Effect of auditory localization training in individuals with unilateral hearing loss

by Devi N

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PROJECT PROPOSAL FORMAT

Part -A

1.0 Title of the Project:

Effect of auditory localization training in individuals with unilateral hearing loss

2.0 Area of Research:

a) Speech, Language, Hearing

1.1	**Principal Investigator:**	Dr. N. Devi
1.2	**Principal Co-Investigator(s)**	Dr. Ramadevi Sreenivas K. J.
1.4	**Collaborating Institution**	Nil
1.5	**Total Grants Required (in figures and in words)**	Rs 4,42,000 (four lakhs forty two thousand)
1.6	**Duration of the Project**	One year

2.0 Project Summary:

Individuals with unilateral hearing loss experience difficulty not only with perception of speech in noisy environment but have poor localization ability. However, with appropriate rehabilitative procedure, perception of speech in noise can be improved to a greater extent, whereas the localization abilities are reported still to be poorer. Hence the present project aims to investigate the influence of specific auditory localization training for individuals with unilateral hearing loss with different amplification devices. This would provide us the information if training induced plasticity can help for better perception of localization task in individuals with unilateral hearing loss.

3.0 Introduction

3.1 Definition of the problem:

Unilateral hearing loss (UHL) refers to having normal hearing sensitivity in one ear and hearing loss in the other ear. The individuals with UHL might find difficultly in various conditions like listening to speech in the noisy environment, localizing a sound source that arrives from the direction of the poorer ear and understanding speech from a distant source. However, there are various rehabilitation approaches are available like fitting them with an BTE hearing aid, CROS hearing aids or Bone anchored hearing implant (BAHI). Reviewing the literature, the reports reveal that individuals usually prefer BAHI over the conventional hearing aids or CROS hearing aids for better speech perception in quiet as well as in noise. But the results of auditory localization test revealed poorer performance with BAHI.

Aim:

To evaluate the effectiveness of auditory localization training in individuals with unilateral sensorineural hearing loss.

3.2 Objectives:

- To estimate the accuracy and degrees of error (DOE) for horizontal localization task in individuals with unilateral hearing loss
- To estimate the accuracy and degrees of error (DOE) for horizontal localization task in individuals with unilateral hearing loss fitted with digital BTE hearing aids, digital CROS hearing aids and, programmable digital bone-anchored hearing implant (BAHI with soft band)

- To compare the accuracy and degrees of error (DOE) for horizontal localization task with unaided and aided measures with different amplification devices

3.3 Review of status of research and development in the subject:

Auditory localization relies on the detection and interpretation of spatial cues generated by the interaction between sound waves and the head and external ears (King, Doubell, & Schnupp, 2001). Localization in the horizontal plane is based primarily on binaural disparity cues, interaural time differences (ITDs), and interaural level differences (ILDs), whereas spectral cues produced by the filtering properties of each external ear are used for making elevation judgments, discriminating between front and back, and, under certain conditions, for localizing sounds using one ear alone (Wightman & Kistler, 1993). However in individuals with unilateral hearing loss there is lack of ITD and ILD cues. Hence, the performance of the localization task is poorer in these individuals even when fitted with BAHA or CROS hearing aids (Wazen et al, 2005; Lin et al, 2006; Newman, Sandridge, & Wodzisz, 2008). These reports are the results of an experimental condition and this question for a need to probe into the plasticity of the auditory localization system in individuals with unilateral hearing loss. Nawaz, McNeill, and Greenberg (2014) have reported improvement in auditory localization test with training after fitted with cochlear implant in an individual with single sided deafness. Hence it's hypothesized that recovery of accurate spatial responses to sounds presented in the horizontal plane is possible when appropriate training is provided in specific.

3.4 International and national status:

The studies mentioned above are on an experimental set up, where the plasticity of the auditory localization system is less tapped. This study will provide us with better understanding of the rehabilitative options for individuals with unilateral hearing loss.

3.5 Importance of the proposed project in the context of current status:

There is a lack of literature on the training induced plasticity in unilateral hearing loss as they are reported to provide limited benefit in the outcome measure for the localization task. Hence this project with provide an opt information on the training module for auditory localization in individuals who get limited ITD and ILD cues.

4.0 Work Plan

4.1 Method

Subjects / Participants: A total of 15 participants with with unilateral hearing loss, having normal hearing sensitivity of <15 dBHL in the frequency from 250 Hz to 8000 Hz for air conduction and 250 Hz to 4000 Hz for bone conduction in the better ear and having moderately-severe to severe hearing loss of > 56 dBHL – 70 dBHL in the poorer ear. The age range of the participants would be 15 – 40 years. All the subjects should have a speech recognition threshold of +\-12 dB relative to their pure tone thresholds and normal middle ear functioning with A type tympanogram as depicted through immittance audiometry. No other otological or neurological illness/ cognitive/psychological problems to be reported. None of the participants should report ill health during the testing. Written consent will be taken from all the participants for willingly participating in the study.

The selected participants would be further divided into three groups as Group I- to be tested and trained with Digital BTE hearing aids, group II – to be tested and trained with digital CROS hearing aids and group III – to be tested and trained with digital BAHI (with soft bands)

Material:

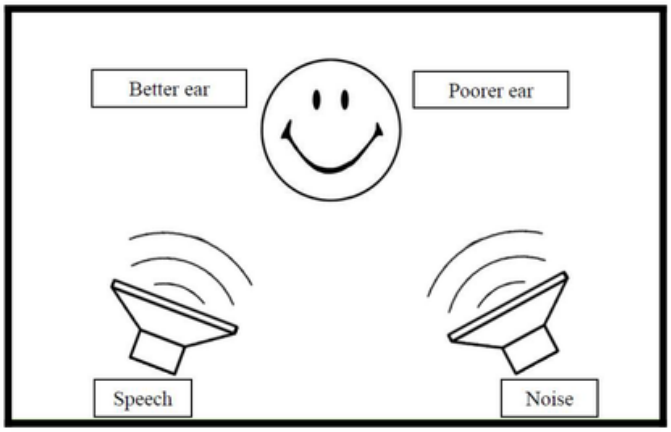
a. Speech perception in noise test (SNR50 in direct and indirect conditions).

Signal to Noise Ratio - 50 (SNR-50) is defined as the difference between the intensity of the live speech material and the intensity of the speech noise in dB when the participant repeats back at least two words in a set of three words presented along with competing speech noise. The SNR-50 will be obtained in two conditions for each of the aided conditions and in unaided condition as depicted in the Figure 1:

Direct: Signal presented towards the better ear and noise towards the poorer ear.

Indirect: Signal presented towards the poorer ear and noise towards the better ear.

A) Direct condition



B) Indirect condition

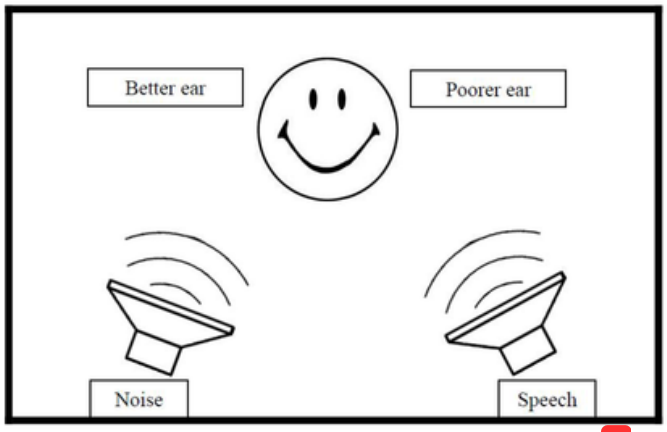


Figure 1: Depiction of A) Direct condition in which the signal is presented to better ear and noise to the poorer ear. B) Indirect condition in which the signal is presented to poorer ear and noise to the better ear.

b) Horizontal plane localization test:-

Train of white noise pulses with duration of 200 ms separated by 200 ms of silence (Tyler et al., 2002) and speech noise will be generated using Adobe Audition 3.0 software for the purpose of localization task. A total of 12 speakers with an angel of 30^0 between the speakers would be used for the presentation of the stimuli. A total of 36 burst for each of the noise will be generated. These burst of noise will be randomly assigned for different loudspeaker leading to have 3 stimulus of each of the stimuli per speaker. The accuracy and the degree of error (DOE) will be further calculated.

c) Horizontal plane localization training module:

The participant will be seated in the centre of sound treated room surrounded by eight loudspeakers. Forty set of noise burst will be generated and will be routed in random order to each of the speaker. Hence, burst of noise will be delivered for 5 times in each speaker. The stimuli will be presented at 75dBSPL. The participant's task is to point out to the speaker that

delivered the stimuli. This procedure will be carried out in three phase. In phase I – only two speakers of 90^0 and 270^0 will be used. Once when they are able to point out to all the stimuli 100% of the time, phase II will be carried out. Here the stimuli will be presented through 4 speakers of 0^0, 90^0, 180^0 and 270^0. Once the participants obtain 100% score, 8 speakers will be introduced as phase III. However, feedback will be provided with the correct response after each stimuli presented.

Procedure:

The following protocol of test procedure will be administered to the three grouped participants.

a) *Speech perception in noise test:*

The participant will be asked to sit comfortably on a chair at one meter distance from the loudspeaker. A list of 40 sets of Kannada bi-syllabic words developed by Sahgal (2005) will be used to find out the SNR 50. The speech material will be presented at a constant intensity of 40 dB HL. The speech noise will be presented at an intensity 15 dB lower than the signal and manipulated systematically in one dB step. The patient will be asked to reiterate the words comprehended. At each level of noise, a set of three words will be presented to the participant. The level of noise will be increased by one dB if the participant restated at least two out of three words correctly. If they failed to repeat at least two of the three words, then the level of noise will be dropped by two dB. This procedure will be carried on till the highest level of speech noise was reached in the presence of which the participant could repeat at least two out of the three words correctly. The difference between the signal and noise at this juncture will be taken as the SNR-50.

b) Sound localization test:

The white noise and speech noise that was prepared will be presented randomly to 12 speakers, such that each stimulus will be presented 3 times per speaker. The participants task is to identify the speaker through which the stimulus was heard.

c) *Sound localization training*:

The prepared auditory localization training module will be used. During the test and the training period, the participants will be instructed to maintain the designated position/orientation of the head. The participants will be instructed that he/she would be hearing a train of noise stimuli from any one of the speakers at a time. Each time, he or she had to report the loudspeaker from which the stimulus was heard. The response mode from the participant will be through a pointing task. The location of the loudspeaker to which participants pointed will be noted down in terms of azimuth. This same procedure will be done at unaided and different aided conditions. This training procedure would be done continuously for a period of 10 sessions.

d) Post – auditory localization training evaluations:

The Horizontal plane localization test and speech perception in noise test will be administered after they complete 10 sessions of localization training. Further after 2 weeks the tests will re-administered to check for its reliability. In the present study, the BAHI device will not implanted surgically. The sound processor of the BAHI will be attached to the soft band that could be used for evaluation of performance pre-surgical implantation.

For the purpose of the study, accuracy and Degree of error (DOE) will measured for the localization task. Degree of error corresponds to the difference in degrees between the degrees of azimuth of the loudspeaker of actual presentation of the stimuli, to the degree of azimuth of the

loudspeaker identified as the source of the stimulus by the participant. For example, if the stimulus was presented from a loudspeaker at 45^0 azimuth and the participant reported the sound to be arriving from loudspeaker at 315^0, then the degree of error would be 90^0 i.e., 45^0-(315^0) = 90^0.

Analyses

A suitable statistical analysis will be performed on the collected data.

6.0 Implications of the results of the study

The proposed project would help in understanding the efficacy of localization training for better outcomes with the rehabilitative options for those individuals with unilateral hearing loss.

a)	**Presentation of scientific papers in professional seminars / publication of articles**	: -- Yes
b)	**Discussion with professionals**	: Yes
c)	**To utilize the results in the development of remediation**	: Yes

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Audiology, 2013.
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