Here, we examine electrophysiological (ERP) changes due to auditory-visual sensory substitution training. Previous brain-imaging studies have suggested that auditory-visual sensory substitution training can lead to increased activation in visual processing areas in response to auditory stimulus. It is currently unknown, however, when in the sensory process activation of visual areas occurs. Here, we examine electrophysiological (ERP) changes due to auditory-visual sensory substitution training.

Essentially, our goals were to examine how learning to ‘hear shapes’ changes the way the brain processes sensory information, and when in the time-course of stimulus processing these changes occur.

### Methods

- **Triad Task**:
  - Each subject followed by 5 images, one of which matched the sound (feedback provided). 20% of stimuli were novel.
  - Subjects indicated “match” or “mismatch” (feedback provided). 20% of stimuli were novel.

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- **Behavioral Results**
  - Cross-modal accuracy (number of correctly identified sound-image matches and mismatches) during EEG post-training was above chance for both groups, significantly enhanced for the Meijer group (p < .05).
  - Correlation between cross-modal accuracy and N1 amplitude, indicating that the better their performance, the higher the amplitude of the visual N1.

- **ERPs**:
  - The P2 modulation was greater (p < .05) in the Meijer vs. Control group.
  - An N2 amplitude difference pre vs. post-training was only evident in the Meijer group (p < .05).

- **Conclusions**
  - Post vs. pre-training auditory P2 and P3 amplitude modulations were present for both groups suggesting that these ERP changes likely reflect general auditory perceptual learning. The amplitude differences were larger for the Meijer group, which may correspond to the enhanced learning made possible by training with the Meijer algorithm (as opposed to random pairings).
  - A post vs. pre-training auditory N2 amplitude effect (270-310ms) was observed only for the Meijer group. The presence of this ERP change in the Meijer group along with the absence of a corresponding change in the control group suggests that this neural modulation may specifically reflect sensory substitution. Considering that the auditory stimuli were 500ms in duration, this effect is quite early (occurring prior to stimulus completion).
  - Visual N1 amplitude (110-180ms) increased for both groups post vs. pre-training, but this increase was larger for the Meijer compared to the control group. This change in neural response may correspond to an enhancement of early LOC activity due to cross-modal learning.
  - Overall, these findings suggest that sensory substitution training via the Meijer algorithm enhances the changes in electrophysiological activity that come about through cross-modal learning, and suggest a possible neural correlate (auditory N2) of auditory-visual sensory substitution that occurs very early in time.

### Future Research

- How long does Meijer training last; does extended training further enhance these ERP effects?
- Are visual cortical responses to auditory stimuli (post-training) automatic or do they require attention?
- If ERPs were recorded for novel stimuli, how would the current pattern of results change?
- Are the ERP effects observed here mediated by mental imagery or direct cross-modal processing?