

ELECTRICAL STIMULATION OF THE AUDITORY NERVE IN DEAF KITTENS: EFFECTS ON COCHLEAR NUCLEI

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Acoustic experience plays an important role in the development of the auditory system. Neonatal sound deprivation will result in significant reduction of both the cell soma area and total volume of the ventral cochlear nuclei (VCN) in adult animals (Webster, 1988). The present study has been undertaken to investigate this phenomenon by examining the effects of electrical stimulation of the auditory nerve of the kitten, on the morphology of the cochlear nucleus in animals deprived of sound following the administration of ototoxic drugs.

Four normal hearing kittens aged from 36 to 41 postnatal days were deafened by co-administration of kanamycin and ethacrynic acid (Xu et al., 1990). At two months of age each animal was bilaterally implanted with bipolar scala tympani electrode arrays. Anaesthesia was induced with saffan (9mg kg⁻¹ i.m.) and maintained with halothane and methoxyflurane. Following a two week recovery period each animal was unilaterally stimulated using charge balanced biphasic current pulses at a rate of 100 pulses per second. Charge densities developed at the electrode surface were in the range 12 to 24 $\mu\text{C cm}^{-2}\text{geom.}$ per phase. Each animal was stimulated for a total period of 1100 - 1600 hours and then killed with an overdose of pentobarbitone sodium (i.m.). The cochleas and the brain were removed for histology. The cochlear nuclei were frozen and serially sectioned at 20 μm in the coronal plane. Sections were stained with toluidine blue. The cross-sectional area of all soma were calculated for cells within the anteroventral (AVCN), posteroventral (PVCN), and dorsal cochlear nuclei (DCN) using a video image analysis system. Only cells with a clearly visible nucleolus and a clear nucleus were measured. A total of 10393 AVCN, 2535 PVCN and 811 DCN cells were measured for this study.

The combined mean soma area and standard deviation for each of the three cochlear nucleus regions is shown in the Table. The mean area of cell soma within the stimulated AVCN was larger than corresponding soma in the same region on the control side. The difference in the mean soma area was highly statistically significant ($p < 0.005$) as determined by Chi-Square and U tests. In contrast, comparison between cells in the stimulated and control PVCN showed no statistically significant difference in soma area. There was also no statistically significant difference in soma area for cells in the DCN.

	Stimulated			Control		
	mean (μm^2)	s.d.	n	mean (μm^2)	s.d.	n
AVCN	155.26	50.77	4933	111.31	39.66	5460
PVCN	183.20	71.69	970	172.20	69.50	1565
DCN	167.57	71.83	445	171.83	62.41	366

The present results indicate that long-term electrical stimulation of the auditory nerve can at least partially negate some of the central effects of a neonatal hearing loss. The fact that no significant difference was observed among DCN neurons is consistent with previous reports that suggest that auditory deprivation effects the development of the DCN far less than the VCN (Anniko et al., 1989). The present findings have encouraging implications for the use of auditory prostheses in young children.

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