AN APPROACH TO TRAINING LOCALIZATION

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INTRODUCTION

Localization ability is a skill that is known to decrease with hearing loss [Byrne and Noble, 1998; Lorenzi et al, 1999]. The studies by Lorenzi et al, 1999 and Best et al., 2011, suggest that the loss of audibility and the distortion of spatial cues from hearing loss contribute to the diminished localization ability of the hearing impaired compared to normal hearing listeners. Prior to amplification intervention, the hearing impaired listener may have experienced cortical re-organization with their hearing loss [Dahmen and King, 2007]. Studies with amplification and directional microphones, such as Keidser et al. 2009, have shown improvement in localization over unaided performance for the hearing impaired. Perhaps, while using amplification with features to preserve localization cues, a training program would enhance the use of these cues and enable the listener to develop more appropriate localization strategies.

There has been very little attempt to train localization with a home training program. A two-loudspeaker home training program had been developed by Tyler et.al. [2010]. This system focused only on the front horizontal plane and provided guided listening in that correct responses were confirmed and incorrect responses were compared and contrasted with the correct response. This and other studies with cochlear implant users that utilized laboratory training for the front horizontal plane demonstrated improvement with localization training.

Other studies on auditory perceptual learning have indicated that learning is strongly influenced by top-down processes of motivation and intelligence [Amitay et.al. 2010]. The study by Amitay et al. emphasized the importance of providing feedback and motivation in order to promote learning. It was determined that if a task is perceived as impossible then motivation will be impaired which would negatively impact learning. The more difficult a task, the more feedback would be needed.

The current study attempted to create a home localization training program for the hearing impaired which focused on the identification of sounds from the front and from the back. The challenge of the current study was to develop a home localization training program that provided immediate error correction [feedback] and was challenging but not too difficult in order to maintain interest of the listener [motivation].

Purpose

The purpose of this study was to develop a home localization training program that would assist with front/back localization improvement.

Participants

- Ten participants divided into 2 groups based on age, gender, experience, and unaided localization performance for 3000 ms stimuli.
- Control Group: average audio in Figure 1A; 2 male and 3 female; median age 75; 3 BTE users; 1 very poor unaided localization score for back loudspeakers.
- Home Training Group: average audio in Figure 1B; 2 male and 3 female; median age 74; 2 BTE users; 2 very poor unaided localization score for back loudspeakers.

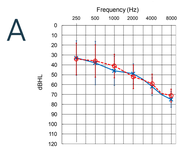

Figure 1A: Control group; average audio

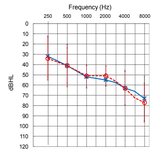

Figure1B: Home training group; average audio

METHODS

Considerations for Home Training Program

- The program needed to be portable and easy to use for the listener.
- The program needed to provide motivation.
- The program needed to provide immediate error correction.
- The program needed to provide a way for the listener to monitor progress.

Home Training Program

Home training was based on a computer program accessed by a USB thumb drive using 2 [Logitech S-120] loudspeakers: one placed in front and one behind the listener; equidistant. This made the system very portable.

Stimuli: 30 sounds from the Life Sounds Library [Widex Compass software], and sound effects from the album '500 Ultimate Sound Effects' by Dr. Sound Effects, published by HDsoundFX 2010 and purchased online [see Table 1]

1	Church Bells	16	Smoke Detector
2	Silverware	17	Burglar Alarm
3	Cafeteria	18	Music
4	Samba Music	19	Seagulls
5	Birds	20	Camera Click
6	Coins	21	Police Siren
7	Dog Bark	22	Train on Tracks
8	Chamber Music	23	Female Speech
9	Electronic Phone Ring	24	Male Speech
10	Fire Truck Siren	25	Jingle Bells
11	Hammer	26	Water Running
12	Cow Moo	27	Meadow Crickets
13	Jazz Music	28	High Pass Noise
14	Sports Whistle	29	Telephone Ring
15	Train Crossing Bell	30	Female Speech

Table 1: List of 30 sounds used in home training program

- Each stimulus was high pass filtered with 18th order Butterworth filter using a cut-off frequency of 2000 Hz.
- The program would randomly choose ten of the 30 sounds for a training block.
- Each stimulus would be presented from the front loudspeaker and back loudspeaker three times for a total of 60 items.
- Participant would complete as many training blocks to total 30 minutes of training.
- The program was adaptive in nature to provide motivation.
- Duration was modified to increase or decrease difficulty; testing was easier with the longer stimulus.
- The back loudspeaker was attenuated in conjunction with increases in duration.
- The attenuation helped to exaggerate pinna cues for front/back identification which would make identification of sounds to the back easier.
- The listener may be motivated when the stimulus became more difficult if they first obtain success at an easier level.
- The training program would begin with the easiest level of 3000 ms with 8 dB back loudspeaker attenuation and would adapt based on performance.
- Feedback with immediate error correction was used to reinforce correct identification [see Figure 2].
- Correct response = button would turn green.
- Incorrect response = button would turn red and correct location would turn green.
- Listener was required to compare correct and incorrect locations before proceeding to next stimuli.

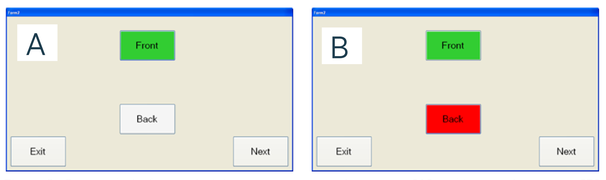

Figure 2: Screen shot of home training program; correct response [A] and incorrect response [B]

METHODS [CONT.]

Home Training Program [Cont.]

Figure 3: Screen shot of progress chart for training; back loudspeaker score displayed

At the end of training, a progress chart was shown with the last ten performance scores for the back loudspeaker. This allowed the listener to see if they were improving over time [Figure 3].

- Two trainings at the same level were averaged to determine the condition of the next training.
- Front score needed to be 50% correct or better and then the back score was examined.
- Based on back score performance, the following conditions were used:
  - 80% correct or better = 300ms duration and 0 dB attenuation
  - 70% -79% correct = 500ms duration and 0 dB attenuation
  - 60% -69% correct = 1000 ms duration and 2 dB attenuation
  - 50% -59% correct = 2000 ms duration and 4 dB attenuation
  - 49% correct or less = 3000 ms duration and 8 dB attenuation

Participants also completed a home test at baseline [prior to training] and after every five days.

- Test comprised of all 30 stimuli used in training at 300 ms duration and no back loudspeaker attenuation.
- Each stimulus presented from front loudspeaker and back loudspeaker three times each for a total of 180 items.
- There was no indication if answer was correct or incorrect during the test.
- Test program would randomly choose order of stimuli and loudspeaker location.

Procedures

Each participant fit with Clear 440 C4m-CB with custom CAMISHA shells.
Control group had baseline and one month hearing aid use evaluations.

- No training provided.
- Participants were not instructed to pay attention to direction of sounds for home use.

The home trained group was evaluated at baseline and after one month of hearing aid use.

- Participants trained 30 min/day at 5 days/week for 4 weeks.
- Participants were instructed to identify the location of sounds in their environment outside of the laboratory.

RESULTS

Home Testing Results

The average home training test results were shown in Figure 4. The initial test, Test Number 1, was baseline before any home training began. The participants repeated the home test every five days [tests 2-5] and were scored on percentage correct. It can be seen that the average back score improved by 25% over time and the average front score improved by 7%. Prior to training, the back score was worse than the front score. By the end of training, the scores for the front and back were similar.

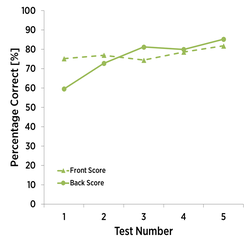

Figure 4: Average front and back score for home training test

RESULTS [CONT.]

Lab Testing Results

Each group was evaluated with 300 ms stimuli with no back loudspeaker attenuation in the laboratory prior to any training [baseline testing]. The control group was evaluated in the laboratory at the end of one month of hearing aid use. The group that received the home training program was evaluated in the laboratory at the end of the home training [also at the end of one month]. To assess the laboratory test results, the performance was divided into four quadrants using a 30° of error:

Front: average of 330°, 0°, and 30°
Back: average of 150°, 180°, and 210°
Left: average of 240°, 270°, and 300°
Right: average of 60°, 90°, and 120°

Figure 5

The results for the control group were shown in Figure 6A; and the results for the group that received the home training program were shown in Figure 6B.

Baseline performance showed a significantly poorer result for the back quadrant than the other quadrants for each group.

There was very little improvement for the control group after one month of hearing aid use.

There was improvement in the back quadrant performance after completion of training. [30% improvement for the home training group]

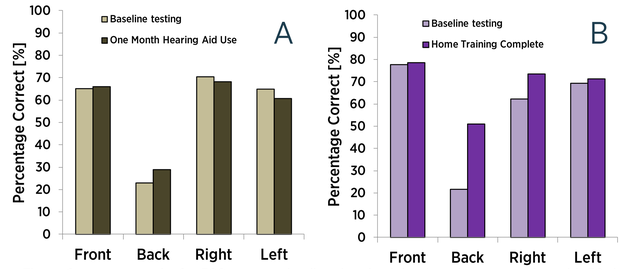

Figure 6: average results for 300ms test stimuli and no back loudspeaker attenuation with 30 degree of error for each quadrant at baseline testing and after one month; [A] = control group; [B] = group that received home localization training

CONCLUSIONS

- The results with these listeners showed that hearing aid use alone [experience] did not improve back loudspeaker identification.
- Back loudspeaker identification at home and in the laboratory improved with the use of the home localization training program.
- This home localization training program may be a viable, simple method of localization training for clinicians to use with their patients.

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