Visual and somatosensory cross-modal reorganization in children with cochlear implants

Theresa Hennesy[a], Garrett Cardon[b], Julia Campbell[c], Hannah Glick[d], Don Bell-Souder[d], and Anu Sharma[d]*

[a]*University of Colorado School of Medicine, Aurora, CO 80045, USA*
[b]*Communication Disorders Department, Brigham Young University, Provo, UT 84604, USA*
[c]*Department of Speech Language and Hearing Sciences, University of Texas at Austin, Austin, TX 78712, USA*
[d]*Department of Speech Language and Hearing Sciences, University of Colorado, Boulder, CO 80305, USA*

Background

- **Cross-modal reorganization** occurs when a deprived sensory modality's cortical resources are recruited by other intact modalities.
- Cross-modal reorganization has been proposed as a **source of variability** underlying **speech perception in hearing-impaired cochlear implant (CI) users** [1,2]
- Visual and somatosensory cross-modal reorganization of auditory cortex has been documented separately in children with CIs [3,4], but **reorganization in these modalities has not been documented within the same subject group**

Aim of the study

- To examine cross-modal reorganization across **visual and somatosensory modalities** within a single group of CI children (n=10) using high-density electroencephalography

Methods

- Analyzed **evoked potentials** in response to visual and somatosensory stimuli [5,6]
- Performed **current density reconstruction (CDR)** of brain activity sources [7-11]
- Performed **speech perception-in-noise** testing [12,13]
- CDR patterns were analyzed within the entire subject group and **across groups of CI children exhibiting good vs. poor speech perception** [13]

Results: Waveform analysis

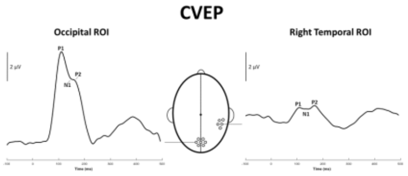


Figure 1. CVEP grand average waveforms in the occipital and R temporal ROIs in children with CIs (n=10). Each waveform shows all CVEP waveform components of interest including P1, N1, and P2

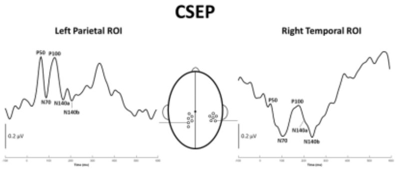
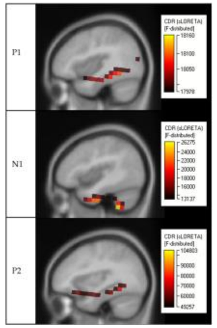
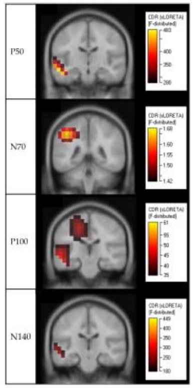


Figure 2. CSEP grand average waveforms in L parietal and R temporal ROIs in children with CIs (n=10). Each waveform shows all CSEP waveform components of interest including P50, N70, P100, N140a, and N140b

Results: Current density reconstruction





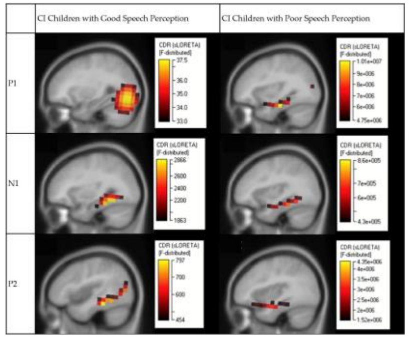


Figure 3 (upper left): CDR images illustrating cortical activation underlying CVEP peak components P1, N1, and P2 on sagittal MRI slices in children with CIs (n=10)

Figure 4 (upper right): CDR images illustrating cortical activation underlying CSEP peak components P50, N70, P100, and N140 on coronal MRI slices in children with CIs (n=10)

Figure 5 (right): CDR images illustrating cortical activation underlying CVEP peak components P1, N1, and P2 on sagittal MRI slices in CI children with good speech perception (left panel; n=5, mean BKB-SIN score 3.9 dB SNR, mean age 10.7) and poor speech perception (right panel; n=8, mean BKB-SIN score 11.3 dB SNR, mean age 10.5)

Results: Waveform latency and amplitude analysis

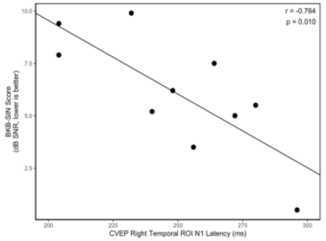


Figure 6. Scatter plot illustrating the correlation between BKB-SIN score and CVEP N1 latency in the right temporal ROI in children with CIs (n=10)

Results: Waveform latency and amplitude analysis (cont.)

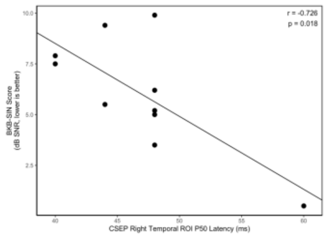


Figure 7. Scatter plot illustrating the correlation between BKB-SIN score and CSEP P50 latency in the right temporal ROI in children with CIs (n=10)

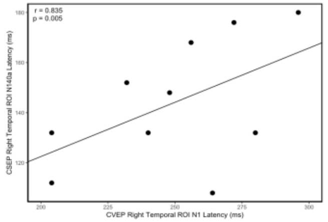


Figure 8. Scatter plot illustrating the correlation between CSEP 140a latency and CVEP N1 latency in the right temporal ROI in children with CIs (n=10)

Discussion

- **Cross-modal reorganization of auditory cortex** by visual and sensory modalities
- **Positive correlation between visual and somatosensory cross-modal reorganization,** suggesting that neuroplasticity in different sensory systems **may be interrelated**
- CI children with **good speech perception did not show recruitment** of frontal or auditory cortices during visual processing, while subjects with poor speech perception did
- Findings reflect **widespread changes** in cortical networks in CI children that **may relate to functional performance**

References

Disclosure: The authors declare no conflicts of interest.
Funding: This project was funded by National Institutes of Health grants R0113010945, R01DC006257, T32DC012280, F31DC011970, F31DC013218