Effect of some basic and premium hearing aid technologies on non-speech sound acceptability

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Presented at the 169th Meeting of the Acoustical Society of America, Pittsburgh, PA, May 2015

BACKGROUND

Acceptability of everyday non-speech sounds is closely related to hearing aid satisfaction. Acceptability is determined by a listener's overall impression of a sound when its different aspects, such as loudness, naturalness, and clarity, are considered. Various hearing aid features, especially digital noise reduction (DNR), are designed to improve acceptability. Compared to basic hearing aids, premium hearing aids have more advanced DNR functions, as well as other unique features that are not included in basic hearing aids. Manufacturers often claim that everyday non-speech sounds are more acceptable when listening with premium hearing aids relative to basic hearing aids. However, there is minimal evidence to support this claim.

OBJECTIVE

This study evaluated acceptability of non-speech sounds in laboratory and real-world settings when using exemplars of basic and premium hearing aids.

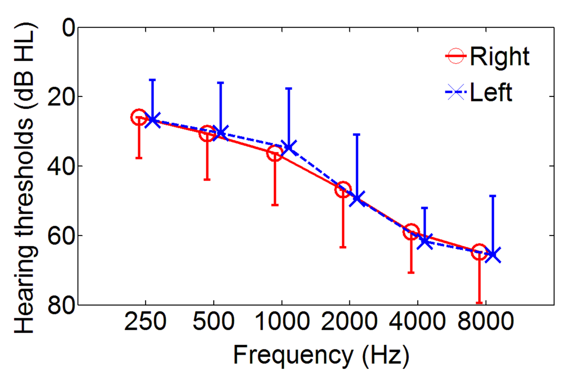
Research questions were:
In the laboratory and in daily life, were non-speech sounds

1. more acceptable with hearing aids compared to without?
2. more acceptable with exemplars of premium hearing aids compared to basic?
3. more acceptable with one manufacturer compared to another?

METHODOLOGY

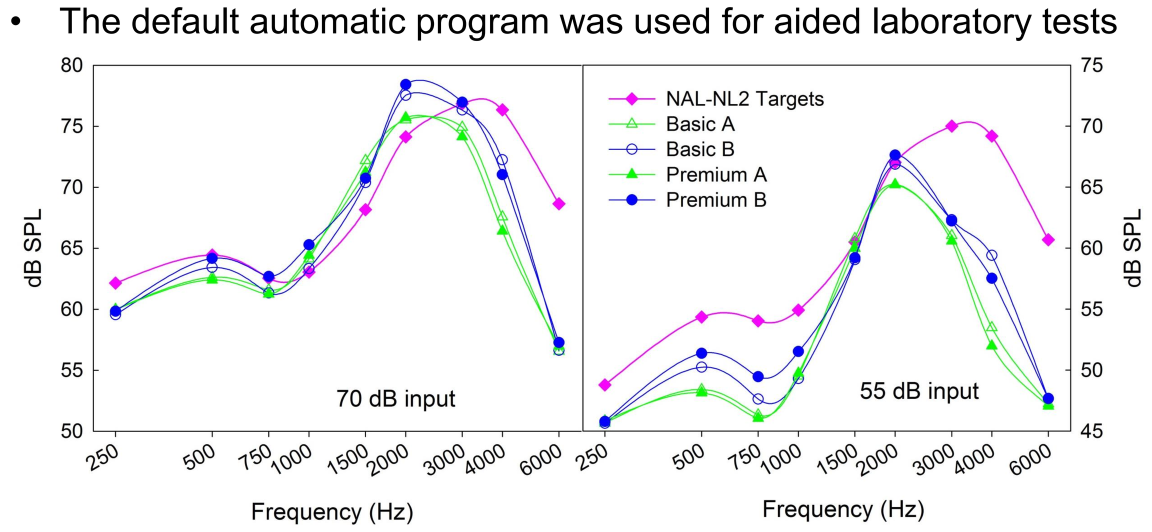
A. Participants

- 45 participants (30M, 15F)
- Age: 61 to 81 (M=70.3, SD=5.5)
- Symmetrical mild to moderate sensorineural hearing loss
- Use of English as first language



B. Hearing aids and related features

- Exemplars of two basic and two premium mini-BTE hearing aids from two major manufacturers (Brands A and B)
- HAs were bilaterally fitted with appropriate coupling strategies verified using NAL targets (see the figure below)
- Feature settings followed manufacturers' recommendations
- There were three manually selectable programs for each pair: the default automatic program and two additional programs for specific listening situations.
- A remote control was provided for each participant
- Four-weeks acclimatization for each pair prior to evaluation
- The default automatic program was used for aided laboratory tests



Related features:

	Basic technologies	Premium technologies	Claimed advantages of premium technologies
DNR (a) overall (b) wind (c) impulse	(a) Few steps (b) no (c) no	(a) Many steps (b) yes (c) yes	More effective control of typical annoying noises leading to greater sound acceptability
Automatic adaptation to acoustic environments	Few options	Many options	Hearing aids analyze & classify the input and adjust the settings of features to optimize sound acceptability
Self-learning or trainable	No, or minimal	Yes, automatic	Hearing aids automatically adjust more precisely to the preferences of the patient in different settings

C. Outcome measures

Laboratory measure:

- Sound Acceptability Test (SAT; Johnson et al., 2012)

Acceptability ratings of 21 real-time produced everyday sounds with different durations and intensities using a Likert scale from 0 (not at all acceptable) to 10 (very much acceptable)

		Duration		
		Transient (≤1 sec)	Episodic (1~5 sec)	Continuous (>5 sec)
Intensity	Soft (<55 dB SPL)	Clicking pen Keyboard typing	Shuffling cards Cutting paper	Electric fan Pen scribble
	Average (55~75 dB SPL)	Pen tapping Door bang	Phone ring Rattling paper	Hair dryer Coffee grinder
	Loud (>75 dB SPL)	Clattering dishes Hammer Desk bell	Silverware Rattling keys Bike bell	Vacuum Drill Marbles

Real-world questionnaire measures:

- Abbreviated Profile of Hearing Aid Benefit (APHAB; Cox et al., 1995)
- Device Oriented Subjective Outcome Scale (DOSO; Cox et al., 2014)
- Profile of Aided Loudness (PAL; Palmer, et al., 1999)

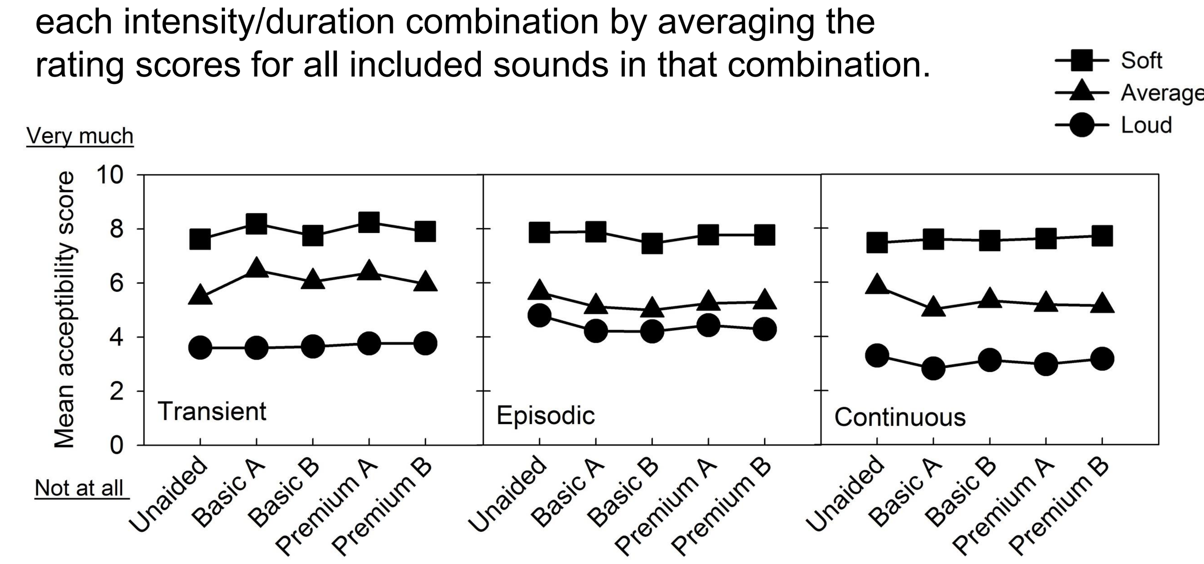
RESULTS

Both laboratory and real-world data were from 5 listening conditions: Unaided, Basic A, Basic B, Premium A, and Premium B. The data were analyzed using a GLM within-subjects ANOVA with planned contrasts:

1. Unaided vs. All aided (Question 1)
2. (Premium A & Premium B) vs. (Basic A & Basic B) (Question 2)
3. (Premium A & Basic A) vs. (Premium B & Basic B) (Question 3)

A. Laboratory data

For each listening condition, a mean rating score was computed for each intensity/duration combination by averaging the rating scores for all included sounds in that combination.



Statistical results:

■ red: $p<.05$
■ orange: $.05<p<.1$
□ white: $p>.1$

Contrast	1	2	3	1	2	3	1	2	3
Soft			orange						
Average	red		red	orange			red		
Loud				red					
	Transient			Episodic			Continuous		

Findings based on laboratory data:

Q1: At average intensity level, aided non-speech sounds were significantly more acceptable than unaided with transient sounds, but significantly less acceptable than unaided with continuous sounds. At loud intensity level, aided non-speech sounds were significantly less acceptable than unaided with episodic sounds. No significant difference between unaided and aided in other intensity/duration combinations.

Q2:There was no significant difference between premium and basic hearing aids.

Q3:Non-speech sounds were significantly more acceptable with Brand A than with Brand B with transient sounds at average intensity level.

B. Real-world data

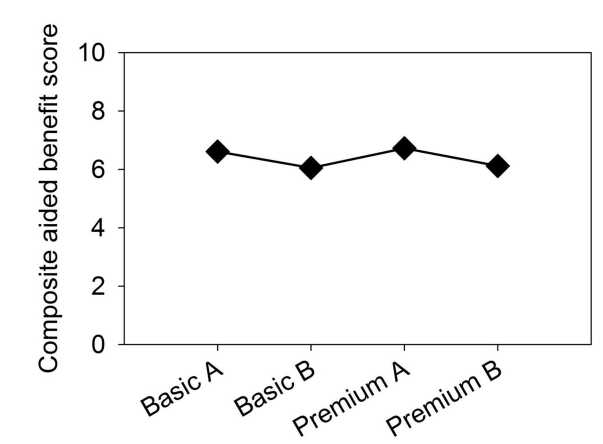
Data from the three questionnaires were used. Data from the APHAB and the DOSO were combined into a composite score. Data from the PAL assessed loudness in three loudness categories.

Benefit scores from APHAB Aversiveness subscale and DOSO Quietness subscale were converted to a 0-10 scale. A composite sound acceptability score was computed by averaging the converted APHAB and DOSO subscale scores for each of the four aided conditions.

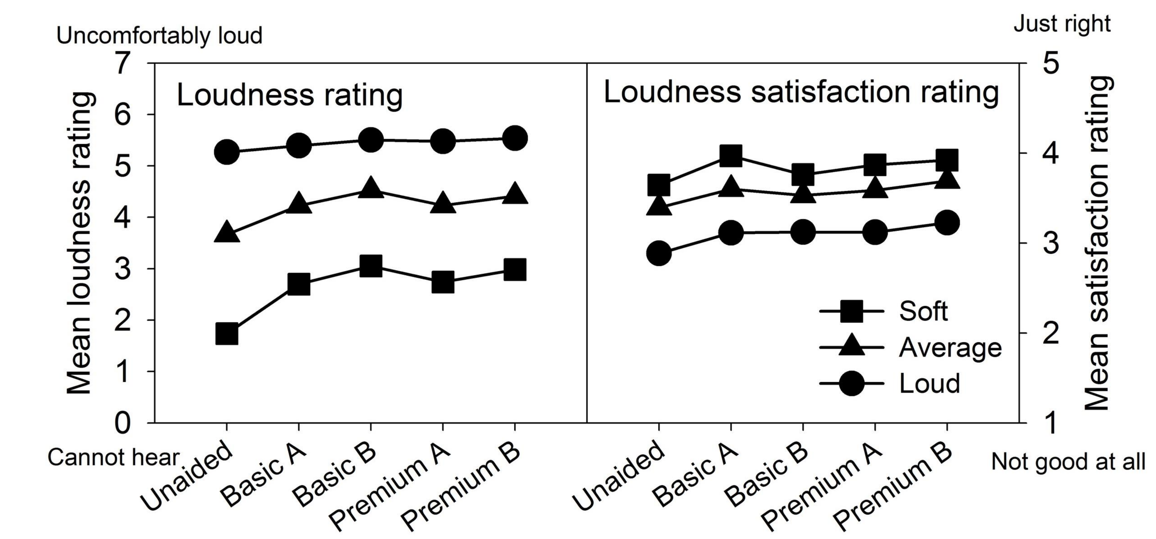
Statistical results:

Contrast	2	3
Composite benefit scores		red

■ red: $p<.05$ □ white: $p>.1$



The PAL comprises both loudness and loudness satisfaction ratings for listening situations that are categorized into 3 intensity conditions: soft, average, and loud. Mean scores were computed for each of the three intensity conditions.



Statistical results:

■ red: $p<.05$
■ orange: $.05<p<.1$
□ white: $p>.1$

Contrast	1	2	3	1	2	3
Soft	red		red	orange		
Average	red		red	red		
Loud				red		
	Loudness rating			Loudness satisfaction		

Findings based on real-world data:

Q1: Aided non-speech sounds were in general significantly louder and more satisfactory than unaided. The exception was that loud sounds were not perceived as louder with hearing aids on average.

Q2:There was no significant difference between premium and basic hearing aids according to both composite scores and PAL data.

Q3:Non-speech sounds were significantly more acceptable with Brand A than with Brand B for overall acceptability in terms of composite scores. According to PAL loudness rating, Brand A was significantly quieter than Brand B at soft and average intensity levels.

DISCUSSIONS and CONCLUSIONS

- No evidence was found in this study to show that premium hearing aids yielded greater acceptability than basic hearing aids.
- Brand A hearing aids were perceived as quieter and more acceptable than Brand B hearing aids.
- It is possible that manufacturers' built in frequency response characteristics and gain limitations, as well as digital signal processing designs make some manufacturers' hearing aids more acceptable than others in terms of everyday non-speech sound listening.

REFERENCES

Cox, R. & Alexander, G. (1995). The abbreviated profile of hearing aid benefit. Ear & Hear, 16(2), 176-186.
Cox, R.M., Alexander, G., and Xu, J. (2014). Development of the Device-Oriented Subjective Outcome (DOSO) Scale. Journal of the American Academy of Audiology, 25(8): 727-36.
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.
Palmer, C.V., Mueller, H.G., & Moriarty, M. (1999). Profile of aided loudness: a validation procedure. The Hearing Journal, 52(6), 34, 36, 40-42.

ACKNOWLEDGEMENT

Supported by NIDCD.

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