Brain centric approaches to designs and applications of cochlear prostheses

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A new approach to the design of cochlear implants and other sensory prostheses is described, in which the brain is regarded as a key (and variable) part of the overall system. In particular, the approach asks what the usually-compromised brain needs as an input in order to perform optimally, as opposed to the traditional approach of replicating insofar as possible the normal patterns of neural activity at the periphery. The traditional approach probably is perfectly appropriate for patients with a fully-intact brain, i.e., an ever-closer approximation to the normal patterns at the periphery is likely to provide the inputs the brain "expects" and is configured to receive and process. For patients with a brain compromised by years of auditory deprivation or a myriad of other causes, however, such inputs may not be optimal and indeed the compromised brain may not be able to "handle" or keep up with the complexity and rates of the inputs. Fundamentally different patterns of stimulation and responses at the periphery, e.g., far slower or far sparser or both, may be better. Patterns tailored to each brain's capabilities may allow the brain to gain a "foothold" in processing the (appropriately modified) inputs, which in turn may engage mechanisms of brain plasticity and thereby allow a growth in capabilities toward normal capabilities. If so, the patient might attain progressively higher levels of performance over time and might require periodic adjustments in the patterns of stimulation and responses at the periphery to provide optimal matches between the patterns and brain capabilities at all times, as the brain "reconfigures itself" through plastic changes. Ultimately, the patterns and the performance of the device may approach those for patients with fully intact brains from the outset, especially if the desired plastic changes in brain function and organization can be facilitated through (1) well-timed adjustments in the patterns of stimulation; (2) directed training to discriminate stimuli at the border of each patient's abilities at any given time; (3) drug treatments; or (4) some combination of these interventions. The previously mentioned foothold may be the essential first step toward high benefit from a sensory prosthesis for patients with initially compromised brains.