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

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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 \cite{1,2}.
- Visual and somatosensory cross-modal reorganization of auditory cortex has been documented separately in children with CIs \cite{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 \cite{5,6}.
- Performed current density reconstruction (CDR) of brain activity sources \cite{7-11}.
- Performed speech perception-in-noise testing \cite{12,13}.
- CDR patterns were analyzed within the entire subject group and across groups of CI children exhibiting good vs. poor speech perception \cite{13}.

Results: Waveform analysis

- Results: Current density reconstruction

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Results: Waveform analysis (cont.)

- Results: Waveform latency and amplitude analysis

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

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.

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 CVEP peak components P1, N1, and P2 on sagittal MRI slices in children with CIs (n=10).

Figure 5 (upper): 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=5, mean BKB-SIN score 11.3 dB SNR, mean age 10.5).

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).

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).

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