Acoustic Beamforming

Acoustic beamforming has been shown to improve identification of target speech in noisy environments for listeners with sensorineural hearing loss (SNHL) (Kidd et al, 2015). The beamformer has a sharply tuned directional response attenuating sounds from sources outside the focus of the beam (i.e., maskers) while amplifying the sound source where the beam is aimed (i.e., the target). It then presents the target and the maskers to the listener through a single channel.

Psychoacoustic Methodology

Typically, the benefit of beamforming would be measured using psychoacoustic methodology. However, standard psychoacoustic methods may not be appropriate for PWA, as they assume intact language comprehension, reading/scanning abilities, and verbal working memory.

Research Questions

1. Can acoustic beamforming facilitate improved speech intelligibility for PWA in multi-source listening situations? 
2. Can psychoacoustic methods be effectively modified for use with PWA?

Adaptation of psychoacoustic methods to examine the benefit of acoustic beamforming in persons with aphasia

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Aphasia and Background Noise

It is common for persons with aphasia (PWA) to report difficulty understanding conversational partners in noisy listening environments, such as restaurants, stores, or family/social gatherings. This issue may have implications for social engagement and community participation in PWA.

Methods

• The listener was seated in front of a computer screen. All auditory stimuli were delivered through headphones and spatialized using head-related impulse responses.
• Three sentences were played simultaneously (1 target, always beginning with “Jane”, and 2 maskers), drawn from a closed-set matrix.

Frequency-specific amplification and individually-tailored modifications

1. National Acoustic Laboratories (NAL) gain added individually for each participant based on pure tone hearing results:
   - P1: about 1.6 dB overall gain
   - P2: about 4.4 dB overall gain
2. Sentence length adjusted to reduce verbal working memory burden and help ensure 100% correct in quiet:
   - P1: 2 words (e.g. “Jane sold”)
   - P2: 4 words (e.g. “Jane sold red socks”)
3. Number of response options adjusted to reduce reading/visual scanning burden and ensure 100% correct in quiet:
   - P1: 4 response options per word
   - P2: 4 response options per word

Group-level results

PWA showed a significant benefit of BEAM (relative to KEMAR) in both conditions.

Thresholds on the KEMAR-speech condition may be associated with selective attention abilities.

Conclusions

• Beamforming may improve speech intelligibility for PWA in complex, multi-source listening situations.
• Individually tailored experimental modifications may facilitate the use of psychoacoustic methods in PWA.

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References


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