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Hearing with the minds eye

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Introduction:

While plasticity within single sensory modalities has been well described in both humans and non-human primates1,2, the neural underpinnings of cross-modal plasticity remain unclear. One possibility is the unveiling of existing but unused connections or less likely the formation of new connections via axonal sprouting. Auditory experiments in visually deprived animals2 and studies in blind human subjects have provided evidence that auditory responses can be found in formerly visually responsive areas3. Is this the consequence of developmental plasticity in congenitally or early blind subjects, or the result of sprouting of new connections after many years of neural plasticity, or the unmasking of connections that we all possess but are functionally inhibited by visual input? In order to answer this line of inquiry we are examining the effects of prolonged blindfolding of normal subjects on the cortical activity during auditory stimulation.

Methods:

So far, four out of eight volunteers were subjected to blindfolding for a total of 4 days and the four others served as controls undergoing the same protocol otherwise. All volunteers underwent a set of behavioral experiments and 3 functional MR imaging sessions: before, during and after 4 days of blindfolding. Non-blindfolded control subjects were blindfolded temporarily at all three time points for the MRI experiment. MR Imaging was performed on a whole body 1.5 T Siemens Vision EPI system. A 3-D T1-weighted MR sequence (1.0x1.0x1.0mm) was acquired for co-localization with functional images. A set of 18 functional MR images (2.5x2.5x4mm) parallel to the ACPC plane were acquired every 5 seconds for a total of 40 seconds/epoch. Volunteers performed three tasks (a tone matching task, a phoneme matching task, and a motor control task) in counterbalanced order. Each task was repeated 8 times. The matching task consisted of a series of tones or phonemes and subjects had to compare each tone or phoneme with the previous one, stating whether it was the same or different using a button press. In the motor control task,subjects were instructed to alternate button presses between the two responses. Image analysis was done using the AFNI software package (v2.2). All images were spatially standardized into the Talairach space. A 2-factorial 3D ANOVA analysis was performed on each of the two groups, i.e. blind-folded and control group, with the first factor being "condition" (phoneme, tone, rest) and the second factor being "scan" (before, during, after blindfolding). The F-tests and planned contrasts were corrected for multiple comparisons.

Results:

The blindfolded subjects differed significantly ($p< 0.01$-8) from the non-blindfolded controls in showing a mesial occipital lobe activation and in showing a pronounced posterior extension of the superior temporal lobe activation possibly extending into polymodal association cortex (see Fig.). The temporo-occipital activation in the blindfolded group was more strongly lateralized to the right compared to the non-blindfolded group.

Discussion:

These preliminary data suggest that short term blindfolding can lead to plastic changes in neural structures both within and across modalities. These temporary activity changes suggest that the underlying mechanism is an unveiling of previous cross-modal connections.

References:

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3. Sadato N, Pascual-Leone A, Grafman J, Ibanez V, Deiber MP, Dold G, Hallett M. Activation of primary visual cortex by Braille reading in blind subjects. Nature 1996;380:526-528.

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