THE ORIGIN OF AUDITORY COMPOUND ACTION POTENTIALS INDUCED BY ELECTRICAL STIMULATION OF THE CAT COCHLEA

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Severely hearing-impaired people with residual hearing restricted to low frequencies may benefit from cochlear implantation. This study examined whether residual hair cells could be stimulated, either electrically or mechanically, by a cochlear prosthesis.

Seven cats were anaesthetized for the duration of the experiment with pentobarbitone sodium (induction - 37mg kg^{-1} ip; maintenance averaged at 7.5mg hr^{-1} iv) and implanted with stimulating electrodes on the round window or inside the basal turn of the scala tympani. At the conclusion of the experiment, the animals were killed by an overdose of pentobarbitone sodium, iv, and the cochleas removed for histological examination. The stimulation of hair cells was estimated by the forward masking of the compound action potential (CAP) to acoustic probes by electrical maskers.

The excitation at a specific cochlear location from electrical stimulation was estimated by examining the masking of a probe of fixed frequency by different electrical maskers. CAP tuning curves measured with localized electrical stimulation at the base of the cochlea were similar to those measured with acoustic stimulation and were sharply tuned to stimulus frequencies close to that of the probe. The spatial distribution of the excitation along the length of the cochlea was determined by examining the masking of different probe frequencies by a fixed electrical masker. A peak of masking was observed for probe frequencies close to the frequency of the electrical stimulus and its harmonics. Masking of low frequency probes did not depend upon the presence of functional outer hair cells close to the stimulating electrodes. Acoustic threshold elevation in the basal regions of the cochlea induced by acoustic overstimulation led to a small increase in sensitivity of apical cochlear regions to electrical stimulation at the base, and to a loss of the tip of the tuning curve of a high frequency probe.

The results suggest that electrical stimulation at the base of the cochlea leads to a mechanical travelling wave, possibly generated electrostatically, which may stimulate hair cells which are acoustically tuned to the frequency of electrical stimulation.

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