Sensory neural prostheses and brain plasticity

James B. Fallon [1,2], Dexter R. F. Irvine [1], and Robert K. Shepherd [1,2]

1 The Bionic Ear Institute, Australia.
2 Department of Otolaryngology, University of Melbourne, Australia.

Address: 384-388 Albert St, East Melbourne, Vic, 3002.
Email: jfallon@bionicear.org
Phone: +61 3 9929 8397
Fax: +61 3 9667 7518

Introduction: The clinical performance of cochlear implant recipients improves over the post-implantation period, and it is increasingly apparent that the plastic response of the auditory pathway with implant use is an important factor in this improvement.

Methods: We assessed the plastic response of the primary auditory cortex (AI) to neonatal deafening with or without chronic cochlear implant use in seventeen cats. A combination of single tungsten and multi-channel silicon electrode arrays were used to record from 812 multi-unit clusters in AI.

Results: Long-term deafness had little effect on the basic response properties of AI neurons, but resulted in complete loss of the normal cochleotopic organization of AI and a greater spread of cortical activation at supra-threshold levels (Two-Way ANOVA; Bonferroni post-hoc; $p < 0.001$). Chronic implant use resulted in a cochlea-to-cortex mapping that was comparable to that seen in normal hearing controls, but with a greater spread of activation ($p < 0.001$).

Conclusions: We hypothesize that maintenance or re-establishment of a cochleotopically organized AI, resulting from chronic implant use, contributes to the improved clinical performance observed in human patients implanted at a young age. Furthermore, the plastic response of the brain – highlighted in the present study - has consequences for all neural prostheses.

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