Sensitivity to interaural time delays in the auditory cortex of ferrets: investigating potential benefits of half-wave rectified stimuli to individuals with bilateral cochlear implants

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Evidence from normal hearing (NH) individuals suggests that sensitivity to interaural time-differences (ITDs) in the modulating envelope of a high frequency carrier can be enhanced using half-wave rectified stimuli. To investigate neural correlates of this phenomenon, and potential benefits of equivalent electrical stimuli to individuals with bilateral cochlear implants (CI), we assessed ITD sensitivity in response to bilateral intracochlear electrical stimulation in the primary auditory cortex and surrounding auditory fields of ferrets. Ferrets were chosen since our long-term aim is to develop a behavioral model of bilateral CI, for which they are highly suited. Animals were deafened with subcutaneous neomycin administration and, subsequently, stimulated via bilateral intracochlear electrode arrays. Under ketamine anaesthesia, single and multiunit responses were recorded from multichannel electrodes in response to ITDs in the envelope of i) half-wave rectified and ii) sinusoidally-amplitude modulated (SAM) biphasic pulse trains, over a range of modulation frequencies and levels. For comparison, cortical sensitivity to ITDs was assessed in NH animals with half-wave rectified and SAM acoustic carriers.

In NH animals, approximately half of cortical neurons were sensitive to ITDs, regardless of stimulus condition. In response to short duration stimuli (<20ms) a single peak was usually present in the peri-stimulus time histogram, whereas for longer duration stimuli peaks corresponding to the stimulus onset and offset were commonly seen in single units. In these units, ITD sensitivity often changed significantly from the onset- to the offset-response. Cortical sensitivity to ITDs was also seen, albeit less frequently, in the offset-response to bilateral intra-cochlear stimulation. As noted previously in the inferior colliculus recordings from bilaterally implanted cats, this tuning was often found only over a limited range of modulation frequencies and levels.

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