An Echolocation Training Package

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The phenomenon of echolocation or using sonar to navigate the environment has been widely studied, though rarely taught to individuals who are blind or vision impaired (Kish 2003). This paper describes the essential content of an echolocation training package designed to assist orientation and mobility (O&M) instructors teach clients echolocation skills. This package will be trialled using volunteer participants who are clients of Guide Dogs NSW/ACT Australia and then refined based on an analysis of the resulting data. The training package includes seven modules containing background information, details of specific training areas, as well as O&M activities for people who are blind or vision impaired.

Echolocation is the phenomenon that enables people who are blind to sense obstacles in their immediate environment (Kish, 2003). It is achieved by ambient or active sounds bouncing off objects in the environment, giving the echolocator an auditory picture of objects including their size, shape, and texture (Kish, 2003).

Although the ways in which people who are blind use hearing to alert them to obstacles has been documented extensively (Griffin, 1986) it seems that no holistic echolocation training program has been constructed and documented to assist orientation and mobility (O&M) instructors teach this skill.

There are many benefits of having the ability to echolocate. Kish (2003) has described the skill of echolocation as “seeing with sound”. Once people who are blind or vision impaired have learnt this skill he suggests, they will be much more competent and capable travellers. Designing a holistic echolocation program will aid in enhancing clients independence, while also enabling higher order interaction with and understanding of the environment around them. The development of a systematic and performance-based echolocation training package will pave the way for echolocation to become a widely taught skill in the Guide Dogs NSW/ACT O&M training curriculum.

Echolocation training package:
The essential content

The echolocation training package in full contains written and audio material, and echolocation literature. This article describes the essentials of the training content including some activities used to teach echolocation skills. The training package is structured with each module containing a brief introduction to the skills introduced, recommended training environments, recommended activities, and where relevant, the materials required for the training session. The author has located and visited each of the training environments, from which documentation of ways to teach specific concepts were gathered. Training environments included: (i) a quiet room with a sound beacon, (ii) an open field, (iii) an
open area with high brick wall, and (iv) an area with high sound reverberation or echo such as a tiled corridor. These environments become progressively more complex as the training progresses. This training package will be trialled using volunteer clients of Guide Dogs NSW/ACT Australia in order to validate its internal and external consistency and validity. The package will also be distributed to a range of O&M instructors to seek their feedback.

The training package contains seven modules that include: (i) assessing skills in sound localisation and echolocation (ii) demonstration of echolocation (iii) determining the desired sound source (iv) defining dense objects ahead and to the sides (v) locating gaps (vi) negotiating overhanging branches (vii) negotiating travel routes specific to the client. A brief outline of each module follows.

Module 1: Assessment of sound localisation and echolocation

In order to individualise this echolocation program, the O&M instructor requires an understanding of a clients current level of echolocation knowledge or skill. Understanding the clients knowledge about echolocation will assist the instructor to determine the level of echolocation training the client requires. For example, if the client is unfamiliar with echolocation, then completing Module 2 (demonstration of echolocation) is essential for the client. However, if the client has a basic understanding of echolocation, then the client can commence training at Module 3 (determining the desired sound source). Hence, the O&M instructor can apply the following activities that will form the basis of an assessment tool to assist the instructor tailor each program to the specific needs of each client. The assessment tool will assess the client’s (i) sound localisation skills and (ii) grasp of echolocation prior to commencing the program.

Module 1 training requirements

(1) Training environments: A number of training locations used at various times are required in Module 1. Locate: first, a quiet and carpeted room; second, a suburban street with relatively high traffic flow; third, a street intersection with high traffic flow; fourth, a client’s home/household ambient sounds; and fifth, a concreted area with a brick or concrete wall which is taller than the client.

(2) Materials: A sound beacon or stereo music; any kind of household machinery, for example, a vacuum cleaner or a lawn mower.

(3) Exercises:

(i) In a quiet carpeted room, place a sound beacon or stereo in different positions in relation to the client (left, right, in-front, and behind). The client is to explain from where the sound is coming. If the client gives correct answers for all positions then proceed to exercise two. If the client reports incorrect answers, check their knowledge of laterality, and find a particular sound stimulus that can be heard by the client.

(ii) Human guide the client along a street and ask whether or not s/he can hear the direction of traffic (in-front to behind and behind
to in-front). Request the client indicate the direction of the traffic to confirm knowledge of this skill. Next, locate an intersection and ask the client to determine whether or not there has been a change in the traffic direction. Ask the client the directions of the traffic flow. Ask the client the meaning of the change in traffic flow e.g. from stationary traffic to turning traffic.

(iii) If there is ambient sound in the client’s home environment e.g., a lawn mower or vacuum cleaner, then ask the client to indicate from which direction the sound is coming. Position the client in various directions in relation to the sound stimulus.

(4) Echolocation Skills:

(i) Ask the client whether or not s/he uses echolocation. If the client responds that echolocation is used then ask how and where they tend to use it. Take note of this information for future planning of the echolocation training. If the client does not know what echolocation is, or whether they use it, move to the following exercise.

(ii) Locate a wall either indoors or outdoors that is taller than the client. Request the client to free walk toward the wall and monitor whether or not he/she stops prior to making physical contact with the wall. If the client does stop before physically contacting the wall then the client is likely to be using passive echolocation to locate the wall. Next, ask the client to use their cane (if applicable) to walk towards another wall nearby. Monitor whether or not the client hesitates prior to contacting the wall with the cane. If the client does hesitate, and vision is not being used, then it is likely that the client is using passive echolocation to locate the wall. If the client cannot perceive the wall at all, then the client requires the echolocation training program to commence from Module 2 (demonstration of echolocation).

**Module 2: Demonstration of echolocation**

To apply echolocation in everyday life, clients need to understand the ways in which it works. Examples of exercises follow to give clients a sense of how and where they might incorporate echolocation in their own lives.

**Module 2 training requirements**

(1) Training environments: A number of training locations used at various times are required in Module 2. Locate first, a large quiet room; second, a sporting oval with a grandstand or high brick wall; third, a room with a tiled floor and walls; fourth, a carpeted room; and fifth, outdoors.

(2) Materials: A computer with internet connection; a flat glass plate (30cm x 30cm).

(3) Exercises:

(i) Explain echolocation: Echolocation means using hearing to detect objects in the environment. Sound bounces off objects and back to the
place from which it was emitted. The echo gives information about objects such as shape, size and texture within an environment.

(ii) Show and describe the YouTube video available from http://www.worldaccessfortheblind.org/node/135

This video gives a real life presentation of a person who is blind using echolocation and shows its potential. The video also presents varying tongue clicks which can be used in active echolocation.

(iii) Demonstration of echolocation:

First, the client will stand in an oval with a grand stand or tall brick wall located to the left or right side. The grandstand or brick wall will be located within 200 metres of the client. The effectiveness of echolocation will be demonstrated by using a loud clap or tongue click. It will be explained that the clap or tongue click stimulates an echo that bounces off the building and back to where it originated. The demonstration will continue until the client recognises the echo and its direction.

Second, the client will stand in a tiled room such as a tiled stairwell, then a carpeted room, then outdoors. A vocal demonstration in each environment will highlight the echo differences between each environment.

Third, in a quiet room, a flat glass plate (30cm x 30cm) will be presented to the client. The client will be requested to talk while the plate is moved from half a metre to two centimetres from the client. This activity will be repeated in front, behind, to the left and right of the client. The instructor will confirm that the client is able to sense when the plate is coming closer to them and from each direction. The client should be able to notice a change in the sound of their voice as the glass plate is moved.

Module 3: Determining the desired sound source

Echolocation can be used actively or passively. Active echolocation is demonstrated when a person uses sounds such as tongue clicks, finger clicks, clapping, loudly tapping their cane to produce an echo.

Passive echolocation is where a person detects echoes resulting from sound stimuli within the environment. Passive echolocation can occur through various means, according to the sounds within an environment such as other people’s foot steps, people talking, sound from machinery, and using constant contact with the cane.

Although some author’s suggest that sounds produced ‘above the waist’ closer to the ears is most effective for the echolocation of objects (Burton, 2000; Kish, 1995; Schenkman & Jansson, 1986), client preference should determine the form of echolocation used (active or passive) and the type of sound produced (e.g., tongue click, finger click, cane tap) (Brazier, 2008). Further, different environments might require the production of varying sounds to gain the best echo. For instance, a loud and strong tongue click might alert the client to the size and shape of a room, while a softer
tongue click might provide information about objects within the environment such as furniture. It is important to be mindful that loud tongue clicking might cause unwanted attention. Discuss with the client the possibility of negative attention and possibly assist the client develop coping strategies. Ideally, clients should use sounds that give them the most information about an environment, whether or not it causes attention to the client.

**Module 3 training requirements**

1. **Materials:** A computer with internet connection;
2. **Exercises:**
   1. **Active echolocation:** Tongue clicking.

Tongue clicking can be used in a variety of ways depending upon the environment, and particular features the echolocation user is trying to gather. First, the quiet tongue click is used to gather the type and distance of objects in the immediate area of the client (e.g., a table or chair within three metres of the client). To produce this tongue click the client should (a) place the tongue firmly to the roof of the mouth and (b) move the tongue from the roof of the mouth in a smooth but quiet fashion. The YouTube video available at http://www.worldaccessfortheblind.org/node/135 contains an auditory demonstration of the sound quiet tongue click should make.

Second, the powerful tongue click is used to gather information about the size and shape of objects at a distance from the client. To produce this tongue click the client should (a) place the tongue firmly to the roof of the mouth then (b) move the tongue forcefully from the roof of the mouth, but do not bring it down to the bottom teeth. Move the tongue from the roof of the mouth forcefully but at a very short distance. This should produce a loud and powerful tongue click. Kish (personal communication, November, 2009) described this process being like “sucking peanut butter off the roof of one’s mouth.”

**Module 4: Defining dense objects ahead and to the sides**

A common use of echolocation is to enable the client to define dense objects such as walls, buildings, bus shelters, parked cars, and doors which remain ajar. The objective of using echolocation among these objects is to avoid them while travelling through the environment. Prior to learning the methods to avoid these objects using echolocation, the person requires knowledge of the size and shape of the object, as well as the kinds of echo it produces.

**Module 4 training requirements**

1. **Training environments:** A number of training locations used at various times are required in Module 4. First, locate first, a brick wall; second, an indoor corridor, third, a bus shelter, fourth, parked cars, fifth, doors which remain ajar.
2. **Exercises:**
(i) Request the client to walk towards a 
brick wall, at distances ranging from 
10 metres to 0.5 metres. Repeat this 
exercise until the client is confident in 
using active echolocation to 
sense the wall and stop prior to 
physically contacting it. Then direct 
the client to approach walls from the 
left and right. Ask the client to walk 
along a wall, using echolocation to 
keep it on either their right or left. 
Complete this exercise with walls of 
different heights and textures.

(ii) Transfer the previous exercise to 
walls of different textures and heights 
and in different environments such 
as indoor corridors, wooden doors, 
glass walls, and concrete walls. 
Discuss the texture and height of 
each wall so that the client has a 
clear understanding of the wall, 
and the range of wall types in the 
general environment in which they 
might travel.

(iii) Transfer the echolocation exercise 
to bus shelters, then parked cars, 
and finally to doors that remain ajar.

Module 5: Locating gaps

Echolocation is a useful tool in locating 
gaps such as open doorways, alcoves, the 
space between two parked cars, and even a 
clear passage through a crowd of people.

Module 5 training requirements

(1) Training environments: A number of 
training locations used at various times 
are required in Module 5. Locate first, 
the corridors of an office building 
(ensure that doors are open); second, 
residential streets containing houses 
with fences and open driveways; third, 
car parks or streets containing parked 
cars; and fourth, busy train stations or a 
crowded area.

(2) Exercises:

(i) In a corridor of an office building 
request the client to walk past 
the open doors indicating when 
a door is passed. If the client has 
difficulty identifying open doors 
then use the point at which one 
corridor intersects with another as 
this produces a wider gap than that 
created by an open door.

(ii) Transfer the previous exercise to 
outdoor environments e.g., gaps 
between front fences of two adjacent 
houses, and gaps between parked 
cars. Choose gaps in environments 
that are likely to be used by the 
client in the future. It might also be 
necessary to human guide the client 
if he/she has difficulty using the cane 
and concentrating on echolocation 
at this early stage of its acquisition.

Module 6: Negotiating overhanging branches

Using echolocation to negotiate 
overhanging branches might be difficult to 
master as branches are hardly ever rigid. 
This means that the echo heard from sound 
waves bouncing off branches is weak and 
will not be as pronounced as the sound echo 
from a rigid object such as a brick wall. 
This application of echolocation to negotiate 
overhanging branches should be introduced 
after the client has a thorough understanding 
of recognising gaps, as overhangs may be 
misinterpreted as gaps due to the weaker 
echos they produce.
Module 6 training requirements

(1) Training environments: Various locations used at various times are required in Module 6. Locate first, a park or field with trees; and second, a residential street lined with trees and overhanging branches.

(2) Exercises:

(i) Choose a park with many trees and overhanging branches. Human guide the client towards these branches and direct the client to use active echolocation to locate them. This process might need to be repeated a number of times near a number of different branches for the client to be able to hear the location of the branch. Begin this exercise with the densest branches, and progress to sparser overhangs.

(ii) Choose a residential street with many overhanging branches. Give the client the choice of either using their cane or being guided along the street. Ask the client to count the number of overhanging branches which can be detected when using active echolocation.

These exercises might need to be conducted repetitiously over a period of weeks for the client’s echolocation skills to adapt to detecting branches. This time length is likely to vary with each client.

Module 7: Negotiating travel routes specific to the client

Once the basic skills of echolocation described in the modules have been taught to the client, the instructor can begin to integrate echolocation into the client’s travel routes. First, the instructor should walk the travel route and note features of the environment where the client could use echolocation. Second, the instructor would walk the route with the client, explaining where they are able to use echolocation. It is important to check whether or not the client is able to gain echolocation from features of the environment as individual clients possess different abilities in echolocation. Third, request the client recall and/or write down the features of the environment from which they can gain echoes. Recalling the features will assist the client to keep track of the environmental features to which they are required to pay attention and the type of sound they should make. Finally, repeat this process across many environments until the client is able to apply the skills independently.

Conclusion

This training package presents a range of different uses for echolocation, as well as practical exercises guiding the teaching of echolocation to clients with vision impairment.

The package will be trialled by volunteer clients’ of Guide Dogs NSW/ACT, Australia who do not use echolocation as a navigation tool. The trial of the package will result in qualitative and quantitative data from which further refinements will be made. Once the refinements have been made, the package will be retested with a new set of volunteer clients (with half of the clients as the control group). It is expected that the final training package will be performance-based necessitating that each module be completed successfully prior to the commencement of the following module. Further, the training
exercises will be described in detail allowing for the replication of exercises by a range of instructors across a variety of environments.

References


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