Effect of Bluetooth Hearing Device Amplification for Speech Recognition in Individuals with Hearing Loss

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Purpose

Hearing loss has the potential to degrade the quality of life if untreated. While hearing aids can be used for successful intervention, their use by those with hearing loss is limited by factors such as cost, accessibility to care providers, and stigmatic barriers.

The aim of this study was to explore the benefit of personal sound amplification products (PSAP) and hearing aids (HA) by comparing their frequency responses via on-ear "real ear" measures (REM), speech audibility quantified by the speech intelligibility index (SII), and speech understanding performance in quiet and noisy conditions.

Objectives

1) Recognize the feasibility of using Bluetooth hearing devices for better speech understanding in listeners with mild-to-moderate hearing loss
2) Examine the differences in the benefits of hearing aids and Bluetooth hearing devices
3) Explain the degree of expectation for the relatively less expensive sound amplification through Bluetooth hearing device

Methods (Pre-Experiment)

- A total of 30 adults, 20 female 10 male, ages 55 to 86 years old, with bilateral mild-to moderate hearing loss were enrolled as participants
- **Four conditions were tested: 1) unaided, 2) Samsung Galaxy Buds 2 (GB2), 3) Apple Airpod Pros (AAP), and 4) Oticon More 2 RIC HA**
- Before research visits, the HA and AAP were pre-programmed using audiometric thresholds obtained within 6 months of study
- -HA were programmed through Oticon's proprietary "first fit" formula (VAC+), no other changes to programming were made
- -AAP were connected to an iPhone, then through the audio headphone accommodation settings, patients' audiometric data was entered using custom audio set-up
- -GB2 required no pre-programming as amplification response was the same for all participants
- The listening mode was on "Transparency" for AAP and "Ambient Sound" for GB2

Experiment

•Otoscopy was completed for all participants to check for unobstructed healthy canals

•AAP and GB2 have a closed style earpiece/dome. A closed dome ("Oticons Bass Double Dome") was chosen for HA to more closely mirror their acoustic style

•Real ear aided response (REAR) measures were completed for all conditions using AudioScan Verifit®2 *(Figure 1)*

•Calibration was completed before every participant, and probe tube depth within 5mm of the eardrum was verified using the probe tube placement tool ProbeGUIDE™

•All available air conduction audiometric data was entered, the NAL-NL2 formula was chosen for targets, and stimulus for all conditions was an average speech sample at 65dB SPL

•**Participants performed randomized 3 speech understanding tasks for each condition:**

- •Hearing in Noise Test (HINT) given in noise and in quiet to establish sentence speech recognition thresholds (sSRTs) *(Figures 3 & 4)*
- •Iowa Speech in Noise Test (ISNT): Participants were presented with a crosshair on a screen and were instructed to listen while a word was played auditorily. The following screen consisted of four words; the target word and three other words differing by a phoneme. *(Figure 5)*

Results

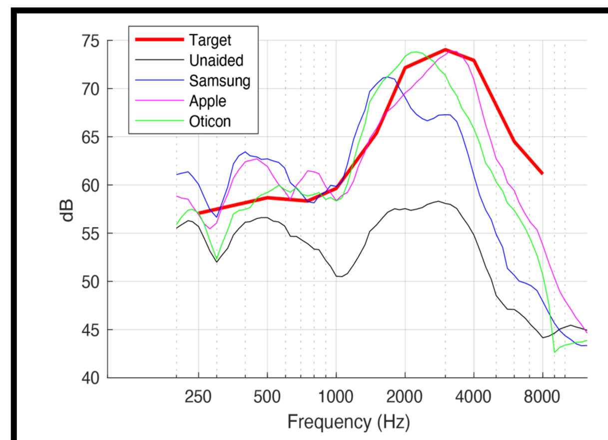

Figure 1. REAR of Conditions vs Prescriptive Targets

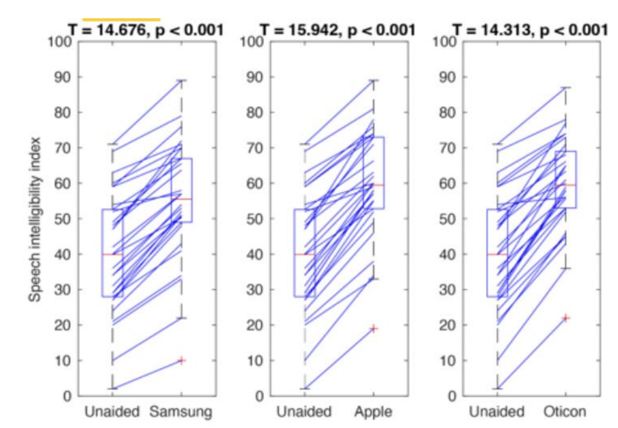

Figure 2. SII Comparisons Unaided vs Aided

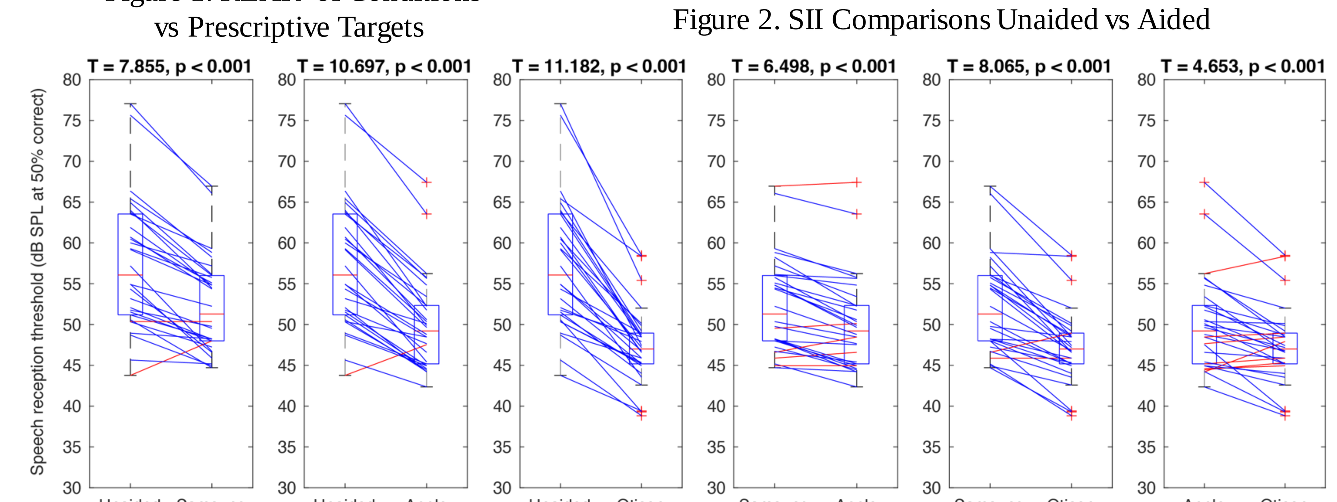

Figure 3: Sentence speech recognition thresholds (stimuli in quiet)

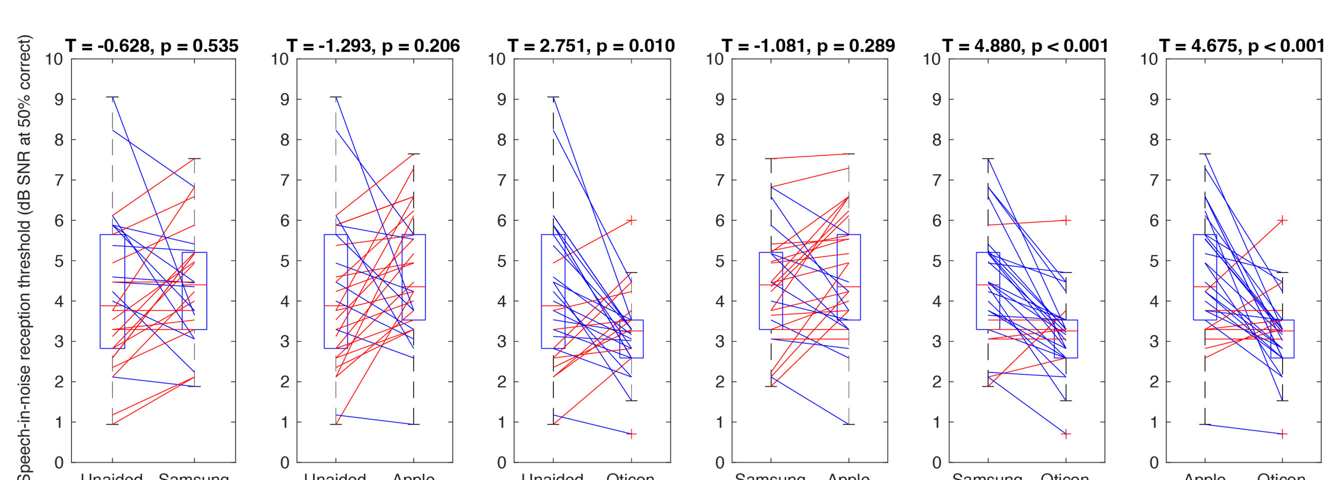

Figure 4: Sentence speech recognition thresholds (stimuli with noise)

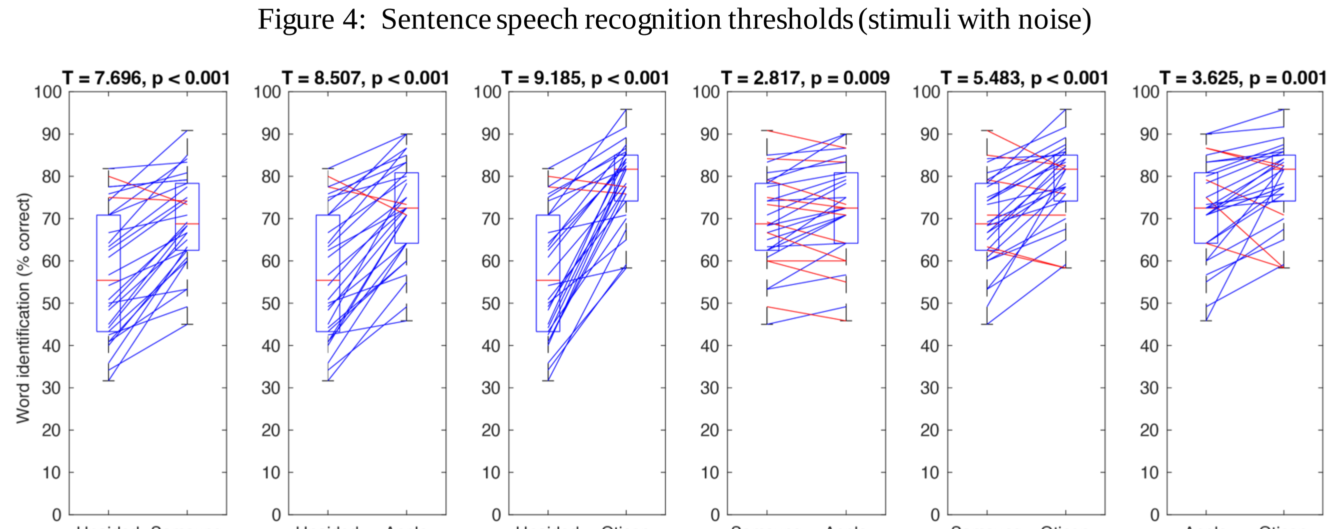

Figure 5: ISNT

REAR and SII:

- GB2 and AAP exhibited over amplification at ~400Hz and under-amplification at 2-3kHz
- All aided conditions achieved a greater SII than unaided
- Overamplification may contribute to greater SII

HINT (Quiet):

- All aided conditions saw a decrease in sSRT from the unaided condition.
- The effect size again was greatest for the Oticon hearing aids, followed by the Apple device, then Samsung

HINT (Noise):

- The effect size was greatest for the Oticon hearing aids, followed by the Apple device, then Samsung
- Only Oticon hearing aids show speech-in-noise benefits

ISNT:

- All aided conditions saw an increase in word identification from the unaided condition.
- The effect size again was greatest for the Oticon hearing aids, followed by the Apple device, then Samsung

Conclusions

In conclusion, our study showed that the ambient and transparency sound amplification features of the Samsung Galaxy Buds2 Pro and Apple Airpod Pros improved speech understanding in a quiet listening environment in patients with mild to moderate hearing loss compared to their unaided condition. With future improvements and quality control, these devices could be a means of bringing the hearing aid experience to people with hearing loss at a lower cost and with less social stigma. Still, hearing aids out-performed both Bluetooth devices in all speech understanding tasks.

Acknowledgements

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