Title: Peripheral versus central age-related temporal processing deficits: Insights from cochlear-implant users

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A long-standing problem in understanding the loci of age-related temporal processing deficits in humans is attempting to distinguish between peripheral and central explanations. Even in the absence of significant age-related hearing loss, peripheral encoding factors still persist, stalling forward progress in understanding this problem. However, there is an ever growing population of human listeners who can uniquely contribute insight in this realm: cochlear-implant (CI) users. A CI can partially restore hearing and speech understanding to high levels, bypassing the non-functional aspects of peripheral encoding by directly stimulating the remaining spiral ganglion cells and auditory nerve. Therefore, we sought to use a human CI model to better understand peripheral vs central contributions to auditory aging.

We bypassed CI users' sound processors by providing direct stimulation to single electrodes; specific parameters were controlled by a personal computer. Over 30 CI listeners had a wide range of ages from 20-84 yrs and a wide range of hearing histories. Two temporal processing tasks were performed: gap detection and amplitude-modulation (AM) detection. Although most of the peripheral encoding structures are bypassed with a CI, the final remaining peripheral component, the survival of spiral ganglion cells, was estimated by measuring electrically evoked compound action potential (ECAP) amplitude growth functions. Steeper ECAP slopes are indicative of better peripheral neural survival. Data were analyzed in a mixed-effects model with stimulus- and subject-related factors.

For gap detection, ECAP slope was the strongest predictor of performance, with steeper ECAPs predicting better gap detection thresholds. ECAP slopes also decreased with increasing age. For AM detection, advancing age was the strongest predictor of performance. ECAP slopes declined with age but did not significantly contribute to AM detection ability.

Because ECAP slope (our peripheral encoding measure) was correlated with age in both experiments, one interpretation of the data is that the results appear to be limited for interpreting the independent contributions of peripheral vs. central mechanisms on age-related temporal processing deficits. Another interpretation is that one cannot rule out a substantial role of peripheral encoding despite testing CI users and using psychophysical tasks that are typically thought of as "central" measures of processing in the field of hearing and aging. We will conclude by discussing future approaches to better dissociate age from peripheral encoding, which should help us better understand peripheral vs central contributions to auditory aging using this novel population.

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