Toward a New Evidence-Based Fitting Paradigm for OTC Hearing Aids

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BACKGROUND

- We conducted a two-part study to develop an evidence-based fitting paradigm for over-the-counter (OTC) hearing aids
- In the previous study, we used audiometric data from an epidemiology database to develop a set of four gain-frequency responses (presets) that can fit approximately 70% of older adults with mild-to-moderate presbycusis
- The set of four gain frequency responses are shown below as audiograms and their associated NAL-NL2 REAR targets

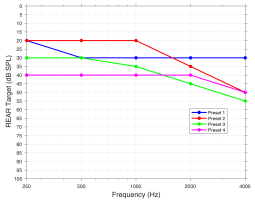


Fig 1: Audiograms associated with the four presets

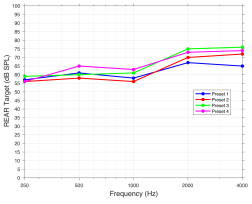


Fig 2: REAR targets of the four presets

- The purpose of this study was twofold: **1)** to test the efficacy of our four presets relative to best-practice verification; **2)** to determine the best method for older adults to select presets

METHODS

- Participants: 37 older adults age 55-88 (17 females, mean age= 70.1) with mild-to-moderate SNHL (PTA ≥ 25 & ≤ 55 and all frequencies 250Hz-6kHz ≤ 65 bilaterally)
- Participants were tested in several device conditions, including five selection models and one best-practice verification condition

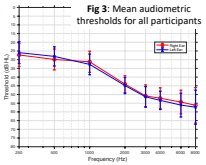
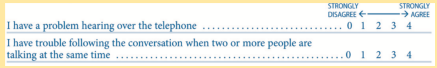


Fig 3: Mean audiometric thresholds for all participants

Device Conditions:

Select by Audiogram: Preset assigned using clinical audiogram. For each ear, preset with corresponding audiogram within +/- 5 dB HL of the participant's audiometric thresholds from 250 Hz-4kHz was assigned. If more than one or no preset fulfilled this criteria, the preset with lowest absolute value deviation from the participant's thresholds was selected.

Select by Questionnaire (BHI): Preset assigned using Better Hearing Institute (BHI) Quick Hearing Check, which provides predicted five-frequency pure-tone average (PTA) based on questionnaire score. For both ears, preset with closest audiometric PTA to participant's BHI predicted PTA was assigned.



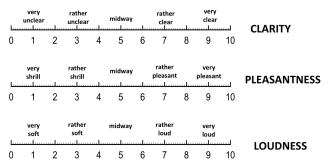
NAL-NL2 (Gold Standard): Each participant was fit with basic-level hearing aids custom-programmed to match NAL-NL2 REAR targets within +/- 5 dB of target from 250 Hz-6kHz. All hearing aids were coupled using non-custom tulip dome tips.

Random Assignment: The same preset was randomly assigned to both ears.

Select by Self Test: Presets assigned using NSRT Online Hearing Screening. This suprathreshold online self-hearing test generates a pseudoaudiogram at the conclusion of the test. Test was completed in each ear individually– test ear had Apple EarPod, non-test ear masked with earplug. For each ear, the preset closest to the pseudoaudiogram– using procedure from select by audiogram– was assigned.

Select by Trying (Try): Participants selected presets by listening to them. The four presets were programmed into the program slots of basic level hearing aids and participants used remote controls to listen to them. Participants listened to concatenated Connected Sentence Test (CST) sentences in quiet (55 dB SPL) and in noise at +5 SNR (65 dB SPL/60 dB SPL), and selected the preset he/she preferred for each ear. Participants were given as much time as needed to make their selections.

- Using a crossover design, speech recognition was measured for all five selection models and the NAL-NL2 best-practice verification condition (Gold Standard) using the ORCA-Nonsense Syllable Test (NST) in quiet (55 dB SPL) and in noise at +5 SNR (65 dB SPL/60 dB SPL). Additionally, each subject completed sound quality ratings for each device condition in quiet and in noise. Ratings were made while listening to concatenated CST sentences.



RESULTS

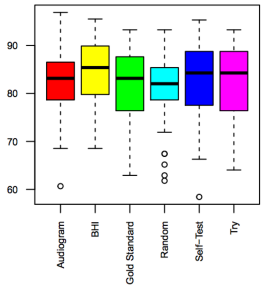


Fig 4: NST consonants in quiet. Gold Standard is the NAL-NL2 condition.

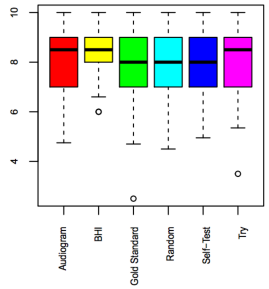


Fig 5: Composite clarity and pleasantness rating in quiet (for each subject, CL and PL scores averaged due to high correlation between these ratings). Gold Standard is the NAL-NL2 condition

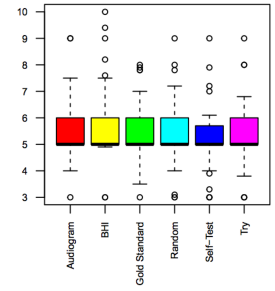


Fig 6: Loudness ratings in quiet. Gold Standard is the NAL-NL2 condition.

- Results in noise showed a similar overall trend among selection models

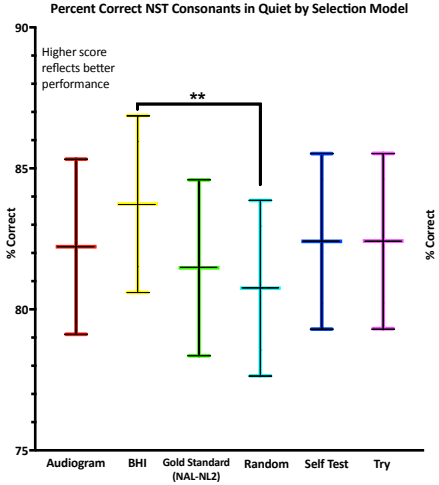


Fig 7: Controlling for better-ear PTA and sound quality ratings, mean and 95% confidence interval of percent correct NST consonants in quiet by selection model. ** denotes significance at p < 0.01.

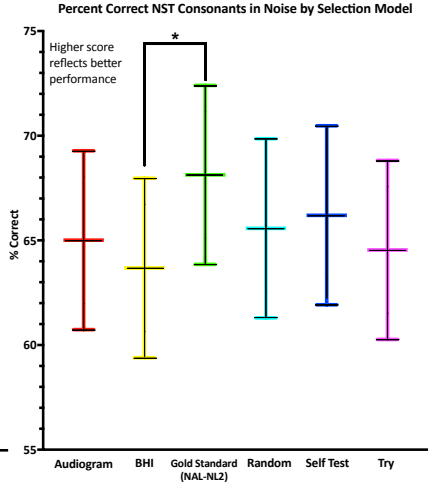
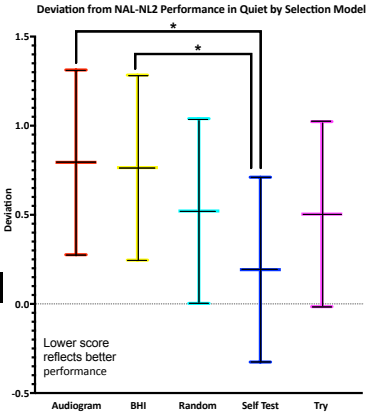


Fig 8: Controlling for better-ear PTA and sound quality ratings, mean and 95% confidence interval of percent correct NST consonants in noise by selection model. * denotes significance at p < 0.05.



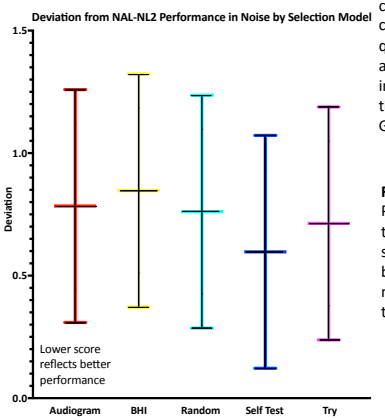


Fig 9: Within Performance in Quiet, Self Test performed significantly closer to the Gold Standard than Audiogram and BHI. * denotes significance at p<0.05.

A linear mixed model with a random intercept for subject was used to compare selection models. The outcome was distance between selection model and the NAL-NL2 condition (Gold Standard). The distance score incorporated both % correct of NST consonants and sound quality ratings. Mean and 95% confidence intervals are shown for the deviation from the Gold Standard.

Fig 10: Within Performance in Noise, there were no significant differences between selection models compared to the Gold Standard.

DISCUSSION

- Considering results in both quiet and noise, select by audiogram, select by self test, and select by trying produced comparable results to custom-fit NAL-NL2 amplification. BHI produced poor outcomes in noise and Random produced poor outcomes in quiet.
- Statistical analysis on the individual level indicated that select by self test produced outcomes most consistent with individual outcomes for the NAL-NL2 condition
- A set of four OTC presets could produce comparable outcomes to best-practice verification in a laboratory setting.
- Older adults are able to self-select appropriate amplification using several selection methods
- The results provide empirical evidence for the efficacy of a new OTC fitting paradigm

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