The Temporal and Entrainment Response Properties of Neurons to Intracochlear Electrical Stimulation

M. Brown¹, S. V. Buden³, A. G. Paolini², G. M. Clark¹,²,³
¹Co-operative Research Centre for Cochlear Implant, Speech and Hearing Research; ²Human Communication Research Centre; ³Department of Otolaryngology University of Melbourne, East Melbourne 3002, Victoria, Australia

Understanding temporal coding in the central auditory pathway following electrical stimulation is important for further development of speech processing strategies and will also lead to a better understanding of temporal coding of acoustic stimuli. The temporal coding of sound frequency is based on the phase or time locked neural response seen to low frequency acoustic stimuli. The ability of neurons to respond in a time locked manner may determine the degree of encoded temporal frequency information. Single unit electrophysiological studies have shown that the degree of response synchrony to charge-balanced biphasic electrical stimuli is far greater than that seen to acoustic stimuli. This study has therefore investigated the temporal and entrainment response properties of single units in the anteroventral cochlear nucleus (AVCN) in the cat to rates of electrical stimulation between 200 and 800 pulses/s. Six adult cats were anaesthetised with pentobarbital sodium (Nembutal; 45 mg/kg) I.P. and maintained with supplemental doses I.V. The AVCN was exposed and the animals were unilaterally implanted with a feline version of the Melbourne/Cochlear scala tympani electrode array. Following acoustic characterisation of 12 isolated primary like units with characteristic frequencies between 0.4 and 20.0 kHz the responses to electrical stimuli at 200, 400, 600 and 800 pps over a 10 to 34 dB (re 1μA) intensity range were recorded. Input-output functions at set intervals throughout the 50ms burst of biphasic stimuli revealed a sharp decrement in response rate from the onset time of each burst over increased stimulus rates. This decrease in the response entrainment was also accompanied by a change in the temporal response synchrony. These data suggest a possible decrease or loss in the coding of temporal information for implant patients receiving high rate electrical stimulation.

Mel Brown
Department of Otolaryngology
University of Melbourne
32 Gisborne St. East Melbourne, 3002 Australia
Phone: 61-3-96659581
Fax: 61-3-96631958
Email: BROWNM@mail.medoto.unimelb.edu.au
Author/s: 
Brown, Mel; Buden, S. V.; Paolini, A. G.; Clark, Graeme M.

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