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TEMPORAL CODING FOR SOUND AND TEMPORO-SPATIAL PATTERNS OF ELECTRICAL STIMULATION

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The anterior division of the ventral cochlear nucleus (AVCN) is the first relay station of the auditory pathway. It receives auditory information via the auditory nerves emanating from the cochlea.

Electrical stimulation via current cochlear implants, [illegible] does not lead to responses at the cochlear nucleus that exactly match those elicited by comparable auditory stimulation. Complex temporal patterns of electrical stimulation may provide a better simulation of the acoustic input. Currently little is known about the physiological responses to variations of the time intervals between pulses. In this investigation we are examining physiological responses of neurons in the AVCN to electrical stimulation using *in vivo* intracellular electrophysiological recordings. Two stimulus paradigms were investigated to determine the synchrony and the effectiveness in eliciting neural responses: (1) pulse pairs with varying interpulse intervals; and (2) a 50 ms burst of charged balanced biphasic electrical pulses delivered at constant rates with varying amplitudes. Rats were anaesthetised with urethane (1.3g/kg i.p), the crania and dura removed and the cochlear nucleus exposed. A small modified version of the Melbourne/Cochlear scala tympani banded electrode array was inserted in the cochlea after exposure of the round window. Upon neuron impalement, the cochlea was stimulated using biphasic pulses (100μs /phase) up to 2.0 mA in intensity. In our sample of recorded neurons, spike responses were elicited by both stimulus pulses in all cells tested up to 1000 Hz on paradigm one. Testing on the second stimulus paradigm showed that at stimulus rates below 600 Hz neuronal firing occurred on presentation of each pulse during the stimulus train (deterministic firing). At higher rates (600 Hz and above) this deterministic response was no longer seen with neurons responding stochastically. In response to higher stimulus rates, between 600 to 1000 Hz, most neurons responded with progressively smaller action potential amplitudes to pulses along the stimulus train. This drop in action potential amplitude was more prevalent with increasing strength of stimulation. At rates greater than 1200 Hz stimulation, however, neurons responded with a stochastic firing pattern with regularly spaced spikes of similar amplitude at a rate lower than that of the stimulus (200-400 Hz). This firing pattern is similar to that seen in neurons classified as chopper in response to acoustic stimulation. In one identified spherical bushy cell stimulated up to 4000 Hz, this neural chopping behaviour became more prominent with increasing rate. In halve the cells recorded, at rates 400 Hz and greater, baseline resting potential became more negative during the stimulus. This hyperpolarising response persisted up to 60 ms post stimulation. Pulsatile stimulation results suggest that AVCN neurons are able to follow high frequency stimulation for short periods. The long duration pulsatile stimulation results suggest that stimulation above 600 Hz and below 1200 Hz produces a loss in encoding ability. Above 1200 Hz stimulation, the rate encoded, however, is effectively lower. The encoding ability of these neurons may have implications in the clinical application of cochlear implants where new speechprocessing strategies have tended to operate at higher stimulus rates.

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