Interaural time difference perception in single-sided deaf cochlear implant subjects

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Background
The interaural time difference (ITD) is an important cue to localise sound sources. We measured ITD sensitivity in CI subjects with normal normal hearing in the contralateral ear (single-sided deaf (SSD) CI subjects) to investigate how the acoustical and electrical signals can be synchronised at neural level and to determine the best match between electrodes and acoustic frequency ranges for ITD perception.

Methods
Sensitivity to ITDs was assessed in eleven SSD CI subjects. As stimuli 100-pps pulse trains on the CI and 100-Hz click trains on the acoustical side were applied. Based on (E)ABR wave V latencies and a comprehensive lateralisation experiment, the required delay of the electrical stimulus for simultaneous excitation of both auditory nerves and the corresponding interaural level difference yielding a centred percept were determined. Then the ITD discrimination threshold was measured in an adaptive procedure. This was all done for three electrodes across the array and different acoustic frequency ranges.

Results
Seven out of eleven listeners were sensitive to ITD, with just noticeable differences ranging from 240 to 1134 us. One listener reported binaural fusion but no ITD sensitivity was found. Three listeners reported neither binaural fusion nor was ITD sensitivity found. To enable ITD sensitivity, a frequency-dependent delay was required to synchronise the electric and acoustic signals at the level of the auditory nerve. Based on ITD sensitivity, it was possible to match a CI electrode to an acoustic frequency range.

Conclusions
In SSD CI users, acoustic frequency ranges can be matched to electrodes based on ITD sensitivity which may serve as a method to allocate acoustic frequency ranges to electrodes when fitting a CI to a subject with normal hearing in the other ear.