Analysis of Speech Intelligibility and Preference for Binaural Beamforming

Ivo Merks¹, Jumana Harianawala¹, Kyle Walsh¹
¹Starkey Hearing Technologies

INTRODUCTION

Binaural beamforming (BBF) is achieved by wirelessly combining directional signals from pairs of microphones from each hearing aid of a bilateral set. The improvement in signal to noise ratio (SNR) by this form of signal processing has been related to improvements in speech understanding in noise (Picou et al, 2014). However, the perceptual effects of different factors associated with binaural signal processing have not been explored. Therefore, the goal of this study was to understand the effects of latency, BBF and wireless processing on hearing aid wearers’ speech intelligibility and preference.

IN-SITU SNR IMPROVEMENT

Purpose: To estimate the effect of direct & amplified sound interaction and participant variability on the observed in-situ SNR with BBF.

Methods:
- Participants: Fifteen NH participants and KEMAR
- Fitting: BTEs programmed for a standard moderate sloping SNHL (Bisgaard et al, 2010).
- Coupling – Open, Vented, Occluded
- Mic modes – Omnidirectional (Omi), Bilateral Directional (Dir), BBF
- Paradigm: In-situ speech and noise measurements were using the Hagerman & Olofsson (2004) method.
  - Two simultaneous speech (66dBA) and noise (70dBA) measurements were made.
  - Phase of the noise was inverted in one of the measurements
  - Output speech and noise signals were extracted by taking the sum and the difference, respectively, of the two measured signals.
  - The recorded signals were analyzed for variability and level differences (suggesting excessive movement). The erroneous measurement was repeated.

Results:
- The openness of the fitting had an impact on the in-situ SNR experienced by the participants for all mic modes.
- BBF resulted in a larger (1.3 dB) SII weighted SNR improvement relative to Dir mic mode.

SPEECH INTELLIGIBILITY

Purpose: To estimate the effect of different factors associated with BBF on speech reception threshold (SRT) in noise.

Methods:
- Participants: Fifteen NH participants
- Fitting: BTEs programmed for a moderate sloping loss; linearized for a 70dBA input.
- Paradigm: Hearing in Noise Test (HINT) using earphones
  - Stimuli was pre-processed using Hagerman method. Recordings were made on KEMAR with speech at 0° and uncorrelated noise from ±45, ±90, ±135 & 180°. The noise field was at 70dBA and speech at 66dBA (-4dBSNR).
  - Test Factors: mic mode, latency/leakage & wireless processing
  - Analysis: Multiple linear regression was conducted to estimate the contribution of different factors on the SRT.

Results:
- Significant SRTs
  - BBF conditions lower (better) than the DIR (p<0.001)
  - No leakage conditions lower (better) than leakage conditions (p<0.001)
- Non-Significant SRTs
  - High latency versus low latency conditions
  - Wireless processing versus no processing conditions

CONCLUSIONS

- The electro-acoustic measurement of in-situ SNR show that BBF improves SII-SRT on participants and KEMAR > Participants.
- The corresponding measures of speech intelligibility & preference show that –

PREFERENCE

Purpose: To identify factors associated with BBF that dictate hearing impaired (HI) individuals preferences.

Methods:
- Participants: 16 HI participants with mild to moderate SNHL
- Fitting: BTEs programmed to their HL. Appropriate acoustic coupling was used.
- Paradigm: Preference via paired comparison and acceptability ratings were obtained for:
  - Stimuli: own voice in background noise (2 passages) and external speech target in background noise (2 SNRs – Db and +3 dB with noise level fixed at 70dBA).
  - Factors: mic mode (Dir/BBF), latency/leakage (No latency/low latency/high latency), wireless processing (present/absent)

Results:
- BBF conditions had more wins over Dir conditions (p<0.001)
- The effect of leakage/latency and wireless processing was small (p>0.001)
- Acceptability ratings were not significantly different between or within factors

REFERENCES


Bisgaard, B., & Vlaming, T. (2010). Non-Significant SRTs

Figure 4: Conditional plots showing the extraneous relationship between the factor and BBF. Stimuli: own voice in background noise (2 SNRs – Db and +3 dB with noise level fixed at 70dBA).