Title:

Electro-haptic hearing: Improving spatial hearing and speech-in-noise performance in cochlear implant users by presenting sound information through vibration on the wrists

Talker:

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Abstract:

Cochlear implants (CIs) are neural prostheses that enable profoundly hearing-impaired people to perceive sounds through electrical stimulation of the auditory nerve. Many CI users achieve excellent speech understanding in quiet listening conditions, but most perform poorly in the presence of background noise. CI users also struggle to locate sounds spatially, particularly the 93% of adult CI users in the UK who are implanted in only one ear. Recent work has suggested that better CI outcomes might be obtained by augmenting the electrical signal from the implant with a haptic signal that provides missing sound information ("electro-haptic stimulation"). Across two studies, we aimed to establish whether haptic stimulation on the wrists of CI users can be used to (1) increase the number of words correctly identified in background noise and (2) improve sound localization ability. In the first study, we used haptics to present the amplitude envelope of speech extracted from a speech-in-noise signal. We found that haptic stimulation can increase the number of words correctly identified in background noise by an average of 8.3 %-points after just 20 minutes of training, with some CI users improving by more than 20 %-points. In the second study, we presented haptic stimulation to both wrists, with the difference in vibration intensity between the wrists corresponding to the difference in sound intensity between the ears (an important cue for sound localization). We found that haptic stimulation dramatically improved CI users' localization ability. Compared to audio alone, haptic stimulation reduced the RMS localization error by 17.9 degrees on average. We hope to develop a low-cost, portable wrist-worn device that can provide this haptic stimulation to CI users in their everyday lives.