

Combined acoustic and electric hearing. Increasing numbers of cochlear implant patients have usable acoustic hearing in the non-implanted and/or implanted ear. However, clinical fitting is not optimized for combined acoustic and electric hearing. Through a number of approaches, we study how acoustic and electric hearing are combined for spatial hearing, speech perception, and music perception.

Spatial perception. With bilateral cochlear implants or combined acoustic and electric hearing, spatial perception is generally better with two ears than with either ear alone. However, spatial perception with cochlear implants remains poorer than with normal hearing. With our 12-speaker array, we are able to measure sound source localization and segregation of competing speech with spatial cues. This is especially beneficial for assessing binaural benefits when combining acoustic and electric hearing or two cochlear implants.



Binaural integration. While combining sounds from two ears may likely improve spatial perception, it may also improve (or possibly interfere with) perception of sounds coming from a single spatial location (e.g., directly in front of the listener). Our research is aimed at optimizing cochlear implant signal processing to improve integration of acoustic and electric stimulation patterns, as well as integration of two cochlear implants.

Music perception. While speech perception is often good with cochlear implants, music perception is generally poor due to the poor pitch and timbre representation by the device. However, improved music perception is a high priority among cochlear implant users. Our research is aimed at improving music perception and sound quality in cochlear implant users using a variety of approaches, including optimization of cochlear implant signal processing and using vocal mimicry to better understand the sound of music with a cochlear implant.

Emotion communication. *How* you say something is as important as *what* you say, if not more so. Emotion perception and production are especially important for childhood development. Pitch cues are important for decoding the emotional intent of a talker. Unfortunately, pitch cues are largely unavailable to cochlear implant users, who must rely on less salient cues such as intensity and duration. Our research is aimed at how utilization of cues to emotional speech are affected by implant experience, the age of implantation, and previous experience with acoustic hearing. We are also studying links between emotional speech perception and production in cochlear implant users.

Auditory training. Given the generally poor representation of sound, the success of the cochlear implant is largely due to brain plasticity. Auditory training can improve and/or accelerate adaptation to the cochlear implant. Our research has shown computer-based auditory training can significantly improve speech and music perception, even in cochlear

implant users with years of experience with their device. We have developed extensive auditory training software in multiple languages to allow cochlear implant users to train at home, at their convenience, at no cost. We are investigating training approaches to accommodate combined acoustic and electric hearing, and to promote better long-term engagement with auditory training.

Psychophysical perception. To improve cochlear implant signal processing, it is important to understand the perceptual limits for psychophysical aspects of sound perception (e.g., modulation sensitivity, loudness, frequency selectivity, etc.). We are currently studying loudness growth in cochlear implant users, and how it may be affected by electrode location and duration of hearing loss. Information from this research may help to optimize signal processing for individual cochlear implant users according to patterns of neural health along the electrode array.