

# Preferences for Digital Noise Reduction & Microphone Mode Settings

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## Introduction

Can hearing aid wearers' preferences for strength of noise reduction (NR) and microphone mode be predicted using tests of noise tolerance and preferred speech levels (PSLs)?

Hypotheses:

(1) People who are intolerant of background noise will prefer more aggressive noise reduction than people who are tolerant of background noise.

(2) People who receive more benefit from noise reduction algorithms and directional microphones will prefer more aggressive versions of these features than people who receive little benefit from them.

(3) People who prefer to listen to speech at higher SNRs will be more likely to prefer directional microphones than those who prefer to listen at lower SNRs.

## Methods

### Participants

- Hearing impaired (30-84 years old, 68 mean)
- 10 with a low tolerance for background noise
  - “High ANLs” 9.5 to 18 dB
- 10 with a high tolerance for background noise
  - “Low ANLs” 1.4 to 5 dB

The ANL test is a measure of the highest amount of background noise that someone is “willing to put up with” while listening to running speech.<sup>1</sup> The ANL equals the difference between the listener's Most Comfortable Listening Level (MCL) and maximum tolerable Background Noise Level (BNL); ANL = MCL—BNL, in dB.

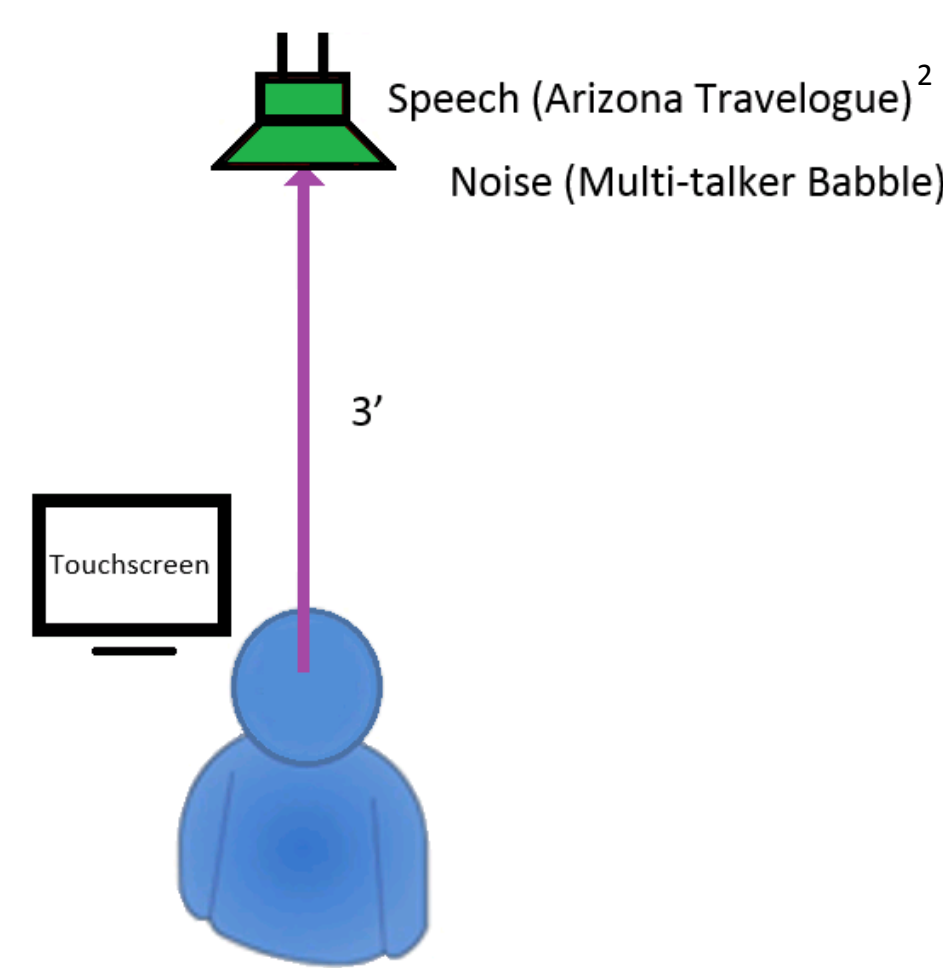
### Testing

#### ANLs (for recruitment) (unaided)

##### —Task:

- 1) Participants set the speech to their MCL
- 2) With speech playing, they set the noise to their BNL

—ANL = mean of 4 iterations (MCL—BNL)

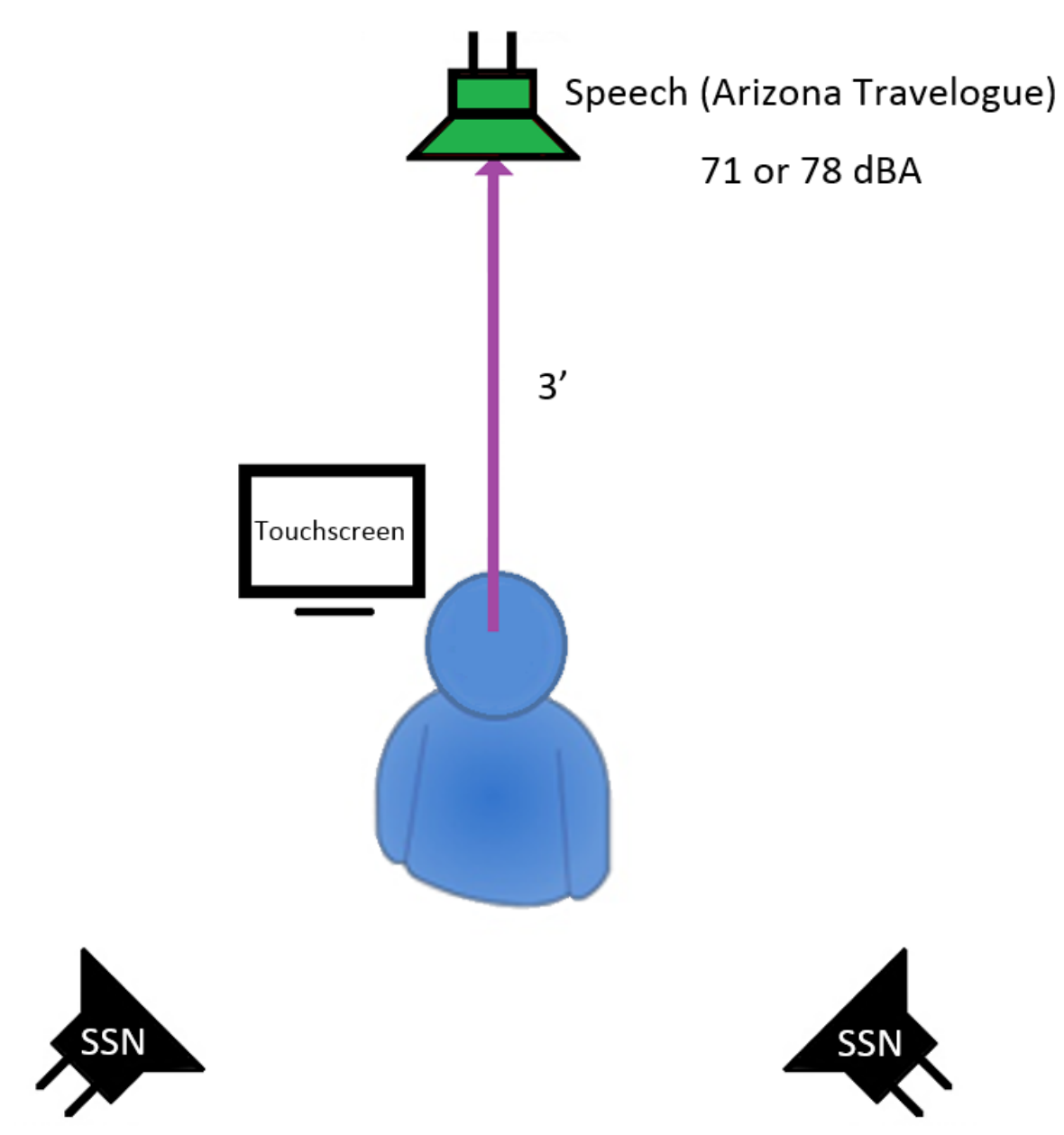


#### Modified ANLs (during the study) (aided)

##### —Task:

- 1) With speech playing, participants adjusted the speech-shaped noise (SSN) to their BNL

—ANL = mean of 3 iterations (MCL—BNL) for each hearing aid feature (below)



#### Hearing Aid Settings (during Modified ANLs)

##### —Microphone Mode (NR was off during these measurements)

- Omnidirectional (omni)
- High-frequency directional (HF dir) (dir > 1870 Hz)
- Broadband directional (BB dir)

##### —NR (microphones were omni during these measurements)

—(up to) 0, 6, 10, 20 dB

##### —NR/Microphone Mode

—6/HF, 10/BB, 20/HF, 20/BB

#### Preferred Speech Levels (PSLs)<sup>3</sup> (unaided)

- Same stimuli and test set-up as unaided ANLs
- Noise fixed at 70 or 80 dBA

—Task: Participants adjusted running speech to “the level that you would prefer to listen for a long time while following the story”

—PSL = mean of 3 iterations at each noise level

—PSL = speech level—noise level, in dB

## Methods

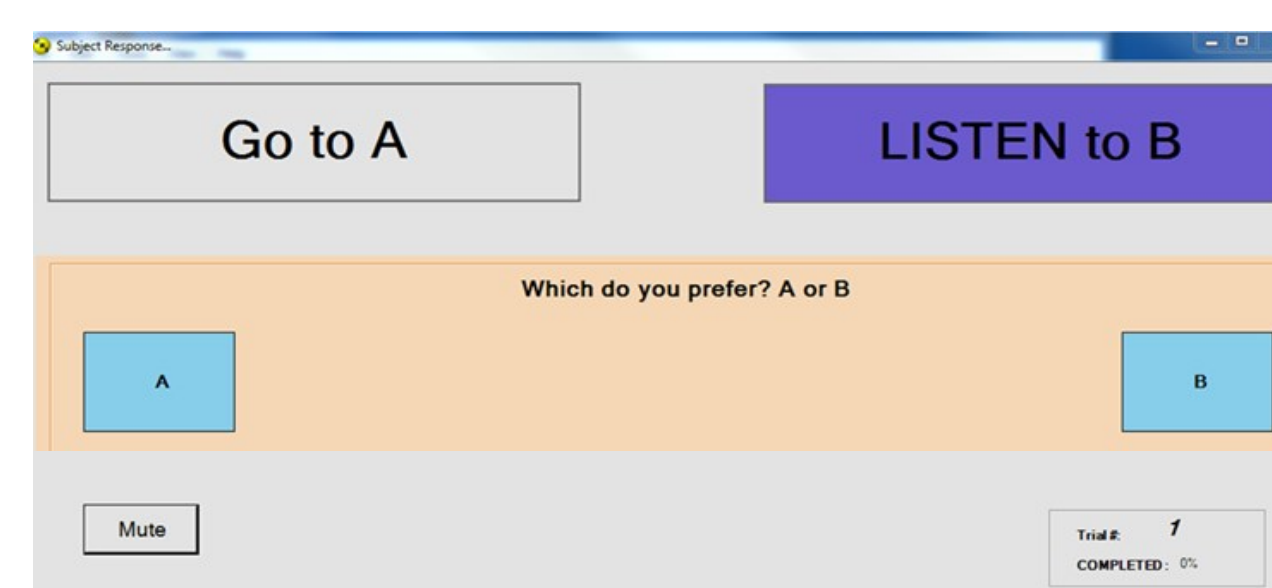
### Preference Testing

- Preferences were tested separately for NR, microphone mode and NR/dir combinations
- Preferences were assessed at two SNRs:
  - Speech 71 dBA/SSN 70 dBA
  - Speech 78 dBA/SSN 80 dBA
- Stimulus type and speaker configuration were the same as with modified ANLs
- Within each hearing aid feature, each setting was compared to each other setting 10 times

##### —Task:

Participants were instructed to:

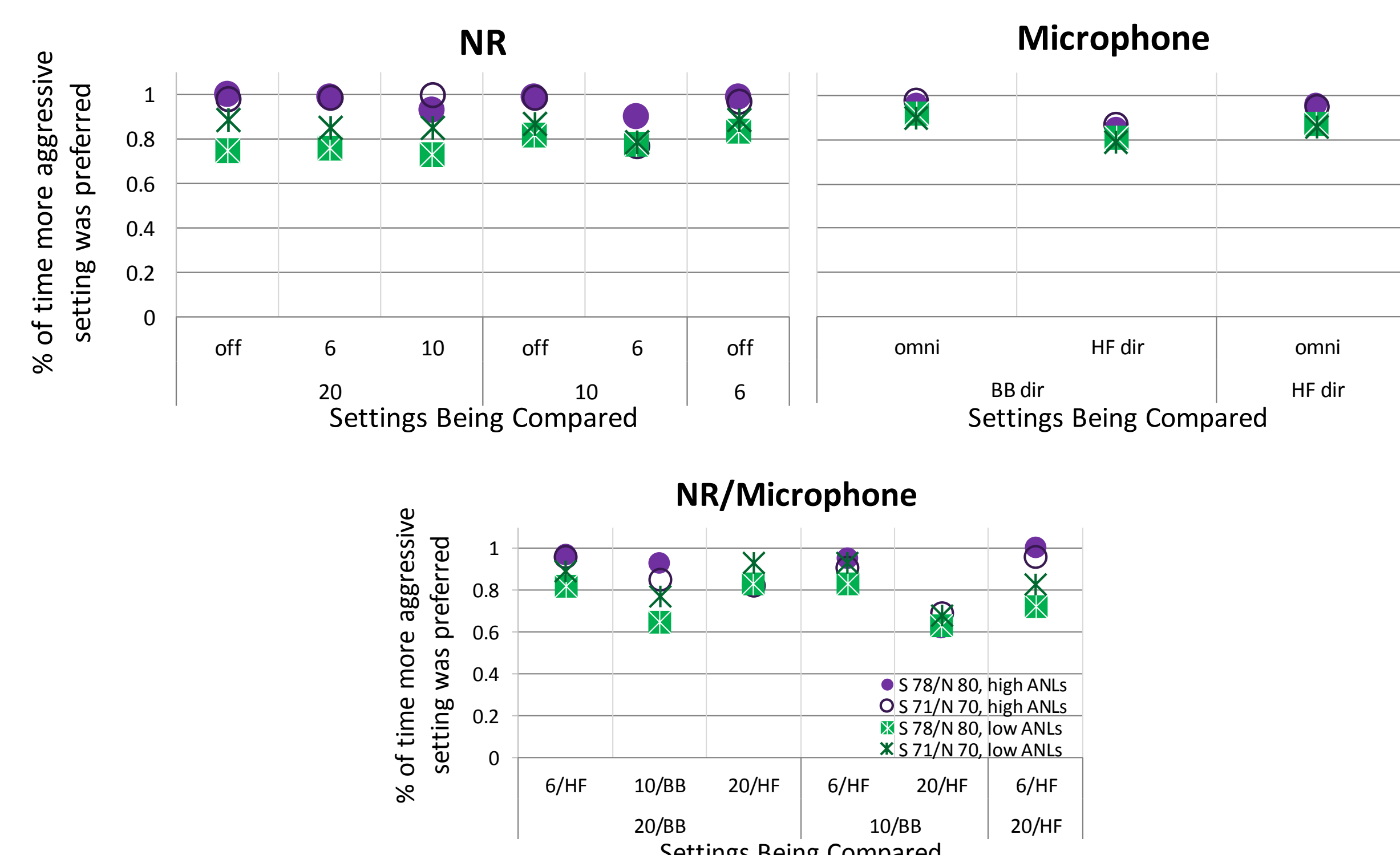
“...determine which of the two settings you prefer—“A” or “B”. When making your decision, you should imagine that you are having a conversation with that person in a noisy situation, and you need to understand what he is saying. Additionally, you should consider the sound quality of his speech, your listening comfort as well as any other cues that are important to you. The setting that you select as your preferred one should represent the best tradeoff among all of the variables that are important to you.”



## Results/Discussion

**Hypothesis 1:** People who are intolerant of background noise will prefer more aggressive NR than people who are tolerant of background noise.

**Results:** Participants almost always preferred the most aggressive setting that was being compared in a pair of settings; there were **no statistically significant differences in the preferences of the two ANL groups for any of the features.**



**Discussion:** Although it was true that if a less aggressive NR setting was preferred, it was always by someone with a low ANL, the majority of the people with low ANLs, and all people with high ANLs, preferred the most aggressive NR setting. This suggests that whatever benefit listeners received in terms of listening comfort (or speech intelligibility) from these settings, for most people it outweighed any negative effects (e.g. distortions or artifacts) that they may have experienced with them.

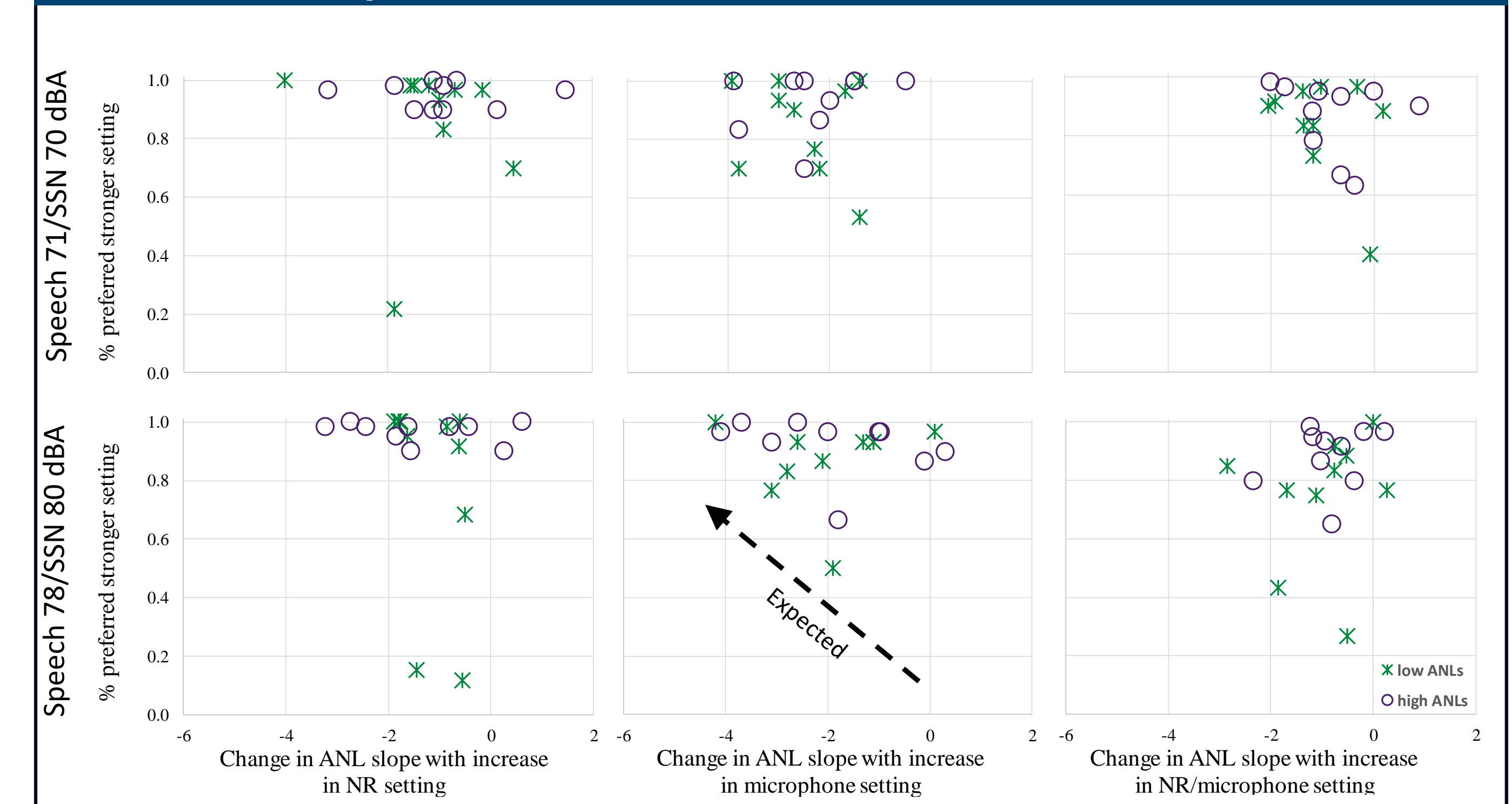
**Hypothesis 2:** People who receive more benefit from noise reduction algorithms and directional microphones will prefer more aggressive versions of these features than people who receive little benefit from them.

—Benefit scores were calculated by subtracting the mean ANL for each participant with each feature active from his/her mean ANL with that feature disabled.

**Results:** Because the amount of benefit with the hearing aid features varied with the strength of those features, a simple regression model was fit to the ANL benefit data (within each feature), and the slopes of the lines were calculated. A slope of “0” indicated no improvement in ANL; greater negative values indicated greater benefit. The slopes of the lines were compared with the overall percent of trials in which the participant preferred the stronger setting. A Spearman correlation test showed **no statistically significant relationships.**

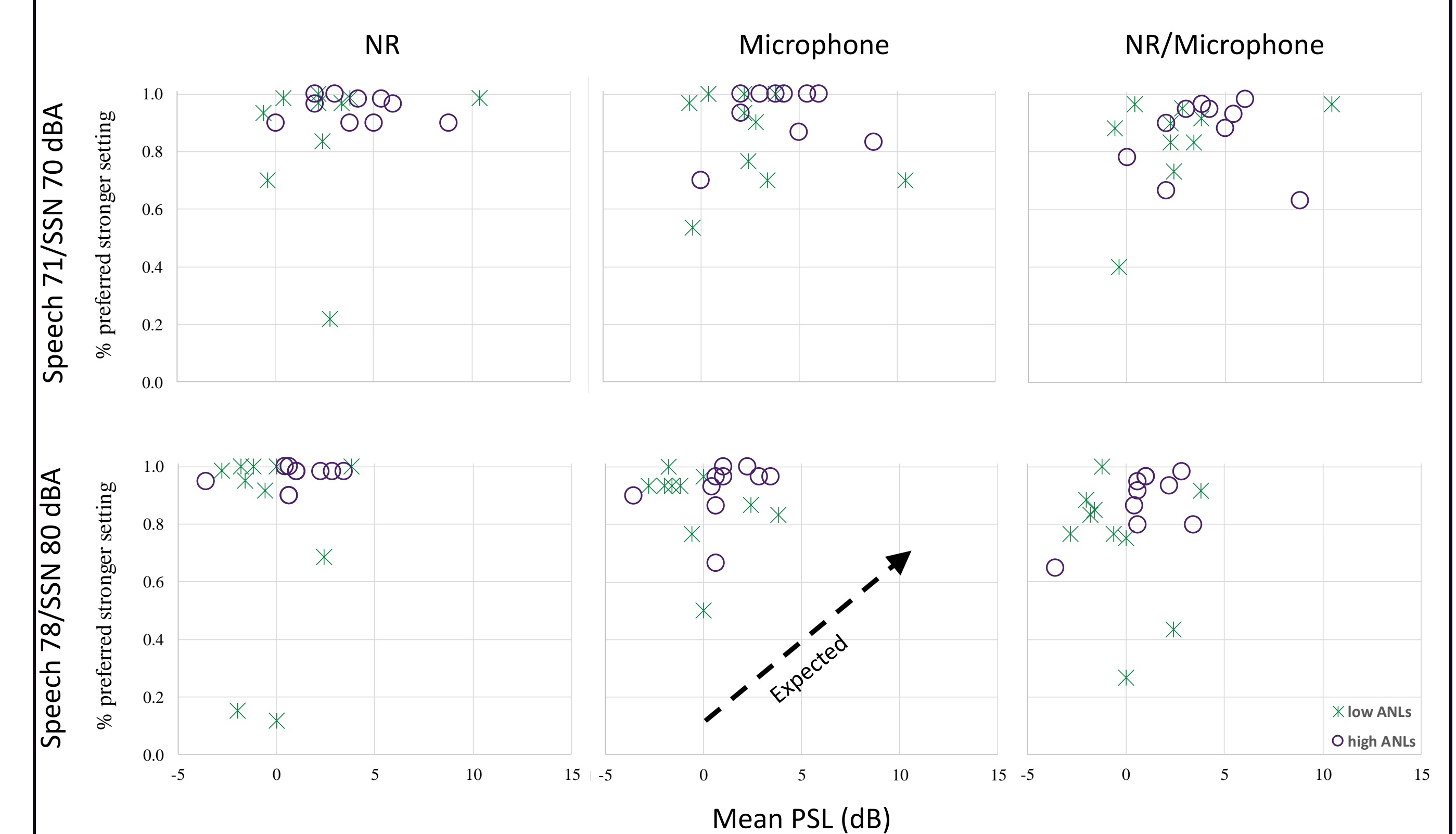


## Results/Discussion



**Hypothesis 3:** People who prefer to listen to speech at higher SNRs will be more likely to prefer directional microphones than those who prefer to listen at lower SNRs.

**Results:** Each individual's mean PSL at each test level was compared to the percent of trials in which he/she preferred the stronger feature setting. A Spearman correlation test was run on the data for each feature/test level. There were **no statistically significant relationships**, suggesting that listeners' preferences for these features were not correlated with their PSLs.



## Summary

This study investigated whether hearing aid wearers' preferences for strength of NR and for microphone mode could be predicted using tests of noise tolerance and PSLs. Results showed that neither ANLs nor PSLs could be used to differentially prescribe hearing aid settings for these features because almost all participants preferred the maximum NR setting and BB directional microphones. Of note, the preferred NR algorithm used in this study could achieve a maximum reduction 20 dB. This finding stands in contrast to recent studies,<sup>4,5</sup> lending credence to the common expectation that a premium hearing aid may be more beneficial (and preferred over) a comparable basic hearing aid. Future research should continue to investigate potential predictors of preferences for these features.

## References

- 1) Nabelek, A. K., Tucker, F. M., & Letowski, T. R. (1991). Tolerant of background noises: Relationship with patterns of hearing aid use by elderly persons. *J Speech Hear Res* 34, 679-685.
- 2) Cosmos Dist. Inc. nd. Quality recordings for the hearing health care industry. Klowna, B.C.
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- 4) Cox, R. M., Johnson, J. A., & Xu, J. (2016). Impact of hearing aid technology on outcomes in daily life I: The patients' perspective. *Ear Hear* 37 (4), 224-237.
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