REPRINTED FROM ANNALS OF OTOLOGY, RHINOLOGY & LARYNGOLOGY, JANUARY-FEBRUARY 1987
Volume 96, Number 1, Part 2 Supplement 128


# NEUROPHYSIOLOGICAL AND PSYCHOPHYSICAL CONSIDERATIONS IN THE DESIGN OF A COCHLEAR PROSTHESIS

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In one model of intracochlear electrical stimulation, an integrated gaussian function defines the probability of fiber discharge versus the stimulus amplitude at the excitation site. The effective stimulus delivered to each excitation site is a function of the type of electrode (ie, monopolar or bipolar) and the distance between the electrode and the excitation site. In this model, the behavioral threshold is reached when a fixed number of discharges are elicited from converging fibers over a time interval of approximately 100 ms. The level of neural membrane noise was estimated by comparing model simulations with measurements of behavioral threshold as a function of the number of stimulus pulses. Estimated noise levels are similar to those determined more directly from unit recordings of electrically stimulated cochleas in the cat. Noise levels are comparatively large, as would be expected with the excitation of small diameter nodes. Node diameters estimated with this model are nearly identical to the diameters of nodes directly measured in cats (ie, nodes peripheral to the ganglion cell bodies). The model indicates that the diameter of initially excited nodes may be a function of the electrode type and the stimulus amplitude.

Internode resistance (ie, intra-axonal resistance between nodes) and the discharge probability versus stimulus amplitude function are strong functions of the diameter of excited nodes. These two factors may be fundamental in determining a wide range of behavior. For example, the spectrum of the stimulus can have a strong effect, or only a small effect, on fiber excitability, depending on internode resistance. Consider another example: if the discharge probability increases rapidly with increments in stimulus amplitude, only a small increase in stimulus amplitude will be necessary to compensate for a reduction in the number of pulses in a stimulus. The slightly higher amplitude of the shorter duration stimulus generates as many discharges as the lower amplitude, longer duration stimulus. In contrast, if the discharge probability only gradually increases with increments in stimulus amplitude, a relatively large increase in stimulus amplitude will be necessary to compensate for a decreased number of stimulus pulses.