

# Laboratory Comparison of PSAPs and Hearing Aids

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 Presented at the American Auditory Society Convention, Scottsdale, AZ, March 2015

## INTRODUCTION

Personal Sound Amplification Products (PSAPs) are devices that are intended to amplify hard to hear environmental sounds to enhance hearing in difficult listening situations but not to compensate for hearing impairment. However, many high quality PSAPs have advertised features that are similar to modern hearing aids. These PSAPs have the advantages of lower cost and easier accessibility relative to hearing aids. Therefore, PSAPs could potentially benefit some hearing-impaired listeners, especially those who have not used amplification before. We define potential PSAP candidates as those with mild to moderate hearing loss and reported some listening difficulties in everyday situations.

### Research purpose

The purpose of this study was to examine the preference of PSAPs and hearing aids by listening different sounds processed by these devices.

- Q1: How well did different devices process the same sound?
- Q2: How well did each device process different sounds?
- Q3: Do PSAP candidates prefer PSAPs or hearing aids?

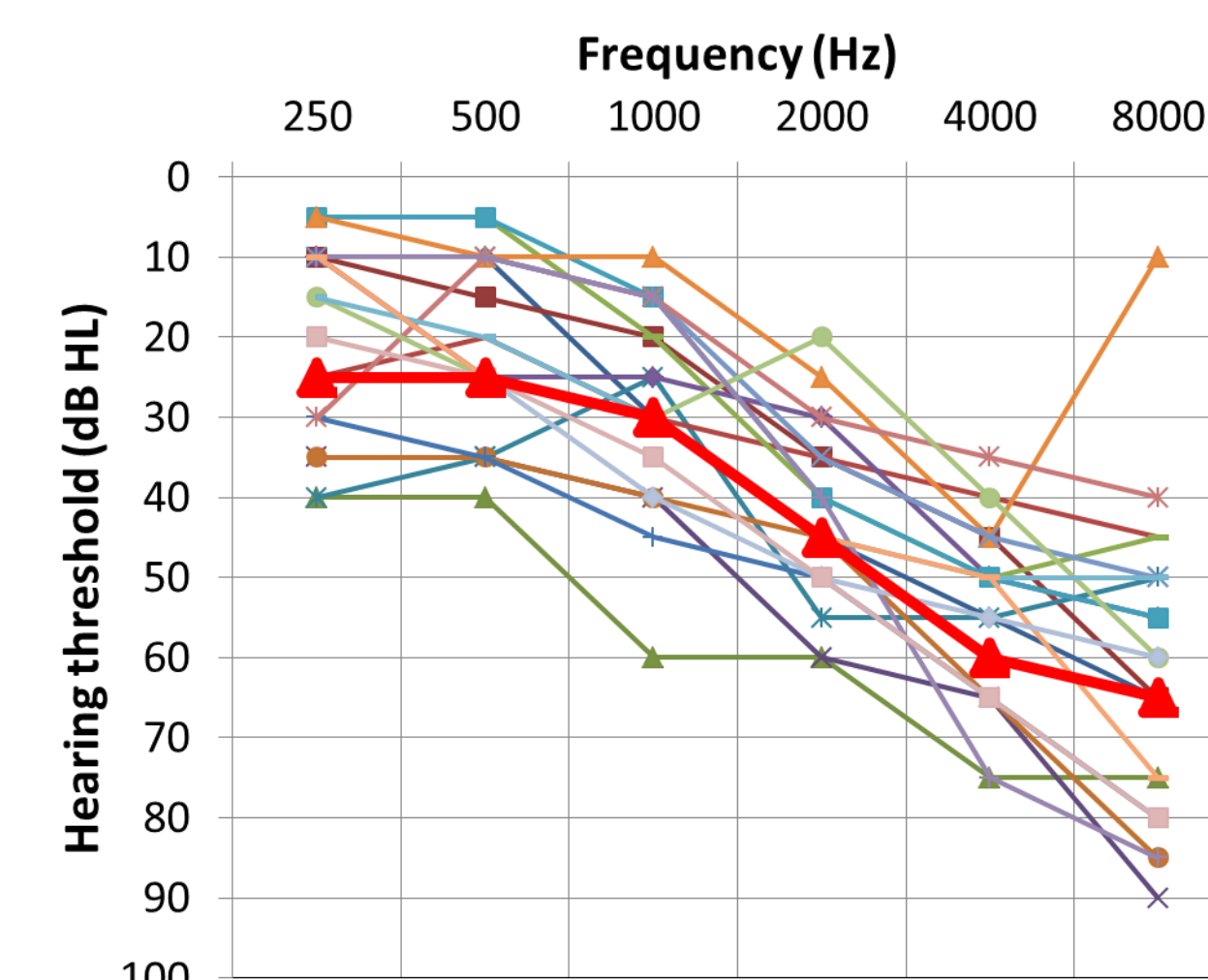
## METHODS

### A. Target audiogram

A target audiogram (red bolded line in the figure below) was determined based on a review of 571 audiograms of potential PSAP candidates in the Memphis Speech and Hearing Center subject database. This target audiogram was used for guiding participant recruitment and fitting/verifying hearing devices.

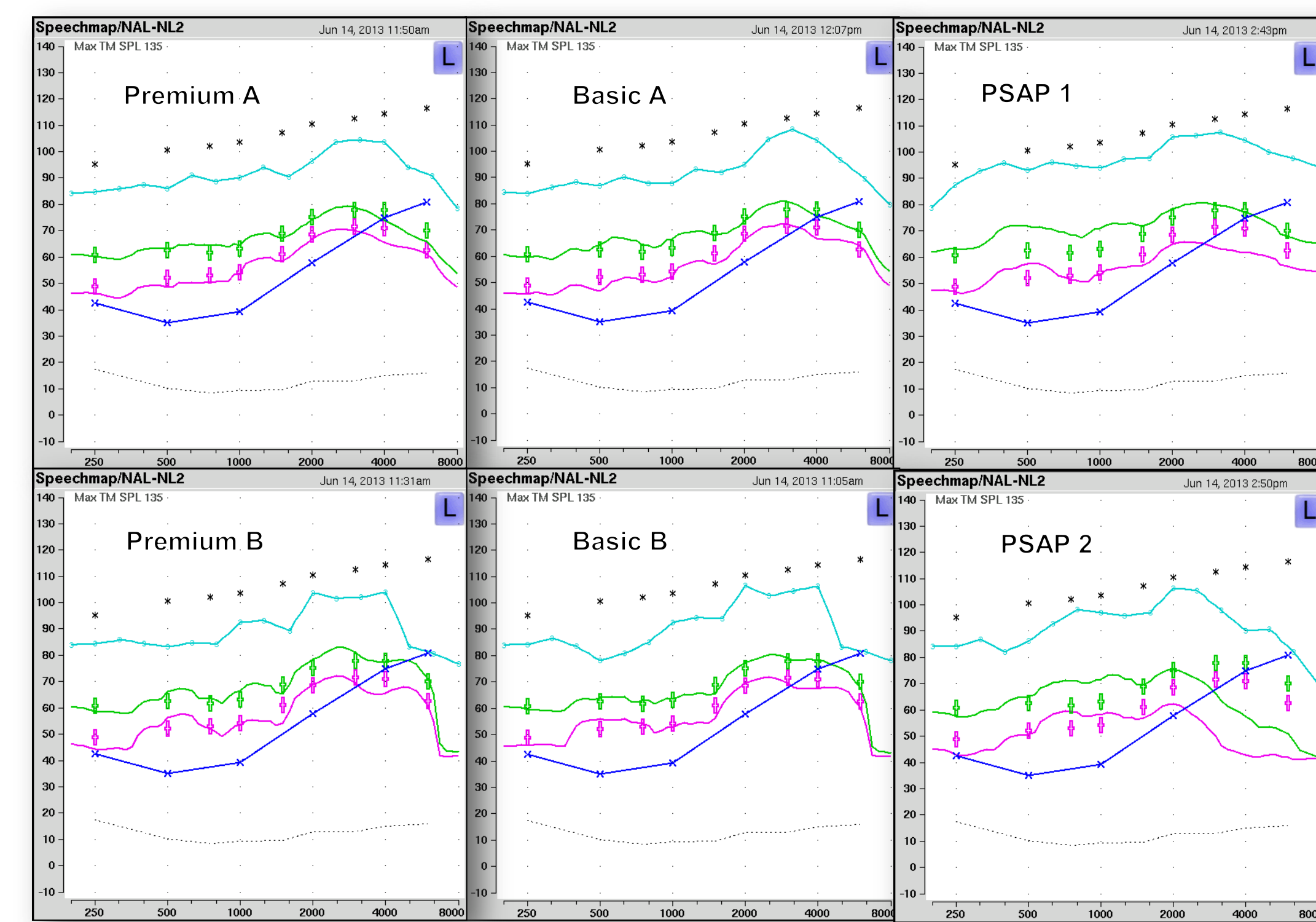
### B. Participants

Twenty adults (age range: 26-83) with mild to moderate sensorineural hearing loss participated. Nine participants were experienced hearing aid users. Audiograms for the 20 test ears are shown in the figure on the right.



### C. Hearing devices and fitting

- Exemplars of 2 premium BTE hearing aids, 2 basic BTE hearing aids, and 2 high quality PSAPs (PSAP1 and PSAP2) were used. The hearing aids were from 2 major manufacturers.
- Real-ear measurements were performed on a KEMAR using an AudioScan Verifit. All devices were adjusted to match the NAL-NL2 targets. The following figure shows the Speechmapping findings (MPO, 70 dB, and 55 dB) for the devices.



### D. Stimuli and recording

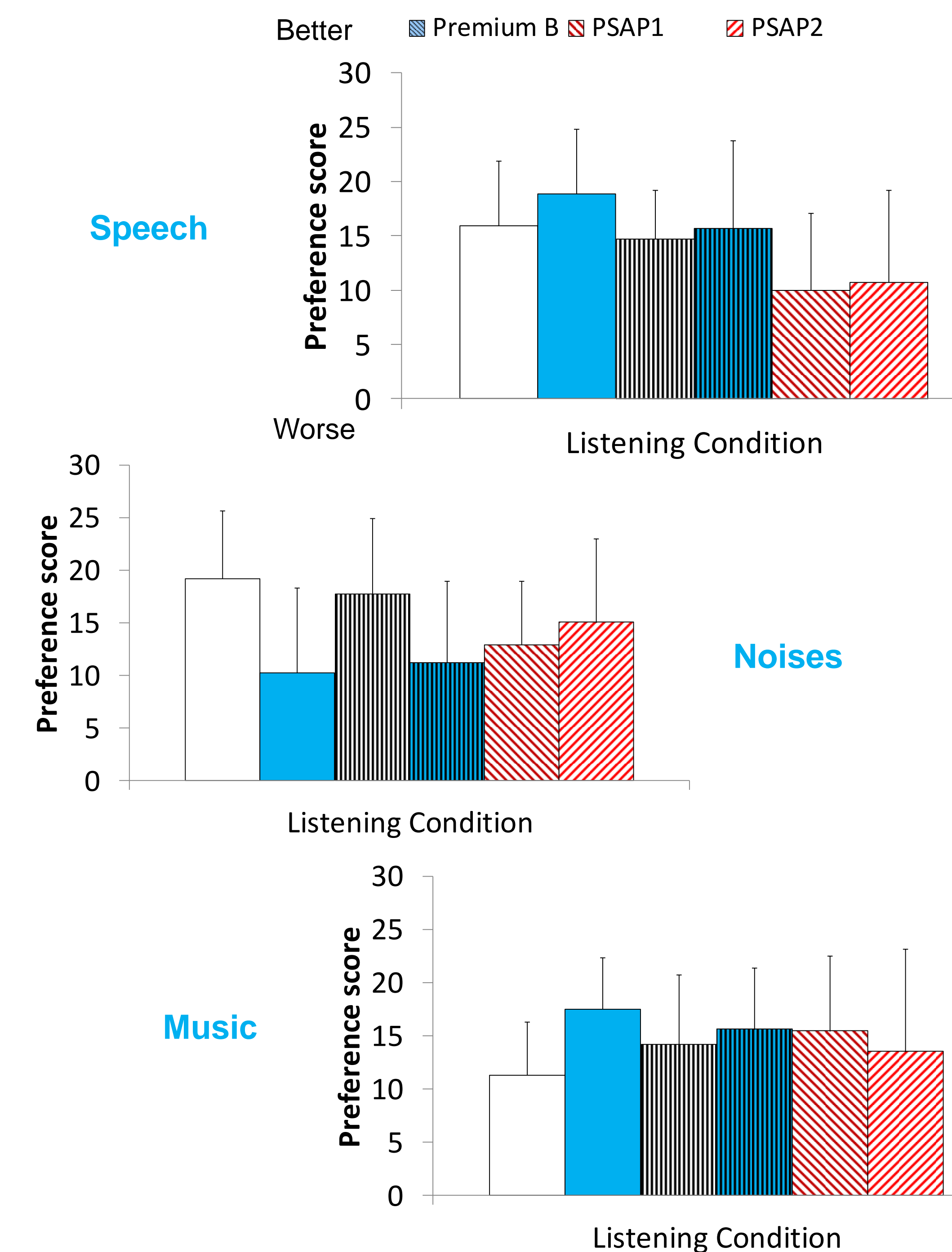
- Three stimuli: (1) Dialogue in quiet (speech), (2) Everyday noises (hair dryer, dishes, electric fan, keyboard typing, silverware, and pen tapping; See Johnson et al., 2012 for details), and (3) Music (Jack Tar March).
- In a double-wall sound treated room, KEMAR wore each device on his left ear with a closed dome. Recorded speech and music were presented from a loudspeaker at 0° azimuth. Everyday noises were presented live by the researchers at 0° azimuth.
- Amplified sounds at KEMAR's simulated eardrum were digitally recorded in WAV format.

### E. Test Procedures

- The participant was seated in a double-wall sound treated room facing a computer monitor and a keyboard.
- Only one ear was tested. An ER-2A insert earphone was placed in the test ear, while the other ear was plugged with an ear plug.
- Each participant performed one double round-robin tournament with each stimulus. In each tournament, every condition compared to every other condition twice in random order.
- All recorded sounds were played back at levels equivalent to the levels at the KEMAR's eardrum during recording.
- A Matlab program was developed and used for controlling sound presentation.
- The participant switched between the two recordings during each comparison.
- The participant verbally responded with their preference.
- For each stimulus, there were in total 30 comparisons.
- Scoring method: 3 points for a win; 1 point for a tie; 0 point for a loss. The sum of the total points for each device with each stimulus was the preference score and it was used for statistical analyses.

## RESULTS

### A. How well did different devices process the same sound?



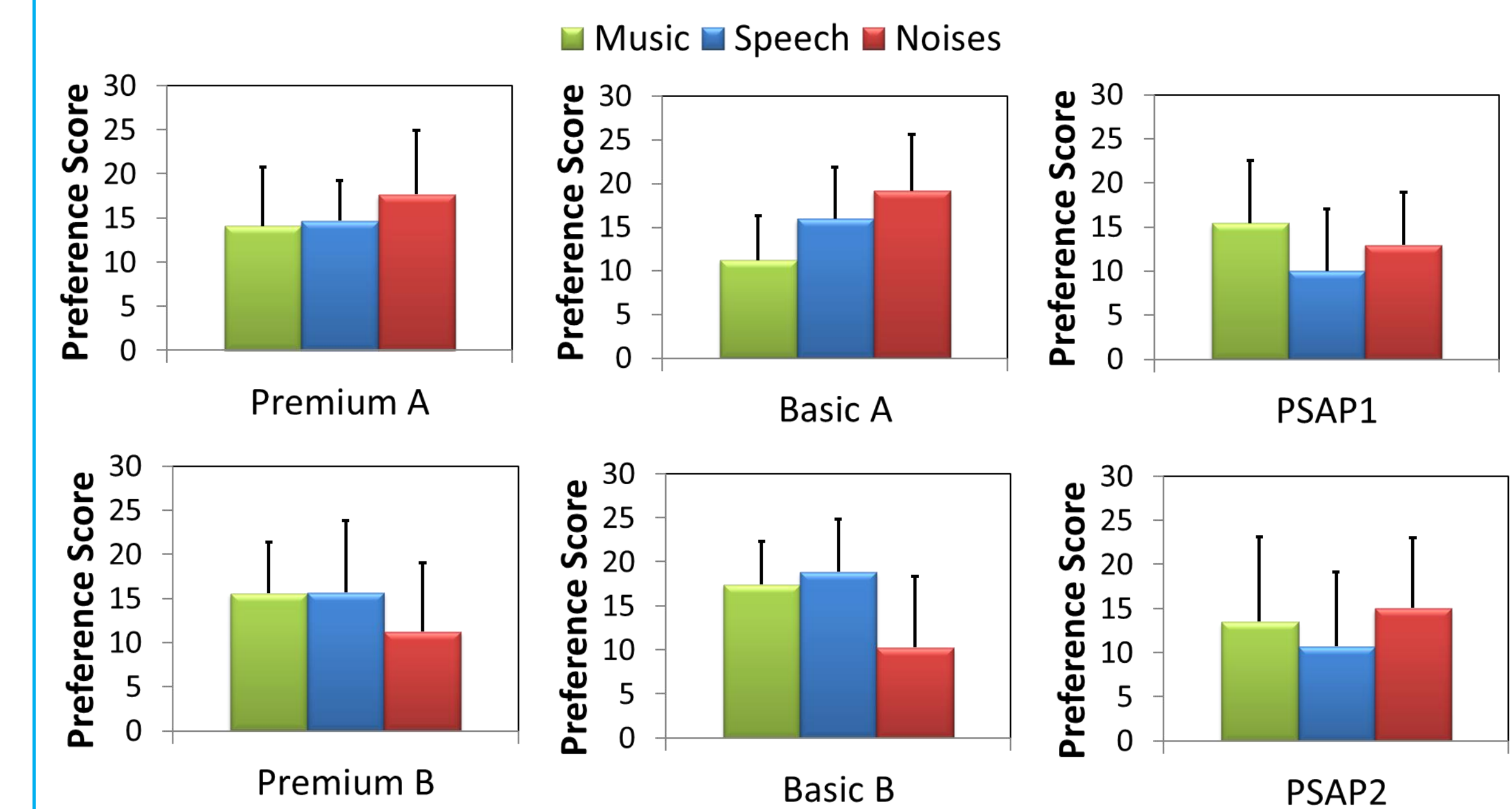
For each stimulus, a GLM within-subjects ANOVA with planned contrasts was performed to compare the scores for the 6 devices.

		Speech	Noises	Music
Main effect (listening condition)		$p = .012^*$	$p = .015^*$	$p = .195$
Contrasts	HA vs. PSAPs	$p = .014^*$	$p = .747$	$p = .95$
	Premium vs. Basic	$p = .219$	$p = .782$	$p = .714$
	Basic vs. PSAPs	$p = .007^*$	$p = .706$	$p = .966$

Answers to Q1:

- For speech, hearing aids (combined) were significantly more preferred than PSAPs (combined). Moreover, basic hearing aids (combined) were significantly more preferred than PSAPs (combined).
- For music or noises, there were no significant differences in preference between PSAPs and hearing aids.
- Premium hearing aids (combined) were not significantly preferred over basic hearing aids (combined) with any stimulus.

### B. How well did each device process different sounds?



Answers to Q2: The mean preference scores reported in Part A were reorganized and displayed for each device. Overall, Brand A had the highest score on Noises; Brand B had the highest scores on Speech but lowest score on Noises; PSAPs had lowest scores on Speech.

### C. Do PSAP candidates prefer PSAPs or hearing aids?

Answers to Q3: Results showed that PSAPs candidates preferred hearing aids over PSAPs for listening to speech. There was no clear preference for listening to everyday noises or music.

## LIMITATIONS

- Only 2 hearing aid and 2 PSAP manufacturers were used.
- Only evaluated performance in a laboratory setting.
- The devices were fit to an average hearing loss without individualized adjustments.
- Some features (e.g., directional microphones, vented earmolds) which might affect performance in the real-world were not considered for this study..

## CONCLUSIONS

In the laboratory setting, PSAPs performed as well as hearing aids for everyday noises and music, but not for speech. Results also suggested that different devices process some kind of sounds more effectively than other kinds of sounds.

## REFERENCE

Johnson, J., Xu, J., Schwartz, K., and Cox, R. (2012). Development of the Sound Acceptability Test (SAT). Refereed poster presented at the Annual Meeting of the American Auditory Society, Scottsdale, AZ.

## ACKNOWLEDGEMENT

This research was partially supported by NIDCD and an anonymous donor.

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