Cochlear Implants and Brain Plasticity

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Cochlear implants are designed to provide important auditory cues necessary for auditory awareness and speech perception in severe to profoundly deaf patients. More than 40,000 adults and children worldwide have now received these devices over the past two decades. Although clinical experience has shown large variability among patients, factors predicting successful outcomes reflect the importance of auditory experience, either before an acquired hearing loss or with the use of a cochlear implant. Moreover, deaf children with little or no prior auditory experience can obtain significant benefit from cochlear implants provided their device is fitted at a young age. This clinical experience suggests that such a response can at least be partially attributed to brain plasticity.

The ability to electrically stimulate the deafened auditory nerve in both humans and experimental animals provides a unique opportunity to study the relationship between neural activity and plasticity. This ‘re-afferentation’ of the deafened auditory system via a cochlear implant has led to considerable interest in both basic and clinical research. Our objective in producing this special issue has been to generate a timely review of this work.

Shepherd and Hardie review the pathological and atrophic changes that occur in the cochlea and auditory brainstem following a sensorineural hearing loss in experimental animals. The review then evaluates the trophic effects of re-afferentation following cochlear implantation, be-

fore examining the relevant clinical literature. Illing reviews the activity-dependent plastic response of the adult auditory brainstem following controlled cochlear lesions and the reactivation of this silenced pathway via cochlear implantation in an animal model. This review concentrates on the molecular and cellular events associated with these altered patterns of neural activity. Kral, Hartmann, Tillein, Heid and Klinke review the behavioural deficits in both auditory- and language-deprived children and the response of the primary and higher-order cortical areas following re-afferentation through a cochlear implant. These authors then review the relevant experimental literature together with the likely mechanisms underlying developmental cortical plasticity. Ponton and Eggermont also address the theme of cortical maturation following a profound sensorineural hearing loss and cochlear implant use. The primary goal of this research has been the use of auditory evoked potentials to assess cortical maturation in a clinical setting. The authors compare their clinical results with experimental data from congenitally deaf animals and provide a model of maturation in profoundly deaf children whose auditory pathway is re-activated via a cochlear implant. In our final paper of this special issue, Giraud, Truy and Frackowiak review human cortical plasticity following cochlear implantation using functional brain imaging techniques. This paper describes the imaging techniques currently available for studies in implant patients, reviews cortical plasticity following deaf-

ness, together with the functional re-organization in both auditory regions and cross-modal effects that occur following cochlear implantation.

The origins of this special issue on 'Cochlear Implants and Brain Plasticity' originate in a symposium of the same name held at the 4th European Congress of Otorhinolaryngology, Head and Neck Surgery, in Berlin from May 13 to 18, 2000. We would like to thank Prof. Anthony Gummer who chaired the Basic Research Committee

of the Congress and who, with Prof. Robert Illing, was responsible for organizing the symposium. Special thanks are also extended to Prof. Manfred Hoke, Editor of *Audiology and Neuro-Otology* for his enthusiastic support of this special issue, to the anonymous reviewers of each manuscript and finally to the authors for their efforts in producing this publication.

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