Channel independence in Children with Cochlear Implants

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Multi-channel cochlear implantation offers hearing rehabilitation to otherwise deaf patients. The resolution of sound perception in these patients can be limited by technical factors of the implant, the auditory nerve response, and central auditory processing. Our goal is to define how objective measures of electrode interaction at the auditory nerve level relate to the perception of channel independence in congenitally deaf children with cochlear implants. We first sought to define how stimulus intensity and electrode position effect the interaction among electrodes at the level of the auditory nerve. We defined electrode interaction as the degree of overlap among auditory nerve fibers stimulated by the implant's individual electrodes. Electrode interaction is measured using the electrically-evoked compound action potential in awake implanted subjects. We found generally that electrode interaction increased with increasing stimulus intensity and apical electrode position. We then sought to define how stimulus intensity and electrode position effect the perception of electrode discrimination. Electrode discrimination is measured as a difference limen (DL) of inter-electrode distance. DLs are determined using an adaptive two-interval forced-choice psychophysical task presented on an animated, interactive videogame platform. Stimulus intensity and probe electrode position were varied between runs. Among the subjects, DLs showed considerable variability (range 0.34 – 8.55 mm). Older subjects tended to have lower DLs (rho = -0.34, $p < 0.01$). Probe location did not covary with DL. Pairwise comparison, however, demonstrated improved electrode discrimination with higher versus lower stimulus intensity (mean improvement 0.62 mm +/- 0.21 S.E.M, n = 55). These results suggest that electrode interaction alone is insufficient to predict electrode discrimination and imply that cues other than the degree of overlap in stimulated auditory nerve fiber populations are used to perceive different channels among electrodes.