1406: A MIXED-RATE STRATEGY FOR REAL-TIME DELIVERY OF INTERAURAL TIME DIFFERENCES TO COCHLEAR IMPLANT USERS

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Bilateral cochlear implant (BiCI) users do not perform as well as normal hearing (NH) listeners on spatial hearing tasks such as sound localization. This can be partially attributed to the fact that BiCI listeners have limited access to interaural time differences (ITDs) using their unsynchronized clinical processors. Prior work has demonstrated that BiCI listeners are able to discriminate and lateralize (localize within the head) using ITDs when stimuli are provided via synchronized, highly-controlled desktop research processors. ITDs can be encoded either directly to the timing of low-rate pulse trains or to a slow envelope modulation on high-rate pulse trains. Sensitivity to ITDs is typically observed when either the pulse timing or modulation is below 300 Hz. However, clinical stimulation rates used for good speech understanding are too fast to yield good ITD sensitivity, around 1000 pulses per second (pps). Previous work has shown that mixed-rate stimulation, in which high and low rates presented on different pairs of electrodes, can result in good ITD sensitivity and lateralization with the potential for preserving speech understanding. However, the utility of envelope modulations embedded in a mixed-rate strategy has yet to be examined. Here, we hypothesize that when coherent ITD cues are provided in both the signal envelope and individual pulses, ITD sensitivity will be maximized when listening with the mixed-rate strategy.

To test this hypothesis, we implemented a real-time mixed-rate stimulation strategy that provides ITD cues via the timing of low-rate pulses and envelope modulations of high-rate pulses. Our novel mixed-rate strategy is based on the principles of continuous interleaved sampling and utilizes five high-rate (1000 pps) and five low-rate (125 pps) channels, whereby low-rate channels are delivered at an integer factor of the high-rate channel stimulation rate. ITDs are estimated from the incoming acoustic signal using a cross-correlation of the left and right ear signals. This strategy was implemented using the CCi-MOBILE research device, a portable and synchronized bilateral research processor.

Stimuli consisted of ten sinusoids that had an ITD of either -800 or +800 microseconds. The frequency of each of the sinusoids were the center frequencies of the ten channels available in the strategy. These acoustic stimuli were processed using either the mixed-rate strategy or an all-high strategy (high rate on all channels), and were streamed using the CCi-MOBILE. Three conditions were tested: 1) mixed-rate strategy with no envelope modulations, 2) mixed-rate strategy with 125 Hz envelope modulations on the high-rate channels, and 3) all-high strategy with 125 Hz envelope modulations on each channel. Based on our hypothesis, we predict that a mixed-rate strategy may yield improved ITD sensitivity if the ITD is available in both the low-rate channels and in the envelope modulations of high-rate channels, as compared to only in low-rate channels or envelope modulations. Participants were asked to report the perceived intracranial lateral location of the sound. Results will be presented in the context of how ITD cues are encoded and delivered by the strategy, and how they map to a lateral location within the head. The results of this study will inform the development of further binaural signal processing strategies and potentially lead to new clinical devices that can deliver synchronized binaural cue information.

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