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Echoidentification: Teaching Individuals with Visual Impairments to Get the Most Back from Sound

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People who are visually impaired (that is, those who are blind or have low vision) use a wide variety of sensory information to understand the world around them. Hearing is a particularly useful sense because of its range. Many visually impaired people use some form of echolocation to monitor the space around them (for example, the sound of a cane tip reflected off a wall is a common way to keep a parallel path without trailing or shore lining).

Literature review

One purpose of this report is to introduce the generic, catchall word "echoidentification" to refer to this skill categorically. A review of the literature found a range of terms that try to differentiate subskills within this topic in ways that may not be functional for practitioners. What some authors call "human echolocation" (Buckingham, Milne, Byrne, & Goodale, 2015; Fiehler, Schutz, Meller, & Thaler, 2015; Kuc & Kuc, 2016; Pelegrín-García, Rychtáriková, & Glorieux, 2016; Schenkman & Nilsson, 2010), others call "blind echolocation" (Milne, Arnott, Kish, Goodale, & Thaler, 2015; Vercillo, Milne, Gori, & Goodale, 2015); still others use the expression "human sonar" (Wallmeier & Wiegrebe, 2014); and another author uses the term "seeing" (Kish, 2009). Distinctions exist between active echolocation and passive echolocation, based on whether the person generates a sound to seek echoes or uses available echoes in the environment (Wallmeier, Kish, Wiegrebe, & Flanagin, 2015). The buildup of low-frequency waves reflected along walls results in a 6 dB increase in volume, which people detect and use to follow the line or find gaps (Ashmead & Wall, 1999). Another subtype specifies "biosonar," in which the sound source is produced within the body, instead of referring to reflections from a cane tip or other external source (Thaler & Castillo-Serrano, 2016). Rather than separating each subtype of these skills, the authors believe it would benefit the field of visual impairment to unify them under a catchall term, *echoidentification*, and promote teaching students to use this category of perceptual data to improve their wayfinding.

Echoidentification in orientation and mobility

A second purpose of this paper is to emphasize that it is within an orientation and mobility (O&M) specialist's scope of practice to teach students techniques for obtaining the most meaning out of sensory information to interpret the space around them. By teaching students to make a crisp clicking sound and to attend to the reflections of that sound, specialists provide them with more robust skills in this realm. The review of the literature shows evidence that people of various visual acuities can learn echoidentification. Tonelli, Brayda, and Gori (2016) documented that sighted people can learn echoidentification, although several researchers have demonstrated improved acoustic acuity and accuracy in people who are blind following instruction, which they attribute to more experience with interpreting auditory stimuli (Dufour, Despres, & Candas, 2005; Kolarik, Cirstea, Pardhan, & Moore, 2014; Lessard, Pare, Lepore, & Lassonde, 1998). In the authors' experience, blindfolded graduate students can be taught to identify the presence of an object and the direction to it in only a few hours. Children often learn more quickly, but people of any age can learn if they are able to hear the reflected sounds.

Furthermore, students can be taught skills in addition to locating the objects reflecting sound. The relative size of and distance to the object, and its overall shape, as well as its hardness, can be discerned. The authors chose to coin the categorical term *echoidentification* to emphasize discriminating these additional traits. It takes practice to identify material properties of the environment (for example, a surface that is made of wood, concrete, metal, or glass). This skill can be useful to travelers in locating doorways while walking a city block without needing to walk dangerously close to a building, where opening doors may pose a hazard. The leafiness of a bush sounds different than the wooden slats of a bench. It is wonderful to be able to click in a few directions in a park and approach a bench on the first try, thanks to the long-distance perception echoidentification affords.

What can be identified through echoes?

The third purpose of this paper is to provide some concrete strategies that may be useful to instructors interested in teaching higher-level echoidentification skills. Professionals who are beginning to teach echoidentification need to know what objects or items can be detected through echoes. Students with visual impairments may be more attuned to what they are hearing than their instructors, since they do not have visual distractions and can focus on this sense. The following material properties have been documented as perceivable with echoidentification techniques (Arnott, Thaler, Milne, Kish, & Goodale, 2013; Kish, 2009; Kolarik, Cirstea, & Pardhan, 2013; Schörnich et al., 2013):

- location (combination of distance and direction);
- global shape, including edges of an object and concave or convex properties of the near face;

- size;
- material such as fleece or foliage, or a hard surface (Milne et al., 2015); and
- a solid versus an interrupted surface.

As a safety reminder, echoidentification should always be used in combination with a long cane or other primary mobility device, since even the most proficient individuals who use echolocation cannot detect drop-offs.

Teaching echoidentification

Students bring different types of prior knowledge to echoidentification. Thus, the order of instruction may be different for young children who are congenitally blind. Many individuals with visual impairments are naturally attentive to reflected sounds. Some use their mouths to create clicks or similar noises while practicing echoidentification, and others attend to passive echoes in the environment. For children, the authors recommend beginning by building and shaping whatever they naturally do. Once their natural style is maximized, it is logical to introduce other skills to expand into new domains. For example, if a child makes vocalizations and identifies gaps such as doorways, the O&M specialist might work with the student to identify other kinds of edges and determine shapes. Later on, the specialist might teach a more refined click and show the student how to identify gaps from longer distances. For young children, it is also helpful to show parents how to give feedback about the environment. Just as parents say to a sighted child looking at a ball, "Look, you see the ball!"; a blind child who is echoidentifying a ball benefits from, "Look, you can hear there is a ball!"

For students who do not already attend to echoes, early instruction is often focused around contrasts progressing from the easiest discrimination to the most difficult. Again, the O&M specialist should observe the students closely and select whichever contrasts are easiest for them to detect. In the authors' experience of working with sighted graduate students during their blindfold training to become O&M specialists, the presence and absence of near, flat surfaces has been the easiest starting point for most people. The exceptions have been with people who make louder clicks, who sometimes do better at detecting gaps at a greater distance.

Effective clicks

The most effective click is ultimately the one that works best for the person using it in the environment in which it is being used. Sharper clicks—those that are loud, high, and narrow in bandwidth—provide the best resolution (Schörnich, Nagy, & Wiegrebe, 2012). Sharper clicks work better over long distances. Softer clicks are easier to understand for close-up objects, where too much sound may be reflected otherwise, creating a sense of blur. Clicks created in the mouth have the advantage of being centered between the ears, whereas sounds from a cane, even if sent directly back, might miss the observer (Kish, 2009).

Contrasts

Perception is most sensitive to sounds that occur in front of the individual's head, where the reflected sounds reach both ears; however, precise detections of sounds to the side can be developed through practice (Vercillo et al., 2015). For this reason, the authors encourage new students to turn their heads to face each potential object or present the objects directly in front of the head. Contrasts that force a choice are easily used by holding an object either to each student's left or right and asking where it is. This strategy allows the learners to turn their heads each way, click, and compare what is heard on each side. Once students identify which side the object is on, they should reach out and touch it. This confirmation promotes exploring perceptions in independent, nonvisual ways.

Many other contrasts can be created for other features that are useful to identify. For example, a student may be presented with two objects at known angles and asked which is further away. It is important to ensure that the background space is also equidistant when teaching this echoidentification skill. Two objects of different sizes can be presented at the same distance, and the student can be asked to identify the larger one. In an unfamiliar space, a student can be asked to find the doorway in a wall by identifying the presence or absence of reflections from the wall. In outdoor travel, students may be asked whether waist-high obstacles are solid or intermittent, thereby teaching them to identify the difference between retaining walls and fences, which may become useful landmarks on routes. The hard-soft contrast can be presented with a solid, flat object compared to a pillow or folded jacket.

Some students benefit from first comparing the soft object to the absence of an object in order to become familiar with the lower-energy echoes. To assess whether a student needs this step, when presenting the hard-soft contrast the hard-nothing contrast can be interspersed a few times. If the student is consistently choosing empty space as the soft object and if, after several repetitions with feedback, he or she does not identify the cases in which no second object is present, that would indicate the need for teaching additional contrasts. This type of comparison, introducing absences, can be used in any contrast to check if a student is comparing both objects or only detecting the more obvious object and making an inference based on that.

Conclusions

The functional use of echoidentification skills may be individualized by each traveler. Some people known to the authors use echoidentification nearly continuously while traveling. This method provides spatial updating through the acoustic flow (Guth, Rieser, & Ashmead, 2010). Others use their echoidentification skills selectively when looking for a particular landmark out of reach of their canes. Echoidentification does not constitute a primary mobility device, but it could serve as a useful tool to know. The authors have been pleasantly surprised at how easily students learn the skills, and we hope to see O&M specialists providing more echoidentification instruction.

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