, then identification as DB, and held at shoulder level while person with DB was positioned at curb facing street, elicited more help.

Through several studies, Lancioni and researchers showed evidence of improved mobility through a variety of instructional strategies, including use of stimuli, robots, peer caregivers, corrective feedback, preference tests, computer-aided programs, and physical prompting (Lancioni et al., 1993; Lancioni & Mantini, 1999; Lancioni et al., 1998; Lancioni et al., 1992; Lancioni et al., 2000; Lancioni et al., 2007).

Communication

Addressing communication during public transportation use, Azenkot et al. (2011) explored the challenges that individuals with DB, bus drivers, and O&M specialists experienced when using the transit. Results showed that people with DB needed interpreters to use GoBraille and had issues accessing information. The authors concluded that technology should be developed for riders with DB.

Assistance

Assistance was tested using peer caregivers (i.e., 1 female with blindness/IDD and 1 male with DB/IDD) providing physical prompts, edible reinforcement, using a computer-aided program, and supervising trainees with DB/IDD to complete social and vocational activities (Lancioni et al., 1992). Results showed positive interaction between the trainees and their peer care givers.

Assistive Technology

Twenty-four articles addressed AT. Bourquin and Moon (2008) found that larger communication cards elicited more assistance in urban areas at lighted intersections. Franklin and Bourquin (2000) found no significant difference regarding the type of cards (without or with pictures/icons) in the amount of assistance. Sauerburger and Jones (1997) documented the specific order of information on a communication card is necessary to solicit assistance from the public in street crossings. Florence and LaGrow (1989) found that recorded messages elicited more assistance from pedestrians than trying to hand cards to them.

Four articles (Lancioni et al., 1998; Lancioni et al., 1994; Lancioni et al., 2010; Ranjbar et al., 2022) addressed the use of visual orientation systems (light source for guidance); directional verbal instructions and/or vibratory cues; electronic guidance system (control unit, portable device, infrared light source); and vibrotactile guidance (sensors placed on one's skin to give directional cues). The visual system and orientation technology helped with independent mobility. Additionally, users preferred the electronic guidance system but suggested variation of vibrations in the vibrotactile guidance depending on the importance of the information.

Nine articles addressed AT/mobility. Lancioni, Oliva, Adorni et al. (1988) and Lancioni, Oliva, Formica et al. (1988) found that a costly computer-aided program promoted mobility in persons with DB and IDD. Using a computer-aided program with a peer caregiver, Lancioni et al. (1990) found no effect on mobility; however, the dyad condition was favorable. Lancioni et al. (1997) investigated the effect of a robot on ambulation and object manipulation, and found that mobility improved and tasks were completed without tiredness when the robot provided physical guidance. Parker et al. (2020) and Swobodzinski et al. (2022) observed that participants suggested partnering with wayfinding app developers to improve functionality and access to information and that participants preferred tactile maps. Regarding the mobility of people with DB, Vincent et al. (2013) found that Miniguide™, Breeze™, and Quest™ improved performance and satisfaction in mobility, socialization, leisure, and community life as documented by a standardized instrument that measured occupational performance.

Using a vibrotactile aid (Ranjbar & Stenström, 2013) and signal processing methods (Ranjbar, 2014) for environmental perception helped to improve awareness, detection, and identification of sounds. Participants wearing a mmWave sensing hat, coupled with haptic feedback, detected movements of people (Kassem et al., 2022).

Limitations and Recommendations of AT

Hersh (2013) discussed environmental access for wheelchair users with DB and reported that using AT reinforced negative stereotypes (e.g., AT equates disability), hence devices were rejected.

Swobodzinski et al. (2021) advocated involving people with DB in developing technology wayfinding apps and recommended “real-time sound-based safety information” to alert people with DB about emergency vehicles (Swobodzinski et al., 2022, p. 13).

Rehabilitation Programs

Warnicke et al. (2022) suggested intervention through rehabilitation programs that focused on improvement of vision and auditory localization for post-retinal prosthetic surgery and cochlea implant.

Discussion

This study reviewed literature to identify evidence-based strategies and accommodations used by O&M specialists to serve individuals with DB. Findings included evidence in instructional strategies, communication, assistance, AT, limitations/recommendations of AT, and rehabilitation programs.

Specific instructional strategies included teaching in the natural environments, using feedback, prompting, visual tracking, auditory localization training, and peer support. People with DB lack auditory cues and may have difficulty in establishing communication with others (Wiener & Lawson, 2024). For those with functional hearing, O&M specialists should provide them with auditory training (Lawson & Wiener, 2024; McInnes & Treffry, 1982). Training those with some vision to improve functional vision for navigation and safety is recommended (Fazzi & Barlow, 2017; Jacobson, 2013).

Kassem et al. (2022), and Lancioni and Mantini (1999) mentioned the use of feedback (e.g. physical, auditory, and augmentative visual prompts) to facilitate an individual’s response (Fazzi et al., 2024; Kelly & Hallak, 2018; Utley et al., 1991). For example, using augmentative visual cues (e.g., pointing to a car) is recommended for a child with some vision (Utley et al., 1991).

Azencot et al. (2011) and Sauerburger et al. (2024) advocated for O&M specialists to tailor communication methods to the individual's preferences—distinct from the more general approaches used when people with DB interact with the public (e.g., communication cards or cues) designed for pedestrian assistance. Bourquin and Moon (2008) and Clare (2016) discussed the importance of using communication cards to solicit aid from pedestrians for street crossings. All suggested O&M specialists should communicate in the students’ preferred method (e.g., sign language, touch/object cues). O&M specialists who lack skills in using the students’ preferred communication method should have interpreters (Sauerburger et al., 2024).

Regarding assistance, Lancioni et al. (1992) advocated for the provision of physical prompting (guidance) by caregivers to improve mobility. LaGrow and Long (2011) also recommended reinforcement, prompts, and feedback, while Jacobson (2013) and Lancioni et al. (1990; 1992) discussed the value (social interaction and cooperation) of peer-centered experiences.

Lancioni’s research may provide the groundwork for the use of robotics and computer-aided systems for mobility. Robotics (e.g., rolling suitcases using cameras and artificial intelligence being developed and assessed for functionality and usability). However, O&M specialists found cost, functionality, and practicality to be limitations with this technology as observed by Smith et al. (2024).

Electronic travel aids’ use has improved the mobility of people with visual impairments (Giudice & Long, 2024). In Vincent et al. (2013), people with DB expressed satisfaction with secondary ETAs’ contribution to their mobility, while Penrod et al. (2024) found that secondary ETAs (e.g., miniguide, Trekker Breeze) are useful during orientation to new, and complex environments. However, they observed that not everyone is technology savvy and many people with VI are not using it (Penrod et al., 2024).

New advances in AT allow people with VI to use apps (Smith et al., 2024). However, partnerships between people with DB and app developers in creating wayfinding apps (Parker et al., 2020) is recommended to provide users with a voice in the apps’ development and utilization.

Lahav and Siegel concluded that “[m]aps are appropriate for many learners in various learning situations” (2024, p. 378). Tactual maps are used for familiarization, landmark identification, and route content (Bozeman & McCulley, 2010; Giudice & Long, 2024). Like Swobodzinski et al. (2021), Lahav and Siegel (2024) emphasized the benefits of maps for mobility in people with DB.

Ranjbar & Stenström, 2013) reported that Vibrotactile aid was useful in detecting

movement/sounds in the environment by transforming and adapting sounds to the skin frequency sensitivity. However, studies found that vibrotactile feedback is important for interactions with AT as in Ranjbar et al. (2022) where directional information was provided regarding autonomous vehicles (Kassem et al., 2022; Van Rooyen et al., 2024).

Like Warnicke et al. (2022), Moradi et al. (2021) discussed the importance of rehabilitation interventions after cochlear implant surgery to improve hearing acuity. Similarly, Wu et al. (2023) advocated rehabilitation programs after retinal prosthetic surgery.

Several lessons are learned from this study including the need for O&M specialists to adopt strategies that enhance learning for people with DB (e.g., teaching in natural environments, using tactual maps, appropriate AT and communication modes), peer caregivers, physical prompting, and corrective feedback. Collaboration (e.g., partnership between app developers and end users) when developing AT needs consideration. Finally, advances in robotics and technologies need regular reviews to identify potential uses and innovative suggestions about AT.

Limitations

This study had limitations including the exclusion of non-peer-reviewed articles, articles published before 1980, and books or book reviews. It also avoided research that is very dated. Therefore, relevant literature could have been overlooked.

Conclusion

This systematic review explored studies relating to O&M strategies used for individuals with DB. Findings included evidence in instructional strategies, communication, assistance, AT, and rehabilitation programs. Given the broadness of the study period, the research is very thin, and all is based on small sample sizes. Future qualitative research and mixed methods involving interviews and observations with O&M specialists when providing O&M instructions to people with DB will provide more in-depth information.

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Appendix 1. Summary of Article Characteristics

Article	Research design	Purpose of study	Participants	Data collection methods	Results
Azenkot et al. (2011)	Mixed methods	Identify values, stakeholders when using public transit; effectiveness of apps GoBraille, OneBusAway	4 male, 3 female adults with DB. 1 co-designer with DB. 237 bus drivers. 1 O&M instructor	Interview and survey	GoBraille provided nonvisual information but inaccessible to DB, riders need technology with short messages for communication
Bourquin & Moon (2008)	Quantitative	Determine effective variables (e.g., communication cards) when soliciting aid for street crossing	5 students with DB; public	Observation	Larger communication cards elicited more assistance in urban areas at lighted intersections
Florence & LaGrow (1989)	Quantitative	Compare effectiveness for requesting assistance from public between playing a continuous loop tape-recorded message and trying to give people a printed card	1 female, 29, cane user with DB. 120 pedestrians	Observation	Recorded messages were more effective than handing the printed card
Franklin & Bourquin (2000)	Quantitative	Compare use of pictures and icons on a communication card for street crossing assistance from the public	3 males, 2 females with DB. ages 20–60s	Observation	No significant difference
Hersh (2013)	Qualitative	Discover issues concerning assistive technology (AT) for mobility/communication	27 people with DB.1 mother of female with autism/DB	Interviews	Friends/family/DB restriction of AT due to stigma, safety; environmental inaccessibility for wheelchair users
Kassem et al. (2022)	Mixed methods	Document effectiveness of mmWave sensing hat paired with haptic feedback to detect movement	2 adults with DB	Observation. Interviews	Detected movement
Lancioni et al. (1993)	Single subject	Determine if robotic physical supports and an activity keyboard assist in choice making and satisfaction	1 adult male with DB/multiple disabilities	Observation	Effective in guiding/activity and satisfaction
Lancioni & Mantini (1999)	Single subject	Identify effectiveness of corrective feedback	1 adult female, with DB	Observation	Corrective feedback was effective

Lancioni et al. (1998)	Single subject	Explore usefulness of visual orientation system for mobility/activity completion	1 adult female with DB/intellectual and developmental disabilities (IDD)	Observation	Effective for mobility/activity completion
Lancioni, Oliva, Adorni, et al. (1988).	Single subject	Compare effectiveness for performance of unsupervised activities of a computer-aided system to a controlled program	2 adult females with DB/IDD	Observation	Computer-aided program promoted mobility/unsupervised activity; controlled program was unsuccessful
Lancioni et al. (1990)	Single subject	Determine if peer caregiver using computer-aided program increased activity engagement with trainee, interaction of dyad	1 adult female peer caregiver, blind/IDD. 1 male, age 16, trainee with DB/IDD	Observation	Computer-aided program not beneficial; dyad condition (with trainee, peer-caregiver) improved performance; positive interaction
Lancioni et al. (1994)	Single subject	Test preference for electronic-guidance system as alternative to robot	1 adult male with blindness/IDD. 1 adult male with DB/IDD. 10–parent panel	Observation	Guidance system was preferred
Lancioni, Oliva, Formica, et al. (1988)	Single subject	Discover if computer-aided program promotes independence/mobility compared to control program	2 adult males with DB/IDD 1 adult female with DB/IDD	Observation	Increased engagement activities/mobility
Lancioni et al. (1997)	Single subject	Determine if mobility and moving objects improved with use of robot	2 adult males with DB/MD	Observation	Mobility and moving objects improved
Lancioni et al. (1992)	Single subject	Investigate effect of peer caregivers on trainee's ability to complete vocational activity	1 adult female peer caregiver with blindness/IDD 1 adult male peer caregiver with DB/IDD 1 adult male trainee with DB/IDD	Observation	Trainee demonstrated positive changes under caregivers' supervision
Lancioni et al. (2000)	Single subject	Explore robot-assisted program on independent activity, ambulation, and challenging behavior	2 males with DB/IDD	Observation	Independent activities and ambulation increased with robot assistance. Challenging behavior reduced.
Lancioni et al. (1998)	Single subject	Determine participants' preferred task arrangements	2 adult females with DB/IDD	Observation	Mobility tasks preferred

		between mobility and sedentary tasks			
Lancioni et al. (2010)	Single subject	Identify if directional verbal instructions and/or vibratory cues promotes correct direction and room identification during indoor travel	1 adult male with DB/traumatic brain injury and wheelchair user	Observation	Improved travel and speed
Lancioni et al. (2007)	Single subject	Determine if automatically delivered stimuli for walker-assisted steps increases step responses/behavior	1 male, age 8 years and 9 months, with DB/MD	Observation	Stimuli increased step responses, happiness; decreased aberrant behaviors
Parker (2009)	Systematic review	Identify O&M interventions	20 people with DB/IDD, ages 8–36	Online search	Teach in natural environment; use AT; reinforcements
Parker et al. (2020)	Qualitative	Explore use of wayfinding apps	4 male and 5 female adults with DB	Focus group discussion	Apps were effective; need for partnership between app developers and individuals with DB
Ranjbar et al. (2014)	Single subject	Test effectiveness of a Monitor in detecting environmental sounds using differing algorithms	6 adult females with DB	Observation	Monitor increased awareness of sounds
Ranjbar et al. (2022)	Mixed method	Explore experiences with autonomous vehicles using vibrotactile guidance	5 adult females with DB	Interviews Observation	Positive reviews of vibrotactile guidance system using varied vibration
Ranjbar & Stenström (2013)	Qualitative	Investigate use of monitor to detect sound producing events	4 adult females with DB	Observation	Monitor improved detection, identification, and recognition
Sauerburger & Jones (1997)	Qualitative	Identify effective strategies (e.g., communication card) to solicit aid from public	1 adult male with DB 1 adult female with DB	Interviews Observation	Bold print and requested action stated, identification as DB, positioned at curb facing street, and holding card at shoulder level were effective
Surakka, & Kivelä (2006)	Quantitative	Determine effectiveness of training method in teaching 90° turns	1adult male and 3 adult females with DB; mean age of 53.4	Observation	Effective training for making 90° turns; method of measurement for turns developed
Swobodzinski et al. (2022)	Mixed methods	Discover information needs and expectations, using wayfinding tools	9 participants with DB, ages 14–18	Observation and focus group discussion	Use of tactile maps or mobile apps was beneficial. There is need for alert systems and wayfinding apps on smartphones to

					interface with braille display devices
Swobodzinski et al. (2021)	Mixed methods	Identify wayfinding tools preferred on university campus	1 adult male with DB	Observation, survey, and interview	Preferred tactile map and involvement in design of wayfinding technology
Vincent et al. (2013)	Single subject	Identify effects of Miniguide and Breeze electronic travel aids (ETA)	4 participants with DB, ages 50–70	Observation, survey, and interview	Although devices were inefficient in some situations, participants were satisfied with the performance of the ETAs
Warnicke et al. (2022)	Systematic review	Identify rehabilitation interventions	28 articles about adults with DB, ages 18–65	Online article search	Limited number of interventions