Background

• Cross-modal reorganization (CMR) 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.
• 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 both 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].

Subject Demographic Characteristics

<table>
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<tr>
<th>Subject</th>
<th>Age (Years)</th>
<th>Age at first CI (Years)</th>
<th>Age at second CI (Years)</th>
<th>First CI Ear</th>
<th>Duration of first CI experience (Years)</th>
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</table>

1 Subjects had progressive hearing losses associated with diagnoses of enlarged vestibular aqueduct syndrome (EVAS). 2 Subject had hearing aid contraindicated for cochlear implant.

Results: Current Density Reconstruction

Evidence of Visual Cross-Modal Reorganization

Children with CIs demonstrate activation of temporal cortical regions in response to visual stimulus, compared to normal hearing (NH) children who demonstrate activation of occipital regions. This is suggestive of cross-modal reorganization by vision.

Evidence of Somatosensory Cross-Modal Reorganization

Children with CIs demonstrate activation of auditory temporal cortical regions in response to a somatosensory stimulus, compared to NH children who demonstrate activation of parietal regions. This is suggestive of cross-modal reorganization by the somatosensory modality.

Evidence of Increased Cross-Modal Reorganization in CI Children with Poor Speech Perception

Children with CIs who had difficulty processing speech in noise with their implants (higher BKB-SIN score) showed more evidence of cross modal recruitment by somatosensory (earlier CSEP latencies) consistent with previous studies [4].

Results: Relationship Between Visual and Somatosensory Cross-Modal Reorganization

Children with CIs who showed greater visual cross-modal reorganization (as evidenced by earlier CVEP latencies) also showed greater somatosensory cross-modal reorganization (as evidenced by earlier CSEP latencies).

Discussion

• Cross-modal reorganization of auditory cortex by visual and sensory modalities is evident in children with CIs and is negatively associated with speech perception using the cochlear implant.
• Positive correlation between visual and somatosensory cross-modal reorganization suggests that the neuropasticity 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, suggesting that cross-modal recruitment may explain some underlying variability in speech perception outcomes.
• Findings reflect widespread changes in cortical networks in CI children that may impact functional outcomes.

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References

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