MECHANISMS OF TEMPORAL PITCH CODING AND THEIR IMPLICATION FOR COCHLEAR IMPLANTS

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Mounting evidence suggests that the mammalian auditory system is able to extract pitch percepts from both the temporal components of phase-locked neural responses and also from the rate-place components of neural response. Exactly how these two methods of frequency estimation are combined within the auditory system is still an open question, and will depend on the exact properties of each. It is likely that a response averaging is part of the rate-place pitch estimator and that an interspike interval (ISI) sensitive detector is utilised in the temporal pitch estimator. An understanding of the properties of and the blending of both the temporal and spatial mechanisms of pitch perception should account for results from acoustic and electric stimulation. An anomaly however exists when we compare temporal pitch perception for acoustic and electrical stimuli. At low electrical stimulus rates, up to 300-400 pulses/s, pitch percepts are comparable with equivalent sound frequencies, however, at higher electrical stimulus rates pitch percepts plateau. Investigation of single unit interspike intervals at these higher electrical stimulus rates shows clear phase locking that is comparable to that observed for equivalent acoustic stimuli. These data indicate that discrete phase locked responses per sa can not account for temporal pitch coding. In order to address this anomaly, we have modelled the response of auditory neurons to both acoustic and electric stimulation, with models which approximate the behaviour of rate-place detectors, and also ISI decoders. The response of the models are examined for low and high frequency electric and acoustic stimulation. Response parameters and frequency-dependent weightings for model-mixing are fitted to best explain the experimental results. Analysis of the properties of the models improves our understanding of the processes of temporal pitch-perception, which will in turn enable improved speech processing strategies in cochlear implants that will code appropriate temporal pitch information.