Visual cortex reorganization among early and late blind for tactile object recognition

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Introduction: Adaptive changes in brain between early and late blind subjects have been observed for Braille reading and tactile perception [1]. There have been contradictory reports of the issue of plasticity among early and late blind subjects, with crossmodal plasticity suggested during visual development [1-3]. In this study, we have investigated the differences between early and late blind subjects with tactile object recognition task using BOLD imaging.

Methodology: We recruited six early and six late blind subjects from R.P. Centre for Ophthalmic Sciences of our institute, after obtaining informed consent. We also recruited six healthy controls from student population of the institute. The early blind (EB) subjects had lost vision within few months after birth. Late blind (LB) subjects had vision in the first 4-5 years of their life and have been deficient in vision for a minimum of 5 years. Paradigm design for BOLD studies was to manually explore the three dimensional shape and size for object recognition and approximately 18 objects of regular shapes and common life objects (vegetables, fruits, etc). All the subjects were right handed. The study was carried out using 1.5 T MR scanner (Avanto, Siemens Medical Systems, Erlangen, Germany). BOLD images were acquired using single-shot gradient-echo EPI with the following scan parameters: TR 4520 ms, TE 44 ms, FOV 230mm, matrix size 128x128, echo spacing time 0.78 ms, and axial-plane slice thickness 4 mm.

Data Processing and Statistical Analysis: Statistical Parameter Mapping (SPM2) package was used to analyze functional imaging data. Images were smoothed spatially (r = 6 mm). Individual Z maps for each of the contrasts of interest were transformed into the standard Talairach and Tournoux atlas coordinate system. Group analyses were done using one way ANOVA test. Significant response was defined by a cluster threshold of 10 ($P < 0.005$, uncorrected).

Results and Discussion: A total of 6 sighted controls (age 10-28 years), 6 early blind (age 10-24 years) and 6 late blind (20-35years) subjects were considered for group analysis with acceptable limits for motion parameters ($\leq \pm 1.5$mm, $\leq \pm$ 1º). In controls, activation to tactile object recognition was predominantly observed in middle occipital gyrus, temporal fusiform gyrus, frontal precentral gyrus and cerebellum, as compared to early blind, in whom, superior temporal gyrus, middle frontal gyrus, cingulated gyrus, post central gyrus and inferior parietal lobule were the major activation regions. In late blind, parietal precumeus, superior frontal gyrus, anterior cingulate and middle temporal areas showed major activation in comparison with controls. In Controls, occipital, fusiform and temporal gyri were more significant in comparison to late blind subjects.

The level of activation observed in occipital lobe is found to decrease with the loss of vision (Fig.1 A and D). In addition, different neuronal centers are activated in late and early blind subjects. The late blind predominantly recruit precuneus shown earlier to be involved in mental imagery task [4] suggesting that precuneus is taken up as an additional alternative to occipital area. They also invoke more activation in superior frontal gyrus implicated in spatial cognition [5]. In EB subjects, inferior parietal gyrus is significantly more activated than control, and could be attributed to mental imagery involving 3-dimensional shapes [6].

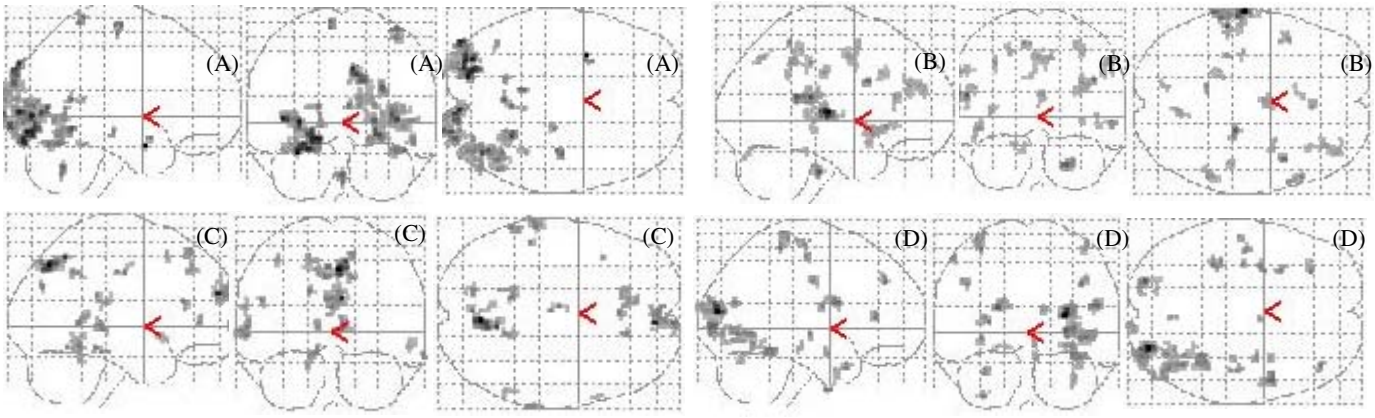

Figure 1: Activation pattern in glass brain map of one way ANOVA analysis ($p<0.005$, uncorrected) for (A) Control-EB (B) EB-Control (C) LB-Control and (D)Control-LB

References

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