Spatial speech intelligibility in single-sided deaf and bimodal cochlear implant users a functional model approach

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Many cochlear implant (CI) users have access to contralateral acoustic hearing that is either normal (single-sided deaf, SSD-CI listeners) or supported by a hearing aid (bimodal listeners). The availability of both, electric and acoustic hearing allows for improved spatial speech intelligibility compared to unilateral hearing. This study aims to model speech-reception-thresholds (SRTs) of simulated bimodal listeners in different spatial settings of speech and noise using a binaural speech intelligibility model and aims at investigating the combination and relative importance of electric and acoustic hearing.

Virtual acoustics was used to render spatial settings of speech and noise for frontal speech, and noise from the front, right or left side. A physiologically-inspired vocoder was used to simulate CIs, and an aided hearing impairment simulation was used to simulate contralateral acoustic hearing. The binaural speech intelligibility model featured both better-ear-listening and binaural processing. SRTs for monaural NH listeners (-7 dB) and simulated unilateral CI listeners (+2.7 dB) were used as reference values and an electric/acoustic weighting function was used.

Predicted SRTs largely matched measured SRTs in all conditions except for unilateral severe hearing loss. The model demonstrates a strong binaural interaction for binaural NH listening that improves SRTs by 7.9 dB upon spatially separating speech and noise and a weaker improvement of 3.5 dB for bimodal and SSD-CI listeners, which is in line with measurements. Comparisons of predicted and measured SRTs allowed for inferring the relative importance of electric compared to acoustic hearing for speech intelligibility.