Frequency discrimination ability of partially hearing cats with and without cochlear implants

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I. Aims

The use of behavioral animal models in hearing research led to understanding of some fundamental questions regards mammalian hearing which helped the advancement of cochlear implants (CI). As more people with partial hearing loss receive cochlear implants, more questions emerge regarding combined electric and acoustic sound perception. To answer these questions a behavioral animal model is required. The aim of this study was to determine the effects of cochlear implant (CI) on behavioral frequency discrimination ability in partially deafened cats. We hypothesized that additional information provided by the CI would allow subjects to perform better on a frequency discrimination task.

II. Methods

Four cats with high frequency hearing loss (7 kHz cutoff) induced with ototoxic drugs and implanted with CI were used. All cats trained on a go/no-go, positive reinforcement, frequency discrimination task and reached asymptotic performance (measured by d’ - detection theory) before starting the experiment. Throughout 6-9 months of continuous performance measurement, the CI stimulator was turned off 1-2 times for one month. Reference frequencies (1, 4, and 7 kHz) were systematically rotated (Latin Square design) every 9-11 days to cover the hearing range of the cats while avoiding bias arising from the order of testing.

III. Results

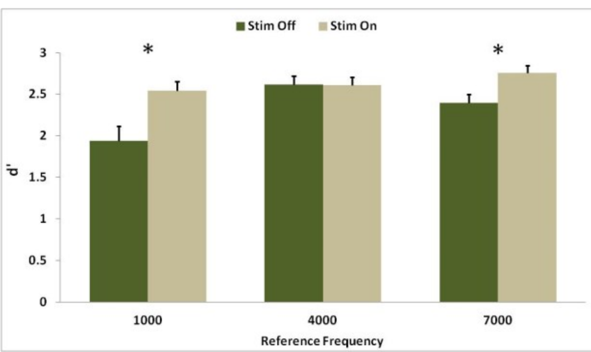

Figure 1 shows significant improvement in behavioral performance for two (1 and 7 kHz) out of three reference frequencies when CI stimulator was turned on. Overall, subjects performed the frequency discrimination task significantly better with a cochlear implant turned on compared to the off condition (3-way ANOVA, $p<0.001$). The analysis also showed no dependence on subject (3-way ANOVA, subject x on-off condition, $p>0.5$) but significant dependence on the reference frequency (3-way ANOVA, reference frequency x on-off condition, $p<0.03$).

IV. Summary

The effects of chronic, behaviorally relevant, intra cochlear electrical stimulation on brain plasticity (cochleotopic organization and temporal processing) are not well studied [1]. This study is systematically showing, for the first time, that cats can use information provided by CI electric stimulation in performing a behavioral frequency discrimination task. Further electrophysiological experiments may reveal how physiological mechanisms such as plastic changes in auditory cortex are used for electric and acoustic combined sound perception.

References [1 J. B. Fallon, et al., "Cochlear implants and brain plasticity," Hear Res, vol. 238, pp. 110-7, Apr 2008.

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