Sensory prosthetics - clinical and scientific utility of a vestibular implant

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Objective:
To determine if a vestibular prosthesis could improve function in subjects with severe vestibular damage and could be used it as a scientific tool to investigate central vestibular processing.

Background: Damage to the vestibular labyrinth is common and usually permanent. We therefore developed and tested a vestibular implant (VI) that is designed to mimic the information normally provided by the vestibular labyrinth to see if we can reduce vestibular-mediated deficits and to study temporal integration of sensory cues in the brain.

Design/Methods: Monkeys had electrodes implanted in the semicircular canals of one ear and then severe bilateral vestibular damage was induced with aminoglycosides. Eye movements, perception, and balance were tested before and after vestibular damage and with the VI activated, which supplied head motion information to the brain via electrical stimulation delivered by the implanted electrodes. Humans also had electrode implantation (done in conjunction with a cochlear implant, CI) and they were tested on a temporal binding psychophysical task
Results: Stimulation provided by VI in vestibulopathic monkeys improved their balance, perception of spatial orientation, and eye movement responses. Timing experiments in humans using CI and VI stimuli showed that unlike past experiments that used motion to generate the vestibular signal, CI and VI signals were received by the cerebral cortex with the same latency and were perceived as simultaneous, but this timing perception was highly sensitive to adaption.
Conclusions: VI improves oculomotor, postural, and perceptual behavior in vestibulopathic monkeys and could prove to be an effective way to improve these

functions in patients with permanent labyrinthine damage. Timing experiments show that when novel stimuli are used, the brain synthesizes them in accordance with their arrival at the cortex, but that experience can rapidly recalibrate this timing relationship, which may be why normal stimuli that are experienced habitually lack this characteristic.

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