Abstract

This investigation seeks to understand the differences in activation between deaf individual TRR and hearing controls using a passive reading task performed in an fMRI scanner. TRR exhibits a pattern of brain activity in response to written word forms that is different from hearing individuals and from other deaf individuals that have been studied. These differences seem to be due to neuroplasticity, where brain areas that typically respond to one kind of input to begin to respond to other types of stimulation if they are denied the input for which they are specialized. TRR shows activation in primary auditory cortex in response to visual word form stimuli greater than control participants studied; data analysis for matched controls is currently in progress.

Background

Previous work has revealed that neural plasticity can allow brain areas that typically respond to one kind of input to begin to respond to other types of stimulation if they are denied the input for which they are specialized. For example, one previous study showed that for deaf individuals, auditory regions are activated in response to basic, non-linguistic visual stimuli (Finney et al., 2001). In past functional imaging studies of reading in the deaf, areas activated in highly proficient deaf readers in response to written word forms were reported as being consistent with those activated in hearing readers (Corina et al., 2013). Corina et al. did not report activation in auditory areas to a greater extent in deaf individuals than in hearing individuals. For hearing individuals, learning to read requires learning to map auditory units
(speech sounds) to visual units (letters). However, profoundly congenitally deaf individuals do not have access to phonological knowledge; if they are using a different strategy for reading, a different pattern of activation should be observed when they perform reading tasks.

Figure 1: from Finney et al.

![Figure 1: Visual stimuli activate auditory cortex in the deaf. Shown is an anatomical scan averaged across all deaf and hearing subjects. Auditory regions of interest (ROIs, green regions) and voxels activating differentially in deaf versus hearing subjects in response to the visual motion stimulus (colors defined in scale bar) are shown on axial (left), coronal (middle) and sagittal (right) sections of an averaged anatomical brain, transformed into the standard stereotactic space of Talairach and Tournoux.](image)

Methods

Data from TRR is compared to data from eight controls matched to TRR for age and education. TRR is 48 years, highly educated (PhD), and right-handed. He is profoundly and congenitally deaf. The group of controls included men and three women, all right-handed with an average age of 46.7 years. The experiment was carried out in Phillips 3T fMRI Scanner. In a block-design passive viewing task, participants look at checkerboards and strings of consonants and read words in the scanner. Pre-processing corrections included those for slice scan-time, 3D motion in the scanner, and high-pass temporal filtering. The functional data were co-registered and aligned with an anatomical scan, then transformed into Talairach space. Three dimensional motion correction was applied, and a general linear model was created for comparing activation for all other events against the activation for checkerboard baseline.
Results

Preliminary analysis of TRR’s functional data showed activation in auditory cortex and seventeen other areas at a bonferroni-corrected p-value less than .05 and a 400 voxel cluster size threshold for activation of words – checkerboards. This A1 cluster was also seen in the words – consonant strings contrast, a more stringent comparison. The comparison to 47 unmatched control subjects using IPPC program (Purcell & Rapp, 2013), a type of meta-analysis, suggests activation in this area for the words – checkerboards contrast is unique to TRR relative to hearing controls (p < .05), though this was not confirmed in the more stringent words – consonant strings contrast. Data analysis for eight control participants matched to TRR in age, education level, and handedness is currently in progress.
Figure 3: Location of TRR’s left primary auditory peak (-48, -40, 16)

Figure 4: Location of closest control group peak (-58, -14, -2)
Discussion

Activation in auditory cortex is novel and robust in TRR in these preliminary analyses, and I hope to confirm this finding in the analysis of the control data. Corina et al. reported clusters of activation characteristic of groups of proficient and less-proficient readers and posit two different strategies used by deaf readers. Proficient readers use similar strategies to hearing English readers while less proficient readers use strategies like those employed by logographic script readers. Of his 17 active areas in response to words, TRR shows activation in 3 of the areas reported for proficient readers in Corina et al. and 2 areas reported for less-proficient readers. These discrepancies combined with the activation in auditory cortex not seen in the deaf readers in Cortina et al. suggest that TRR has recruited different brain areas through neuroplasticity for reading and is probably using an alternative strategy. It is also possible in the Cortina et al. study they did not have sufficient power to detect this activity.

References


