Do self-reported sound acceptability measures predict hearing aid preference?

Lipika Sarangi & Jani Johnson
School of Communication Sciences and Disorders, University of Memphis, Memphis, TN
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Introduction

Modern hearing aid (HA) fitting practices seek to optimize audibility and control the levels of amplified sounds; however, for some patients, loudness and aversiveness issues can impact whether they choose to return or exchange their devices. Repeating lengthy trials with different devices before a successful outcome is achieved can result in substantially increased financial, emotional, time, and effort burdens for both the clinician and the patient. It would be useful if clinicians could predict with some certainty whether a user would prefer one HA over another based on their ratings of selected HA characteristics. This study sought to understand whether users' ratings of sound acceptability might predict their final preference between two different HAs. The possible contributions of working memory and personality to these predictions were also explored.

Specific research questions

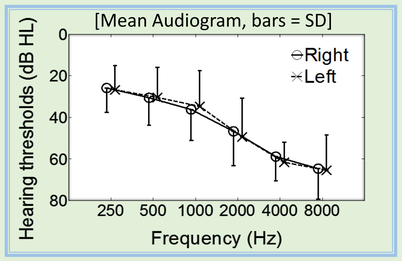
1) Do measures of self-reported sound acceptability predict HA preference?
2) When predicting HA preference based on ratings of sound acceptability, do working memory and personality impact the results?
3) How reliable is a prediction model of HA preference based on ratings of sound acceptability?

Method

Design: Single-blinded, repeated, crossover trial.

Participants:

45 adults (15 females) aged 61-81 years (M = 70.3), with bilateral mild to moderate sensorineural hearing loss.



Hearing aids:

- Participants were fitted with 4 pairs of HAs: Two devices of different technology levels from 2 different Brands.
- Outcomes were assessed after 1 month of wearing each pair of HAs in daily life.

Statistical Modelling - Predictor variables:

Eight subscales related to sound acceptability were extracted from 3 different self-report questionnaires. These included:

- **Abbreviated Profile of Hearing Aid Benefit** (APHAB): Aversiveness subscale
- **Device Oriented Subjective Outcome** (DOSO): Quietness subscale
- **Profile of Aided Loudness** (PAL): Loudness and satisfaction ratings for soft, medium, & loud sounds

For each subscale, we calculated the difference in users' acceptability ratings for each of the two HAs they would later choose between to indicate their preference.

Covariates:

- Working Memory: **Reading Span Test** (RST)
- Personality (Openness and Neuroticism traits): **International Mini Markers** (IMM)

Outcome variable:

- Final preference between 2 HA models for each of 2 Brands.

		Brand A	Brand B
Preference	HA 1	19	18
	HA 2	25	22

Q.1 Do measures of self-reported sound acceptability predict HA preference?

Logistic regression for preference between HAs from Brand A resulted in a final prediction model that comprised 4 of the 8 sound acceptability subscales and 3 covariates (shown below).

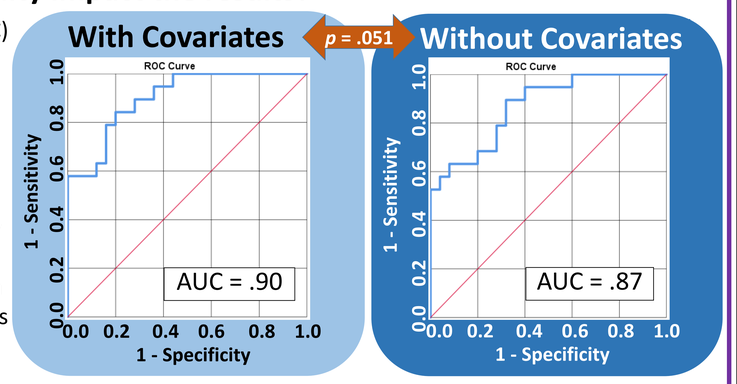
The Quietness subscale of the DOSO was the biggest contributor to the model. Post hoc profile analysis showed that differences in ratings on this subscale of less than 1 unit could reliably predict final HA preference. I.e., If a participant's DOSO-Quietness score was different between the 2 HAs by > ± .8, this model could accurately predict that patients would prefer the HA with the quieter rating.

	DOSO	PAL Loudness (Average Sounds)	PAL Satisfaction (Soft Sounds)	PAL Satisfaction (Loud Sounds)	Working Memory (RST % Score)	Personality (Openness)	Personality (Neurotic)
Coefficient	1.490	-3.747	1.988	-3.620	-.105	-.005	-1.582
p	**.013**	**.031**	.113	**.034**	.065	.948	.091
Odds Ratio	4.436	.024	7.303	.027	.901	.995	.206

Q.2 When predicting HA preference based on ratings of sound acceptability, do working memory and personality impact the results?

Receiver Operating Characteristics (ROC) analyses demonstrated that the final model was able to predict preference with outstanding accuracy (AUC = .9).
(Note: AUC = .5 indicates accuracy not better than chance; AUC = 1 indicates perfect accuracy.)

When working memory and personality covariates were excluded from the model, the AUC decreased. Comparison of Log likelihood values showed that this improvement approached statistical significance (p = .05).

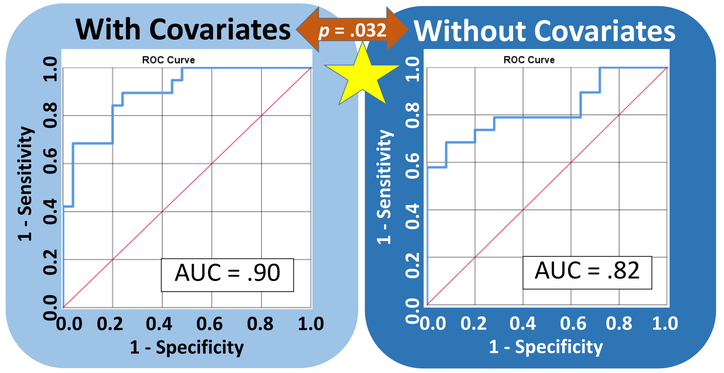


Q.3 How reliable is a prediction model of HA preference based on ratings of sound acceptability?

When the model developed from users' experiences with Brand A's HAs was applied to 2 different HA models from a 2nd Brand (B), the model was able to predict HA preference with outstanding accuracy (AUC = .9).

ROC analyses again demonstrated better ability to predict preferences when working memory and personality traits were included in the model. Comparison of Log likelihood values showed that this improvement was statistically significant (p < .05).

	DOSO	PAL Loudness (Average Sounds)	PAL Satisfaction (Soft Sounds)	PAL Satisfaction (Loud Sounds)	Working Memory (RST % Score)	Personality (Openness)	Personality (Neurotic)
Coefficient	.895	-2.393	-2.039	2.058	.041	-.013	-6.355
p	**.017**	**.036**	.069	.095	.376	.324	.051
Odds Ratio	2.448	.091	.130	7.829	1.042	.987	.002



Results and Discussion

Q.1 Did measures of self-reported sound acceptability predict HA preference? YES

- Out of 8 self-reported sound acceptability subscales 4 contributed to a prediction model that has outstanding accuracy (AUC = .9).
- The Quietness subscale of the DOSO was the greatest and most consistent predictor (p=.013). This subscale assesses perceptions of specific types of noise (e.g., background and wind) and comfort of loud sounds and music. Even a quite small rating difference could accurately predict users' final HA preference. In addition, when users perceived the loudness of average sounds to be softer (p=.031), and were more satisfied with the perceived levels of sounds for one of the HAs, they tended to prefer that device.
- Interestingly, loudness estimates of soft and loud sounds did not contribute to the model, although satisfaction with these estimates did. Further, ratings of aversiveness of loud sounds did not predict final preference. It is possible that the fitting methods used for this study (fit to NAL targets) resulted in similar loudness for these inputs across devices.

Q.2 When predicting HA preference based on ratings of sound acceptability, did working memory and personality impact the results? YES

- Although the individual contributions of these traits did not reach statistical significance, including them as covariates improved the model's ability to predict users' final HA preference. Because individual contributions were small and odds ratios were negligible, it was not possible to infer exactly how these traits might influence preferences based on sound acceptability.

Q.3 Was the prediction model reliable? YES

- When we applied the prediction model to a different brand's devices, the model continued to have outstanding accuracy. This highlights the importance of perceived sound acceptability to users' preferences for specific devices.
- Ratings of device quietness and perceived loudness of average sounds were consistent predictors across the 2 brands. However, it was of interest to note that, for Brand A's devices, users were 7x more likely to prefer a device when they were satisfied with the loudness of its soft sounds; however, they also tended to be less satisfied with the preferred device's loud sounds. For Brand B, users were 7x more likely to prefer a HA when they were satisfied with its loud sounds; but tended to be less satisfied with soft sounds. This finding highlights the types of compromises that HA users face when making decisions about device preferences.

Future Directions

Along with sound acceptability, it is likely that contributions from other listening domains played a role in users' final device preferences. Future research should further explore the relative contributions of individual traits and aided listening experiences to final HA preferences.

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