2Mp: EFFECTS OF LONG-TERM DEAFNESS AND CHRONIC INTRACOCHLEAR ELECTRICAL STIMULATION ON THE PRIMARY AUDITORY CORTEX

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Chronic intra-cochlear electrical stimulation (ES), like that produced by a cochlear implant, is known to alter spectral and temporal processing in parts of the auditory system. It is also generally accepted that monopolar (MP) stimulation results in broader activation in the cochlea and throughout the auditory pathway than bipolar or common ground (CG) stimulation. The effects of long-term deafness and different modes of chronic ES on the cochleotopic organization of the primary auditory cortex (AI) and on temporal resolution in AI, are less clear. We neonatally deafened seventeen cats, via daily neomycin injections, and a further three animals served as normal-hearing controls. Seven of the deafened animals were implanted at two months of age with a multi-channel scala tympani electrode array. These animals received environmentally derived unilateral MP or CG ES for periods of up to 11 months via a Nucleus® CI24 cochlear implant and Nucleus® ESPrit 3G speech processor. We recorded from single- and multi-unit clusters (n = 812) in AI of all cats as adults, using a combination of single tungsten and multi-channel silicon electrode arrays. We assessed spectral processing in AI by measuring the local tuning (i.e., selectivity for the site of cochlear stimulation) of neuronal clusters, the cochlea-to-cortex mapping, and the spread of cortical activation. We assessed temporal resolution in AI by measuring the jitter in response latency and the maximum rate at which clusters could be driven. In contrast to previous reports, MP stimulation did not resulted in significantly broader local tuning or spread of cortical activation compared to CG stimulation. Long-term deafness had little effect on the basic response properties of AI neurons, but resulted in complete loss of the normal cochlea-to-cortex mapping and an increase in the spread of cortical activation (Three-Way ANOVA; Bonferroni post-hoc; $p < 0.001$). Chronic ES did not affect the increase in the spread of cortical activation, but did reverse the disruption of the cochlea-to-cortex mapping, and resulted in a significant increase in the maximum rate at which units could be driven (Mann-Whitney; $p < 0.05$). We hypothesize that maintenance or re-establishment of a cochleotopically organized AI by electrical activation of the cochlea – as demonstrated in the present study - contributes to the remarkable performance observed among human patients implanted at a young age.

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