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Perceptual Changes with Monopolar and Phantom electrode stimulation

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Abstract

Phantom electrode (PE) stimulation is achieved by simultaneously stimulating out-of-phase from two adjacent intra-cochlear electrodes with different amplitudes. If the basal electrode stimulates with a smaller amplitude than the apical electrode of the pair, the resulting electrical field is pushed away from the basal electrode producing a lower pitch. There is great interest in using PE stimulation in a processing strategy as it can be used to provide stimulation to regions of the cochlea located more apically than the most apical contact on the electrode array. The result is that even lower pitch sensations can be provided without additional risk of a deeper insertion. However, it is unknown if there are perceptual differences between monopolar (MP) and PE stimulation other than a shift in place pitch. Furthermore, it is unknown if the effect and magnitude of changing from MP to PE stimulation is dependent on electrode location. This study investigates the perceptual differences (including pitch and other sound quality differences) at multiple electrode positions using MP and PE stimulation using both a multidimensional scaling procedure (MDS) and a traditional scaling procedure.

10 Advanced Bionics users reported the perceptual distances between 5 single electrode (typically 1, 3, 5, 7, and 9) stimuli in either MP or PE (σ=0.5) mode. Subjects were asked to report how perceptually different each pair of stimuli were using any perceived differences except loudness. Subsequently, each stimulus was presented in isolation and subjects scaled how "high" or how "clean" each sounded.

Results from the MDS task suggest that perceptual differences between MP and PE stimulation can be explained by a single dimension. The traditional scaling suggests that the single dimension is place pitch. PE stimulation elicits lower pitch perceptions in all cochlear regions. Analysis of Cone Beam Computer Tomography (CBCT) data suggests that PE stimulation may be more effective at the apical part of the cochlea. PE stimulation can be used for new sound coding strategies in order to extend the pitch range for cochlear implant (CI) users without perceptual side effects.

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