Influence of Binaural Hearing on Speech Intelligibility and Listening Effort

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INTRODUCTION

- Listening conditions can be noisy
- Spatial separation of target speech from noise improves intelligibility

METHODS

Participants

- Subjects: 12 native English speakers; 7 female & 5 male
- Mean age: 22.2 ± 7 years

Stimuli

- Target: Harvard IEME male voiced sentences
- Competitor: 2 male voiced AZ-Bio sentences spliced into continuous loops

Co-localized:

- Target and competitor are presented via front speaker (Fig. 3A)

Symmetric:

- Target and competing sentences are presented via 2 speakers at ±90° azimuth (Fig. 3B)

Listening condition

- Co-localized: Target and competing sentences are presented via front speaker and competing sentences are presented to 2 speakers at ±90° azimuth (Fig. 3B)

Increased pupil dilation has been found with increased cognitive task demands.

Study Goals

- Determine the stimulus parameters for maximizing the TEPR
- Measure the impact of spatial separation and SNR between the target & competitor on speech intelligibility and listening effort

Hypothesis

- Peak pupil dilation will be smaller and speech intelligibility will be greater in conditions where the target and competitor are spatially separated than when the target and competitor are co-localized.

Data Analysis & Results

- Individual pupil tracings were assessed for inclusion before being averaged into a waveform for each condition. Tracings were excluded based on the following criteria:
  - More than 25% of a tracing consisted of eye blink artifacts
  - Mean pupil size of the tracing was below the baseline pupil size

- The maximum pupil dilation value for each subject was identified from the averaged waveform between -500 msec to 2000 msec relative to the onset of the sentence

- Speech intelligibility was scored as % correct for all sentences within each SNR & listening configuration

Fig. 2. Example of pupil tracings from two listening conditions. The orange track is from a difficult condition and the purple track is from an easy condition. The orange track is from a difficult condition while the purple track is from an easy condition. The orange track is from a difficult condition while the purple track is from an easy condition.

Fig. 3A. Co-localized configuration.

Fig. 3B. Symmetric configuration.

DISCUSSION

- The data here demonstrate that binaural hearing has the potential to reduce listening effort for some but not for all SNRs (Fig. 8)
  - A binaural advantage, indicated by a difference in peak dilation between the co-localated and symmetric conditions, was observed only at harder (negative) SNRs

- The speech perception data demonstrated a binaural advantage over a similar but wider range of SNRs than did peak pupil dilation (Fig. 7)

- We also observed an inverse relationship between the TEPR and SNR between target and competitors

- These findings suggest that there is a limited range of SNRs where the spatial configuration of sound sources can impact listening effort

- Forthcoming work will determine the impact of hearing loss and the effect of its treatment(s) on the interaction between binaural hearing and listening effort measured above

REFERENCES