HEARING AID TECHNOLOGY EFFECT ON FRONT/BACK LOCALIZATION IN QUIET

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HARL
Hearing Aid Research Lab.

Introduction

- Levels of Hearing Aid Technology (at least):

- Compared to basic hearing aids, premium hearing aids have more advanced technologies and sophisticated features.

FEATURES THAT TARGET LOCALIZATION

Feature	Basic	Premium	Claimed advantages of premium
Pinna effect simulation	no	yes	Specialized multiband directionality to improve front/back localization and promote natural sound quality
Bilateral synchronization	some	more	Coordinates functioning of left and right hearing aids to avoid imbalance, and maximize localization by preserving inter-aural cues

INTRODUCTION

- Premium hearing aids are claimed to yield better horizontal front/back localization performance than basic hearing aids .

- However, little or no independent research explores how well all features work together, either in the lab or in daily life.

- This research evaluated front/back localization performance in a laboratory as well as localization performance in the real world using premium and basic hearing aids.

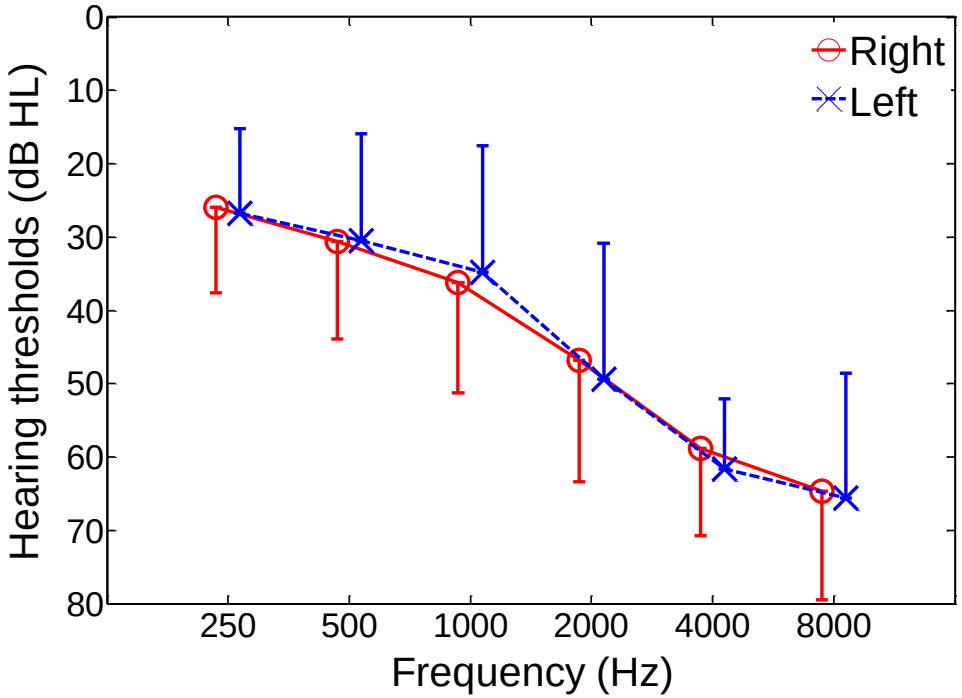
Research Questions

In the laboratory and in daily life, is localization performance:

1. Better with hearing aids compared to without?
2. Better with examples of premium hearing aids compared to basic?
3. Better with one manufacturer compared to another?

Participants

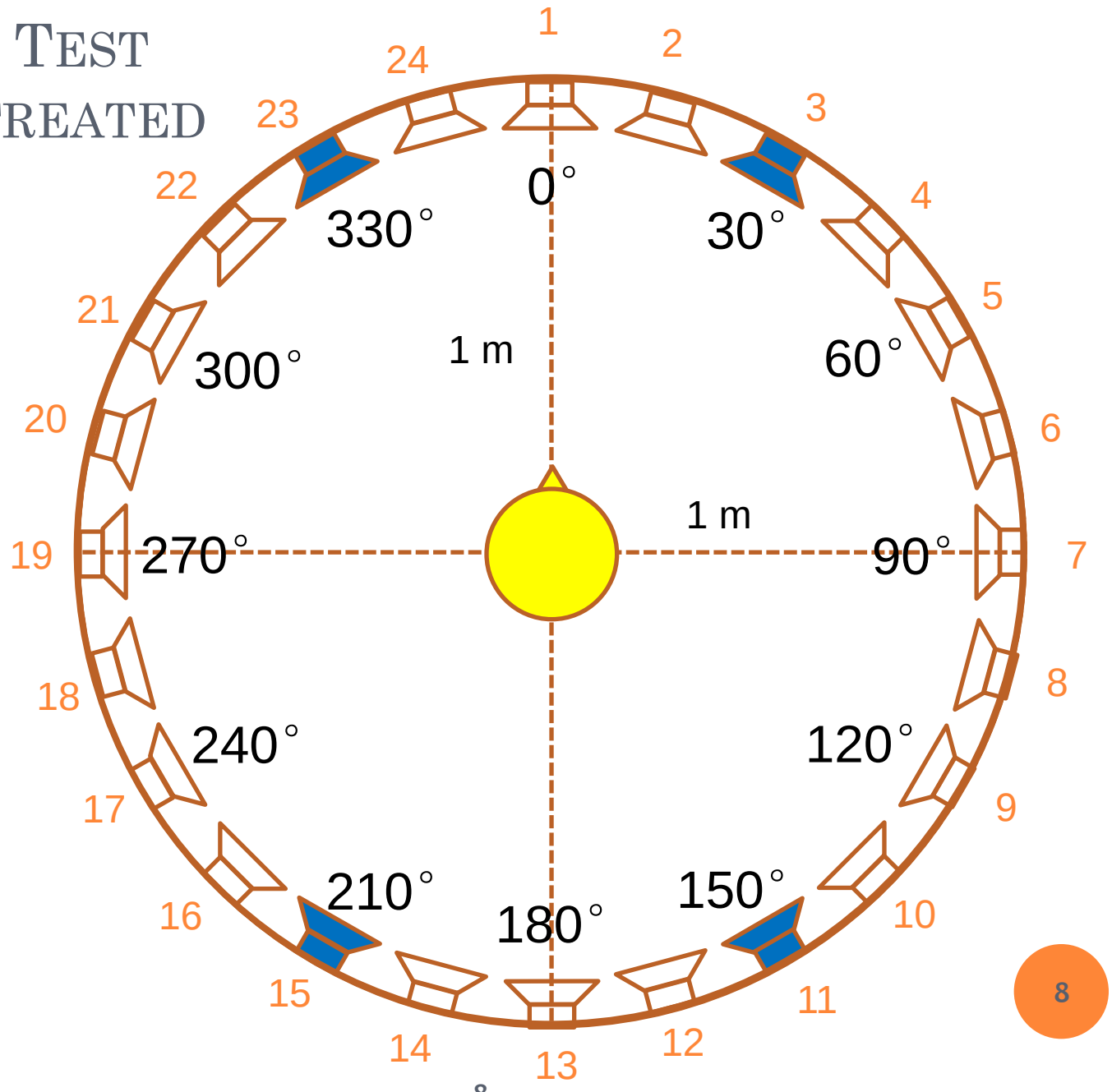
- 45 participants (30M, 15F)
- Age: 61 to 81 (M=70.3, SD=5.5)
- Symmetrical mild to moderate sensorineural hearing loss
- Use of English as first language



Hearing aid fitting and field trial

- Two basic and two premium mini-BTE hearing aids from two major manufacturers (brands).
- The hearing aids were bilaterally fitted with appropriate coupling strategies (Open, vented, or closed) and verified using NAL-NL2 targets.
- Feature settings followed manufacturers' recommendation.
- There were three manually selectable programs: (1) default automatic program; (2) fixed front-facing directional program; and (3) "speech finder" program
- Four-weeks acclimatization prior to evaluation

Laboratory Test in a sound treated booth



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Test stimuli

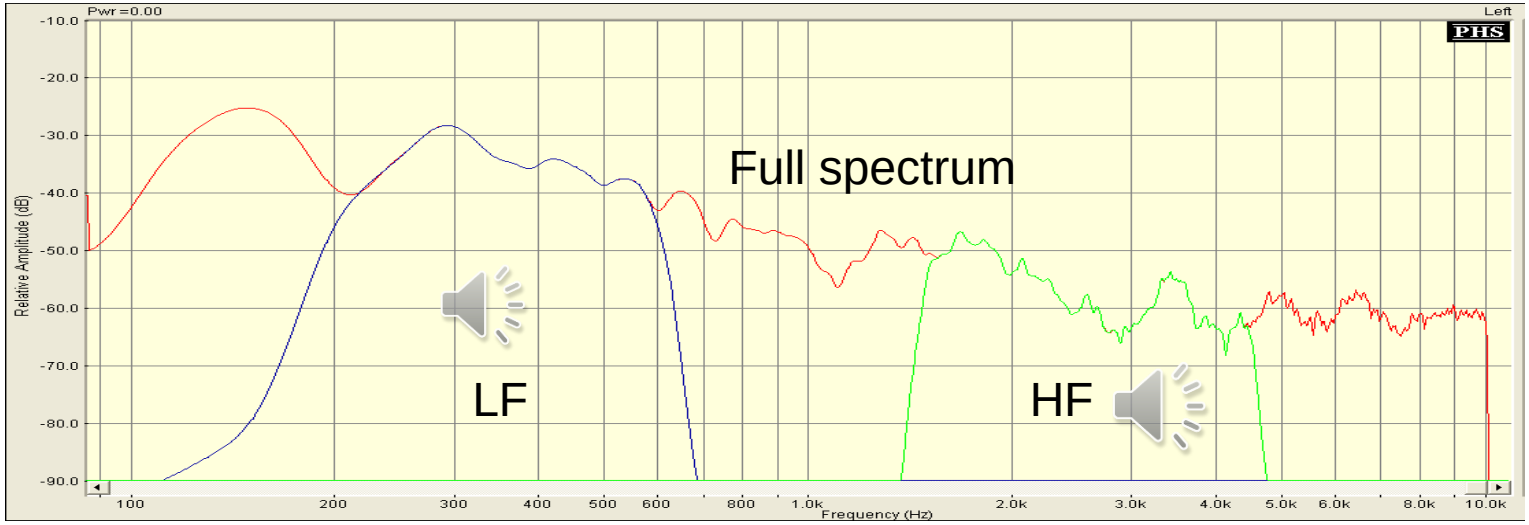
- Thirty-two short sentences spoken by a female and a male talker were selected and filtered to

  -16 low-frequency (LF) sentences (200-600Hz)

  -16 high-frequency (HF) sentences (1500-4500Hz)

- Duration of the filtered sentences: 1.3-1.4s (M=1.33s)

- Presentation levels were determined by setting the level for full spectrum sentences at 75 dB SPL
  - 72 dB SPL for LF sentences
  - 61 dB SPL for HF sentences



Test Procedures

- 4 LF (2 female LF and 2 male LF sentences) and 4 HF (2 female HF and 2 male HF sentences) sentences were presented from each of the 4 connected loudspeakers in random order
- No masking noises
- The default automatic hearing aid program was used
- The participants listened to each presentation and reported the loudspeaker number that they thought the sentence was presented from.

Self-report measure

- Speech, Spatial, and Qualities of Hearing Scale (SSQ) –Benefit (Gatehouse & Noble, 2004; Jensen et al., 2009)

- Example:

Part 2.	For This Pair Of Hearing Aids	
1. You are outdoors in an unfamiliar place. You hear someone using a lawnmower. You can't see where they are. Can you tell right away where the sound is coming from?	Using the hearing aids compared to no hearing aids *Much worse* *Unchanged* *Much better* -5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5	NA

Results

Statistical comparisons

- General Linear Model repeated measures analysis of variance (ANOVA) with planned contrasts:

✓ Unaided vs. Aided (Question 1)

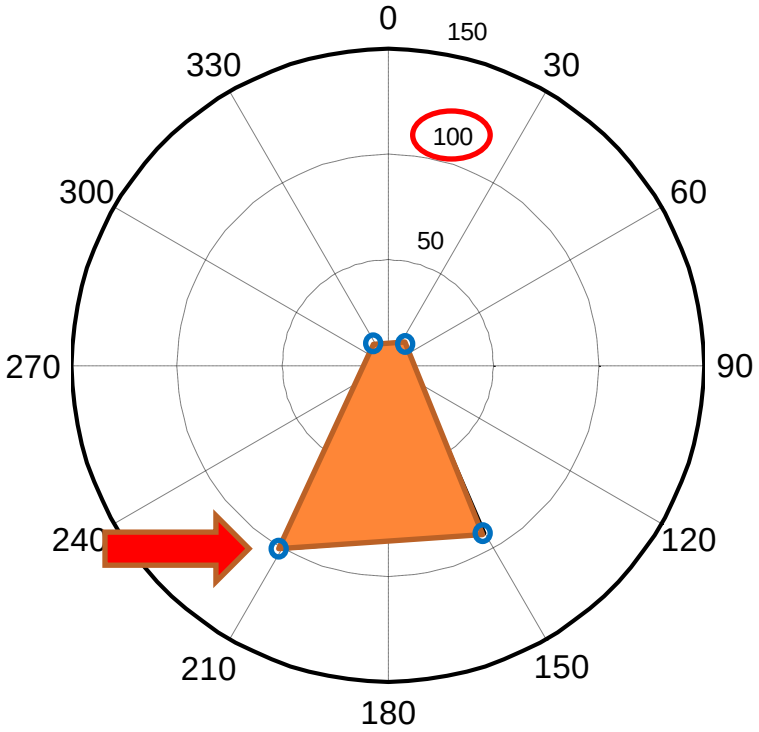
✓ Premium vs. Basic (overall) (Question2)
  - ✓ Premium vs. Basic (Brand A)
  - ✓ Premium vs. Basic (Brand B)

✓ Brand A vs. Brand B (Question 3)

Laboratory data

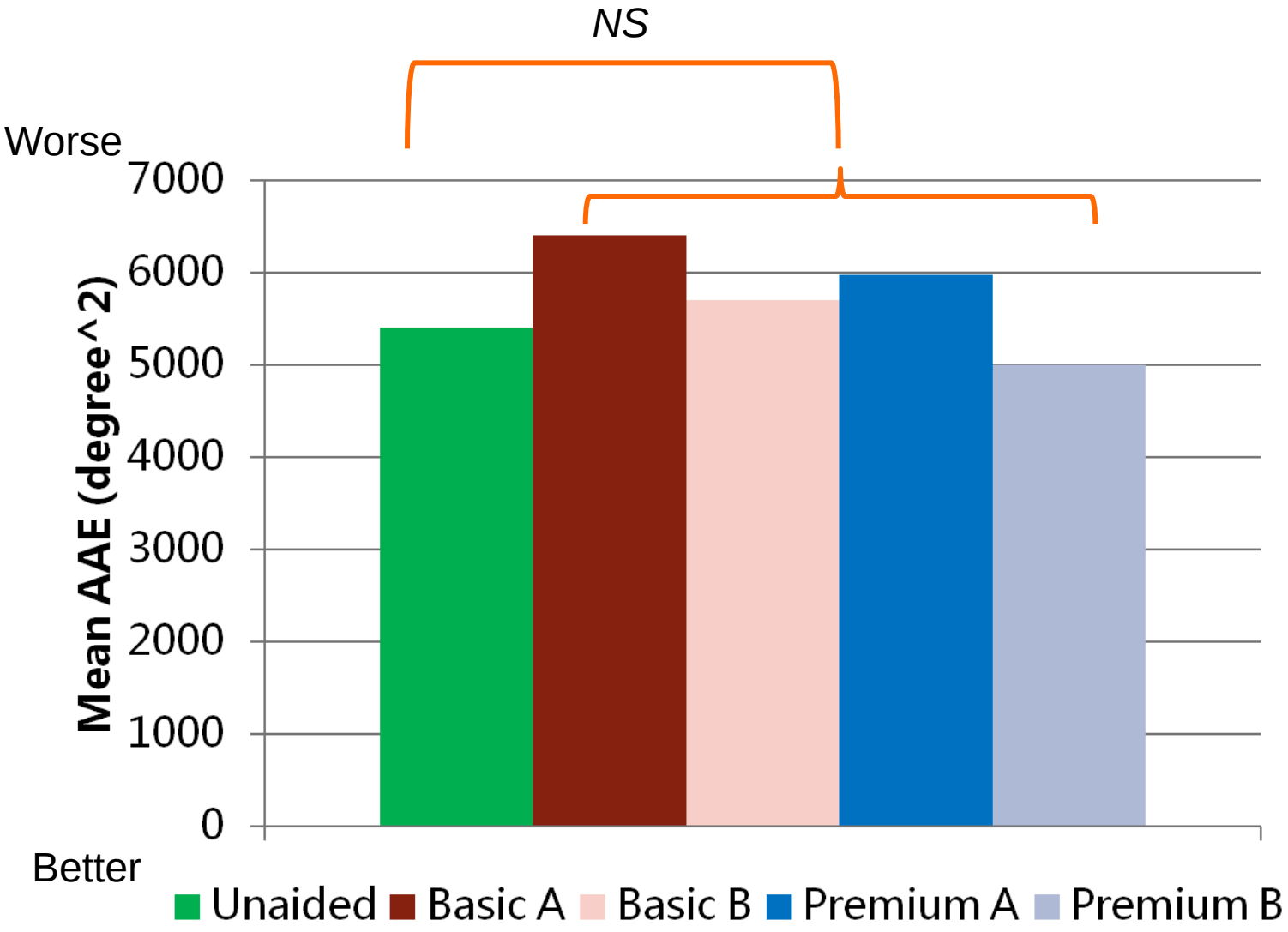
AREA OF ANGULAR ERROR (AAE)

- AAE is the area of the polygon formed by connecting the mean absolute angular errors for adjacent azimuths on a polar plot (Xu & Cox, 2013).
- Greater AAE values correspond to more errors.
- AAE values were used for statistical analyses.



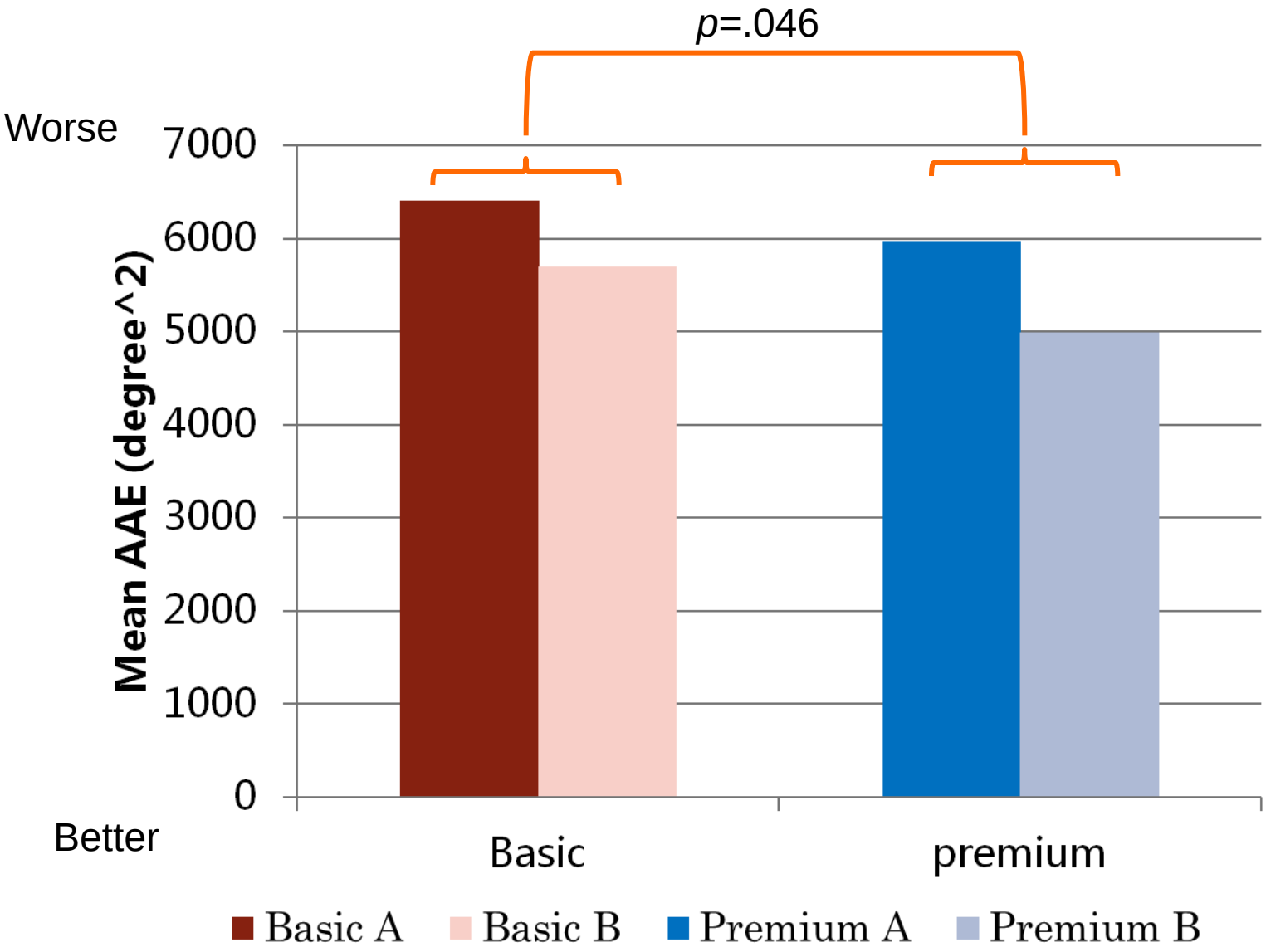
High Frequency Stimuli

IS AIDED BETTER THAN UNAIDED? (HF stimuli)

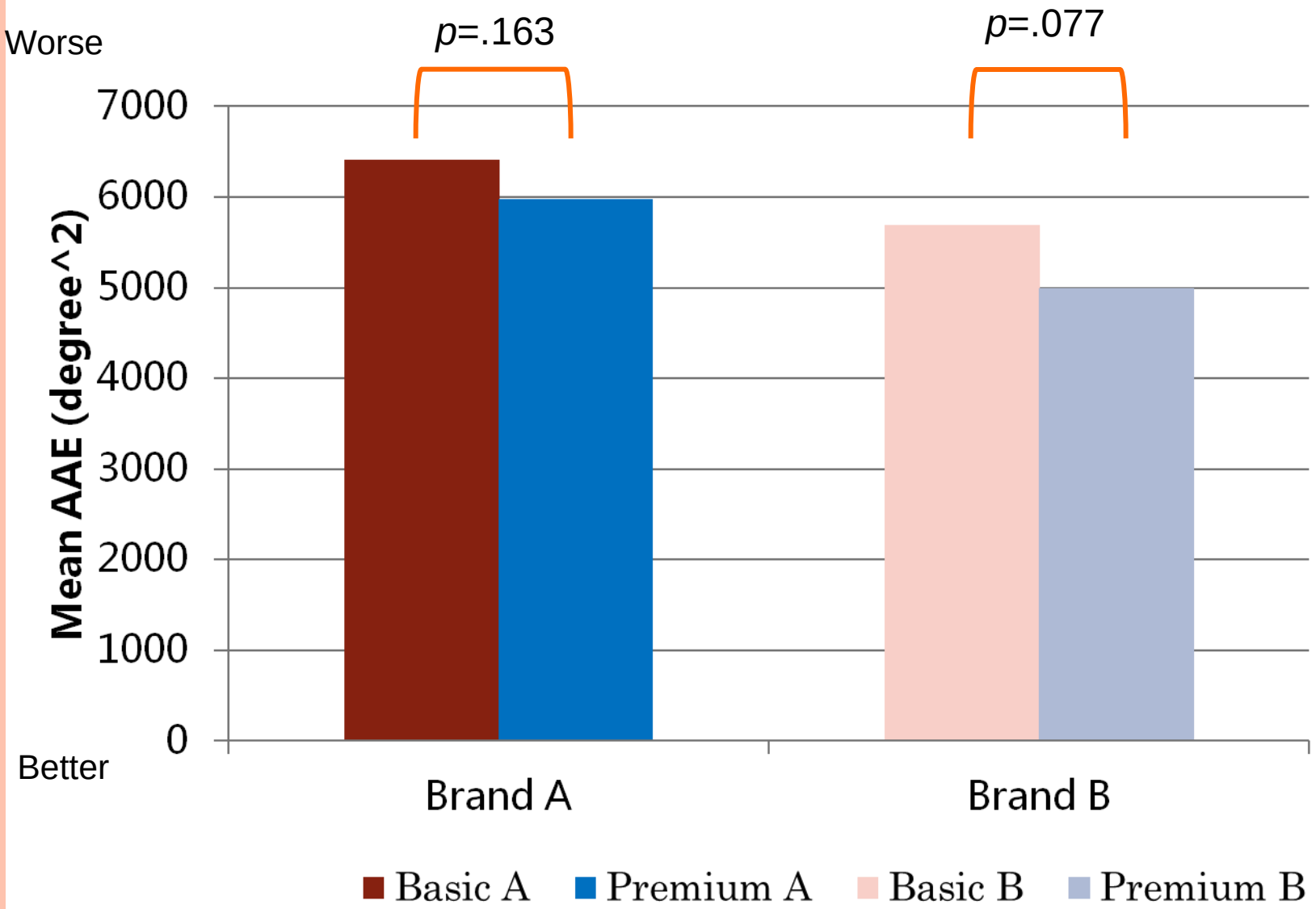


Is Premium better than Basic (overall)? (HF stimuli)

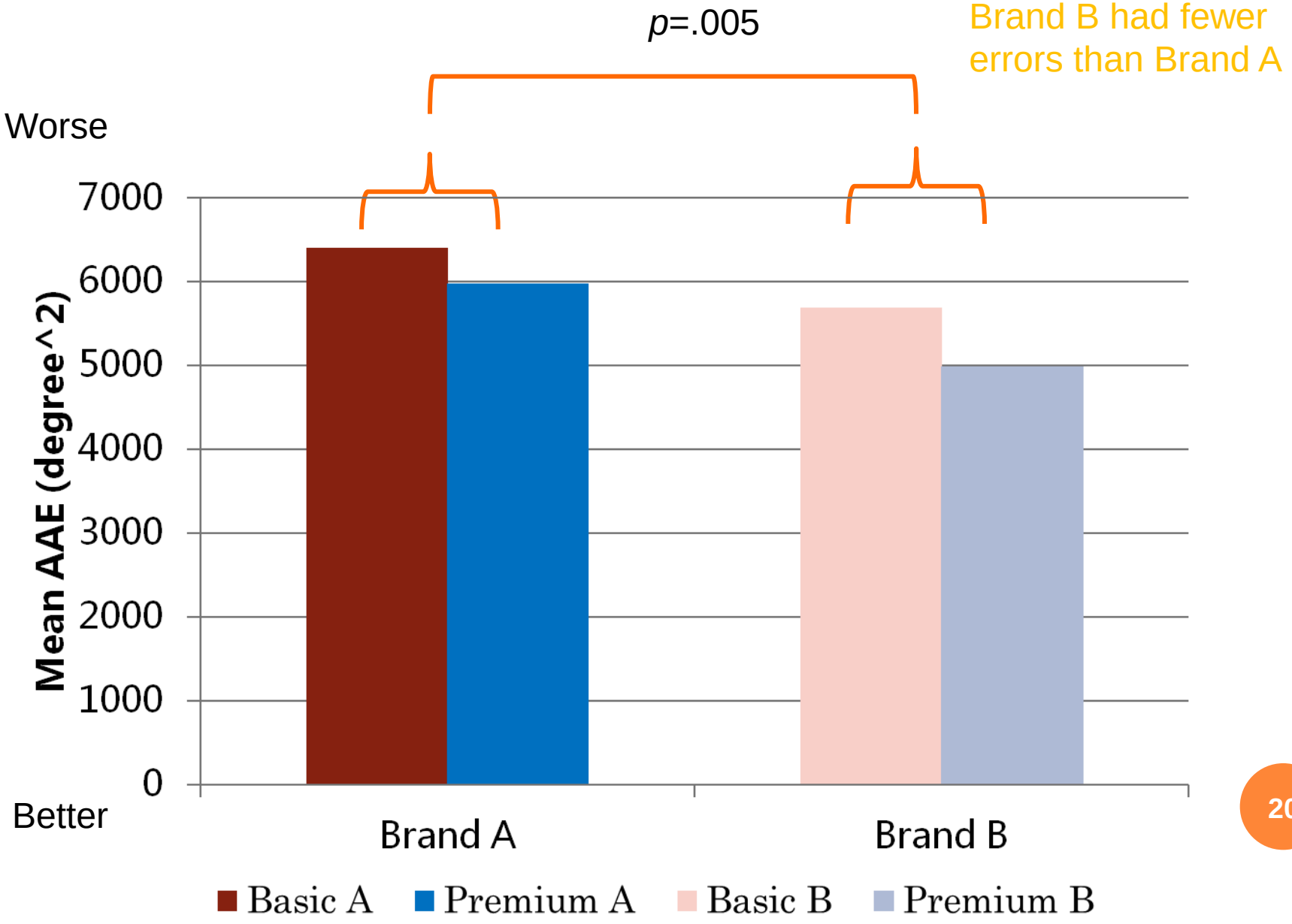
Overall, Premium had fewer errors than Basic



IS PREMIUM BETTER THAN BASIC (FOR EACH BRAND)? (HF stimuli)

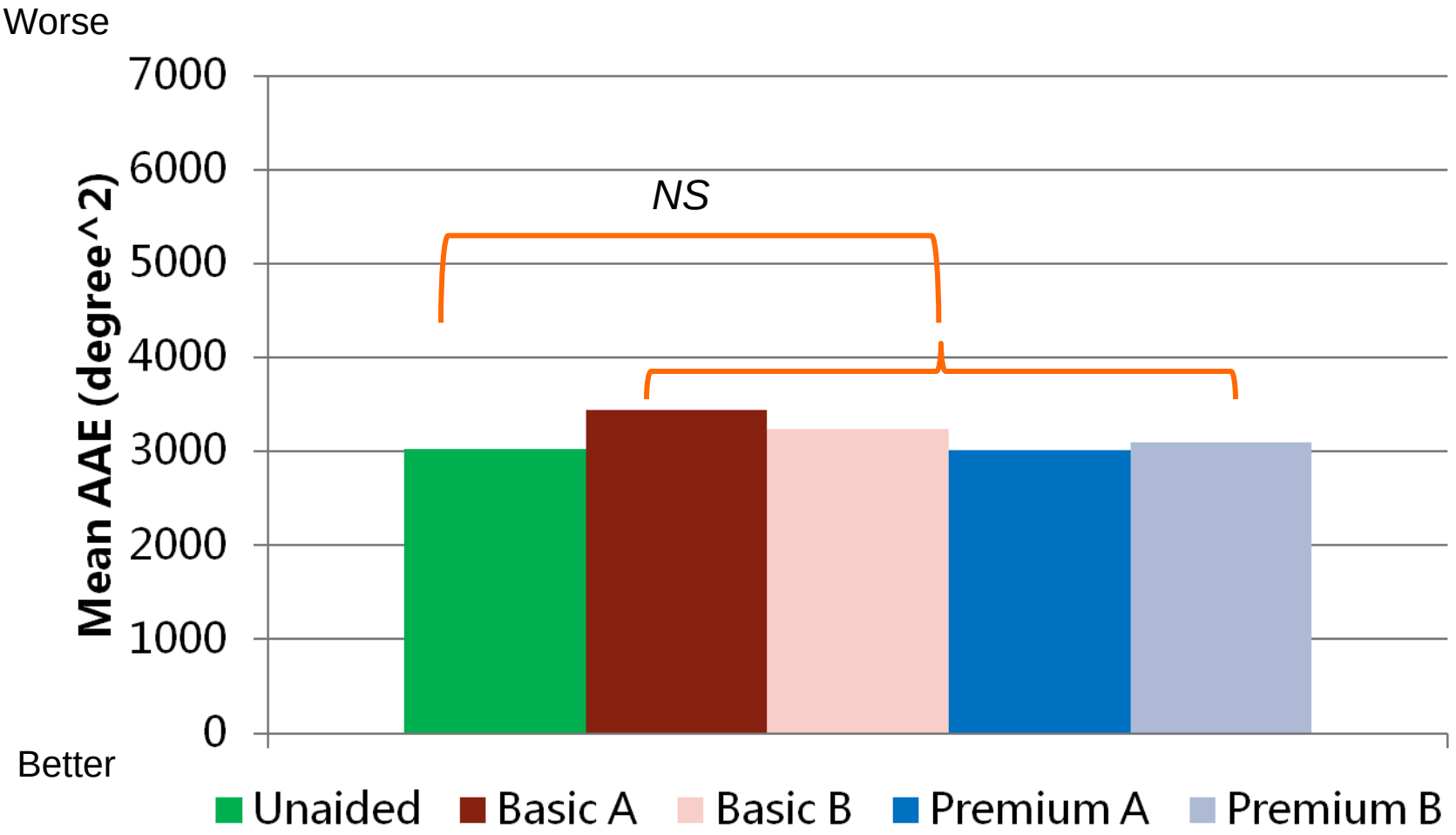


IS THERE A DIFFERENCE BETWEEN THE TWO BRANDS?
(HF stimuli)

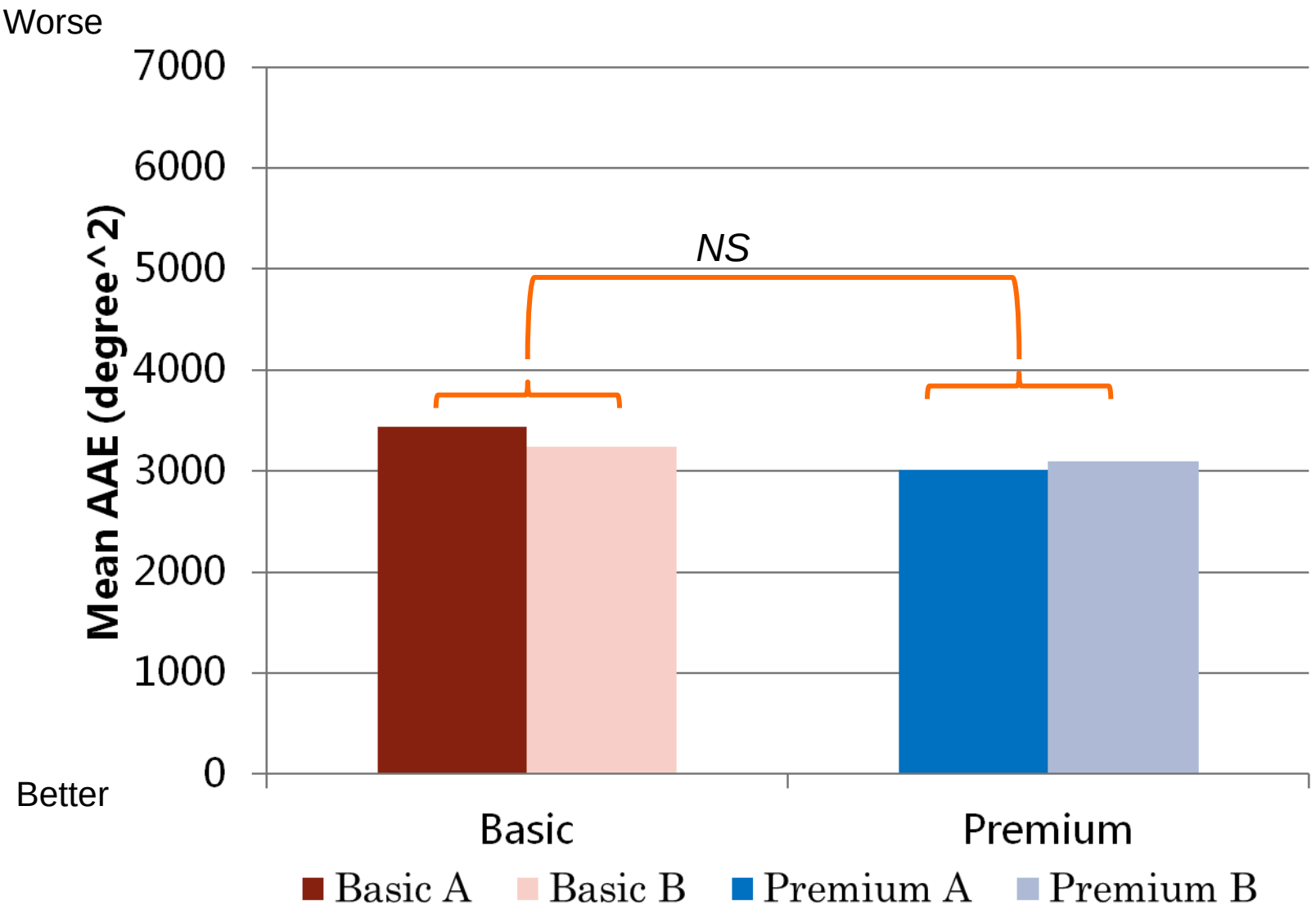


Low Frequency Stimuli

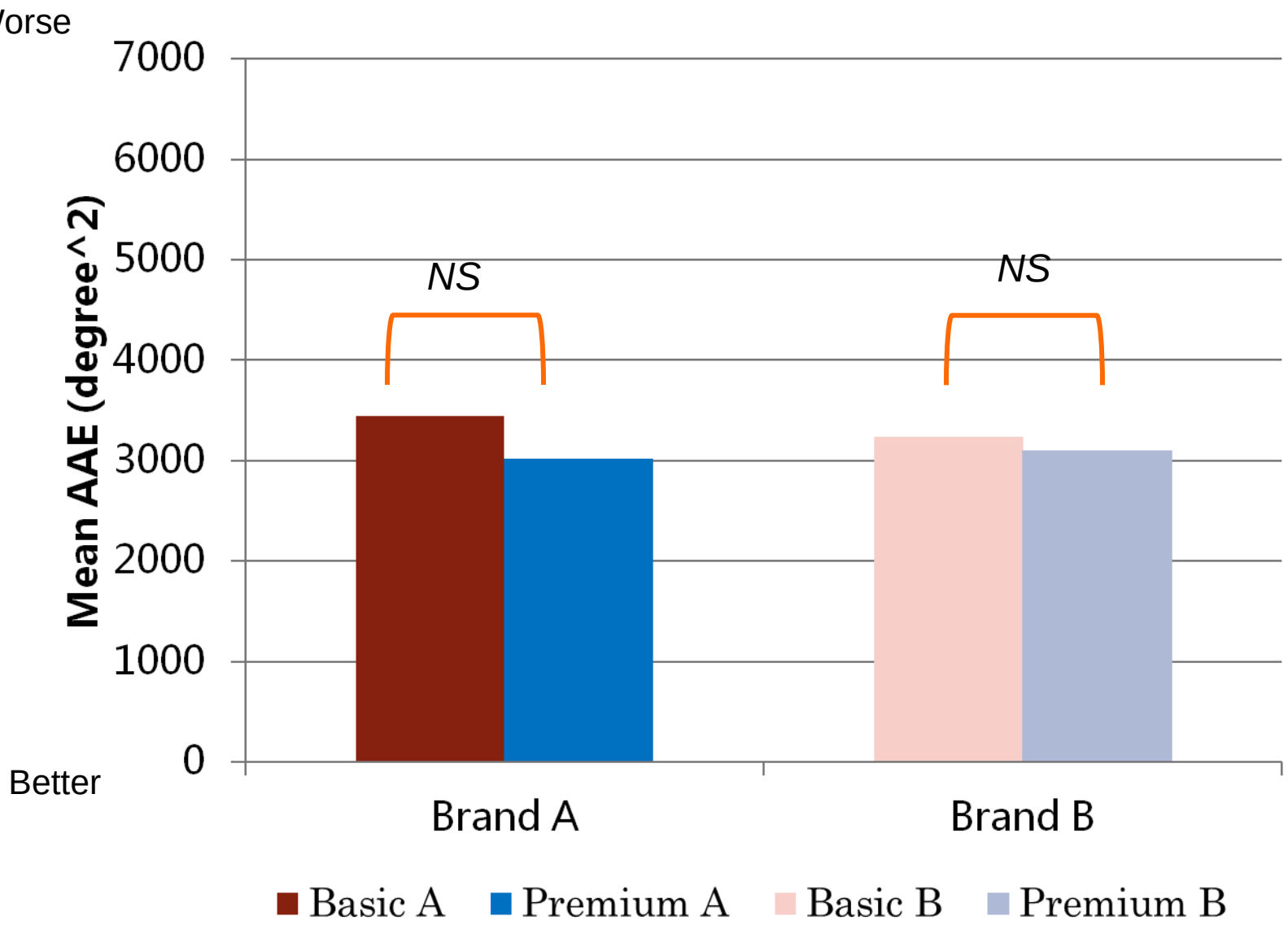
Is aided better than unaided? (LF stimuli)



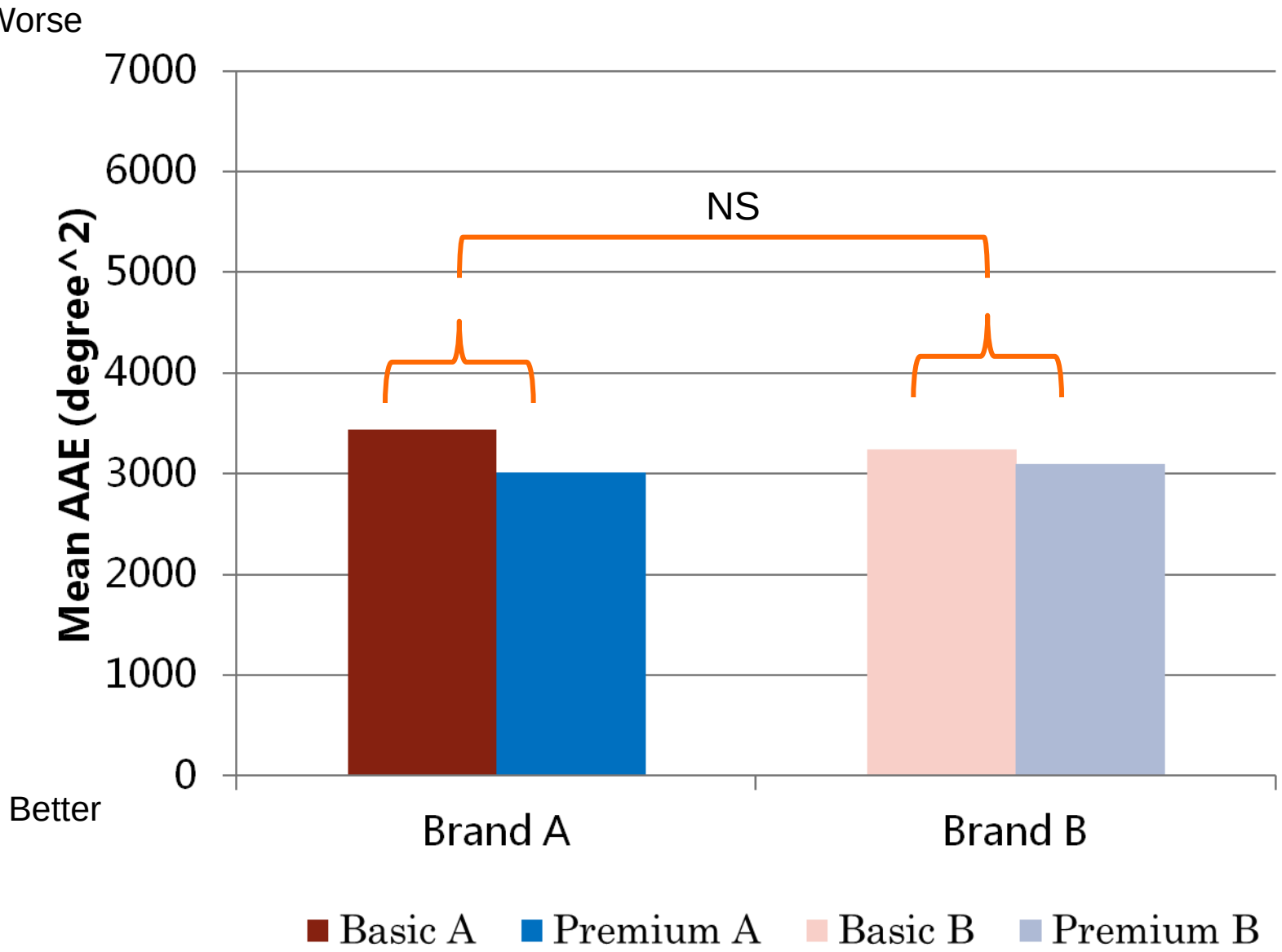
IS PREMIUM BETTER THAN BASIC (OVERALL)?
(LF stimuli)



IS PREMIUM BETTER THAN BASIC (FOR EACH BRAND)? (LF stimuli)



IS THERE A DIFFERENCE BETWEEN THE TWO BRANDS? (LF stimuli)

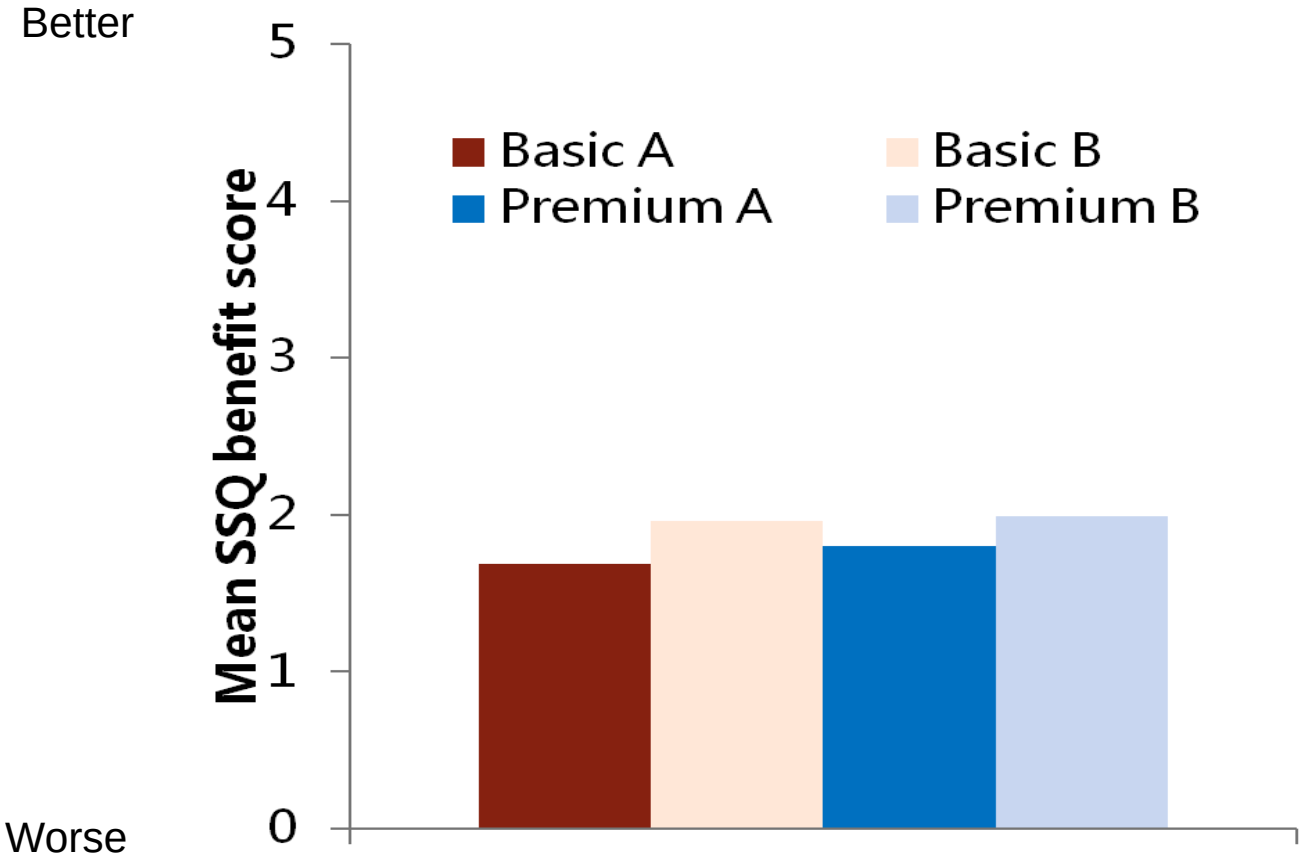


Self-report data

These data are from part 2 of the SSQ questionnaire, including 15 items for two subscales: (1) Localization and (2) Distance & movement.

For each listening condition, an average score across the 15 items was computed for statistical analyses.

Self-report data



The SSQ scores showed that

- the participants reported significant benefit from using hearing aids ($p < .001$).
- no significant difference between premium and basic hearing aids, either overall or for each manufacturer.
- no significant difference between the two manufacturers.

Summary: Unaided vs. Aided

- On the whole, there was no significant difference between aided and unaided localization performance in the laboratory test. Unaided performance was not worse than aided performance. This finding is consistent with previous research (e.g., Van den Bogaert et al., 2006).

- In daily life, participants reported better localization when aided, which is consistent with previous research (e.g., Gatehouse & Akeroyd, 2006).

SUMMARY: PREMIUM VS. BASIC

- Overall, in lab premium hearing aids yielded significantly fewer errors than basic hearing aids with high-frequency stimuli. However, there were no significant differences for low-frequency stimuli.
- In daily life, no difference between premium-basic levels or brands.
- Previous independent research showed that pinna effect simulation improved localization in the lab in quiet (Keidser et al, 2009) but had no effect in daily life (Keidser et al, 2009).

SUMMARY: BRAND A VS. BRAND B

- Devices from one manufacturer (Brand B) yielded fewer errors than those from the other manufacturer (Brand A) when high frequency stimuli were used.

- There was no significant difference between the two manufacturers when low frequency stimuli were used as well as in the real world.

Take home message

- Compared to basic features, premium features yielded better front/back localization performance in some circumstance in laboratory tests.
- However, it should not be assumed that the better localization performance with premium hearing aid features in a laboratory environment will necessarily translate to the real world.
- More effectiveness research on different hearing aid technologies is needed.

Acknowledgement

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