Lateralization Performance With “Channel Specific” Mixed Rate Stimulation Strategy Using the CCI-Mobile Research Processor

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Introduction: spatial hearing is poor with bilateral cochlear implants (BiCIs).

• CIs have restored hearing for over a million individuals with severe to profound hearing loss (1).
• However, CIs don’t fully restore hearing abilities: spatial hearing, for example, which requires 2 ears, is poor even with BiCIs, as shown in Figure 1. ITD (interaural time difference) cues, one of spatial hearing cues.

The following factors contribute to poor spatial hearing in BiCIs.
• External processors are not synchronized. Encoding of ITD is difficult with pulses from two sides not being synchronized.
• High stimulation rate is adopted for all electrodes in clinic. Low rate is needed for ITD sensitivity while high rate is important for speech intelligibility.

There is interaural mismatch between implants:
• Asymmetric insertion depth
• Different lengths in electrode array
• Asymmetric neural health
• Different electrode–nerve interface

“Mixed rate” strategy running on synchronized research processors could improve spatial hearing but so far results have been mixed.

Most clinical strategies use high rate stimulation to preserve speech intelligibility (2). Studies have shown that low-rate stimulation (pulse rate) improves ITD sensitivity (3). The comparison between the mixed rate and all high rates leads to negative values indicating improvements with mixed rate strategy. Not all participants benefited from mixed rate strategy. References: (a–g).

Discussion

Hypothesis: some BiCI listeners gained little benefit from “mixed rate” strategy because low-rate ITD information was presented at a region with large asymmetry across ears (hence poor sensitivity to ITD, the last of the three limitations listed above).

Results

Methods

Subjects were asked to indicate the perceived location of the stimulus on a purple bar (x-axis, lateralization). The stimulus was an ITD of 2 ms for non-BiCI and 5 ms for BiCI listeners for 5 types of stimuli in total: 1) COMBINE, 2) LEFT, 3) RIGHT, 4) INTERLEAVED strategies, and the pure tone stimulus was used to calibrate the MAP for the INTERLEAVED strategy. The final results from each subject were presented as the mean location of stimulus presentation for each strategy. Subjects were asked to indicate the perceived location of the stimulus on a purple bar (x-axis, lateralization). The stimulus was an ITD of 2 ms for non-BiCI participants for 5 types of stimuli in total: 1) COMBINE, 2) LEFT, 3) RIGHT, 4) INTERLEAVED strategies, and the pure tone stimulus was used to calibrate the MAP for the INTERLEAVED strategy. The final results from each subject were presented as the mean location of stimulus presentation for each strategy.

Conclusion

ITD sensitivity predicts the benefit from “mixed rate” strategy. For BiO, the BEST strategy is slightly better than the WORST strategy, when the stimulus is word. INTERLEAVED strategy resulted in the best lateralization performance overall for both subjects.

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References