Observing The Enhancement Effect In Cochlear-Implant Listeners

Matthew J. Goupell and Mitch Mostardi

University of Wisconsin, Madison, WI, USA

The auditory system has an amazing ability to detect novel changes in acoustic stimuli. One such detectable change occurs when eliminating and reintroducing a harmonic in a complex tone, which causes the harmonic to stand out separately from the rest of the harmonic complex. This effect has been called the enhancement effect in the psychoacoustical literature. Previous experiments in normal-hearing listeners demonstrated that listeners could very accurately match the pitch of enhanced harmonics up to at least the twentieth harmonic for a 200-Hz fundamental frequency [Hartmann and Goupell, 2006, J. Acoust. Soc. Am., 120, 2142-2157]. We wondered whether the enhancement effect was observable in unilateral cochlear-implant (CI) listeners using a similar task.

Seven CI users were tested in an enhancement experiment using direct stimulation. Stimuli contained 2, 4, 6, or 11 electrodes as a "background." The stimulation rate was 1000 pulses per second, per electrode. A target electrode was alternated off and on over five 0.75-s intervals. The task of the listener was to match the place-pitch of a target electrode to the place-pitch of a single electrode played without a background. All listeners could detect an audible change in the when target electrode was alternated off and on. Most listeners could reasonably match the pitch of the target electrode within a few electrodes, although their electrode-matching ability was worse than their ability to discriminate single electrodes without a background. It appeared that places with better electrode discrimination (without a background) correlated with better electrode matching in the enhancement task. Listeners who could not perform the task seemed to match with electrodes near the center of the electrode array, which would be the spectral center of the background stimulus. For listeners who appeared to be able to perform the pitch-matching task, a regression effect towards the center of the electrode array was systematically observed. These data show that spectral notches in multi-electrode stimulation, while typically difficult to detect for CI users in static stimuli, play a role in stimuli that change over time.

Support provided by the National Institutes of Health Grants K99-DC010206 (M. J. Goupell) and R01-DC003083 (R. Y. Litovsky).