Plasticity in congenitally blind during object recognition

A. M. SINHA[1], S. S. KUMARAN[2], AND R. SAXENA[3]

[1]DEPARTMENT OF BIOTECHNOLOGY, ALL INDIA INSTITUTE OF MEDICAL SCIENCES, NEW DELHI, INDIA, [2]DEPARTMENT OF N.M.R., ALL INDIA INSTITUTE OF MEDICAL SCIENCES, NEW DELHI, INDIA, [3]DR. R. P. CENTRE FOR OPHTHALMIC SCIENCES, ALL INDIA INSTITUTE OF MEDICAL SCIENCES, NEW DELHI, INDIA

INTRODUCTION

Neurocognitive changes has been observed in congenitally blind subjects associated with object recognition (1) and Braille reading (2). However, there are varying reports with respect to the issue of brain plasticity, probably due to small sample size. To gain an understanding of the perception of routine visual imagery, the present study investigates the neuronal centers associated with perception of object(s) in congenitally blind subjects using BOLD technique.

METHODOLOGY

Twenty two sighted controls and thirty congenitally blind were recruited for the study. Paradigm design for BOLD studies was to manually explore a three-dimensional object (Perspex) so as to infer its shape and size similar to that employed in a study on blindfolded sighted subjects (1). All the subjects recruited 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 4020 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 (isotropic Gaussian filter, 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 analysis was done using one way ANOVA test. Significant response was defined by a cluster threshold of 10 ($P < 0.001$, uncorrected).

RESULTS

A total of 17 sighted controls (Age 10-28 years) and 13 early onset blind subjects (Age 10-24 years) were considered for group analysis with acceptable limits for motion parameters ($<\pm 1.5$mm , $\pm$1degree). Significant bilateral activation in middle occipital gyrus was seen only in controls, in addition to bilateral activation in superior parietal lobule. In the congenitally blind group, exclusive activation was observed in anterior and posterior cingulate areas of the limbic lobe and somatosensory area.

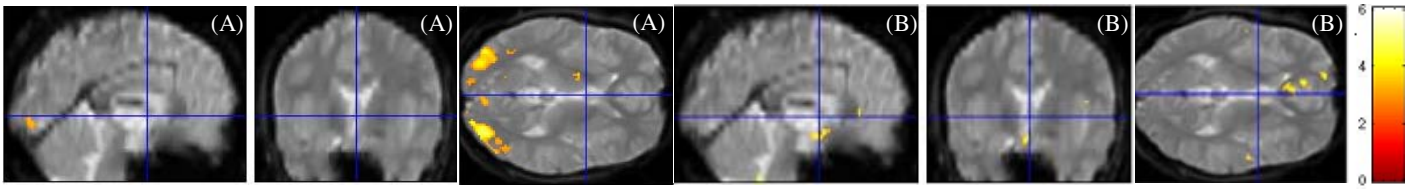

Figure 1: Activation overlaid on anatomical images map of one way ANOVA analysis ($p<0.001$,uncorrected) for (A) Control-Subject and (B) Subject-Control.

Table 1. Significantly activated regions for one way ANOVA test ($p<0.001$,uncorrected).

Controls-Subject				Subject-Control			
Cluster volume	Z value	(x,y,z) coordinates	Region	Cluster volume	Z value	(x,y,z) coordinates	Region
1701	5.67	12,-100,16	Right Middle Occipital Gyrus (BA 18)	230	4.64	-22,-52,14	Left Posterior Cingulate (BA 30)
1541	5.03	-28,–88,-16	Left Middle Occipital Gyrus (BA 18)	205	4.50	-10,42,6	Left Anterior Cingulate (BA 32)
76	4.15	26,-80,36	Right Parietal Precuneus (BA 19)	25	3.96	-58,-40,10	Left Superior Temporal Gyrus (BA 22)
81	4.41	30,–66,46	Right Superior Parietal Lobule (BA7)	39	4.07	-62,–24,44	Left Parietal Postcentral Gyrus (BA1)
32	3.79	-24,-62,38	Left Precuneus Parietal Lobule (BA7)	37	3.70	36,-32,62	Right Parietal Postcentral Gyrus (BA3)

DISCUSSION

In controls, visual imagery task activates bilateral activation of middle occipital gyrus (3) (BA 18) which is not invoked in congenitally blind group. Further, precuneus which is involved in conscious visual imagery memory recall is activated in controls only (4). The posterior cingulate gyrus (BA 30) which has been ascribed to spatial orientation and memory by ablation studies (5) is used exclusively in the congenital blind group. This group also showed significant activity of middle and superior temporal gyrus (BA 21 and 22) which has been recently attributed to spatial perception in TMS study (6). Hence, our study suggests that middle occipital gyrus is not invoked for the object recognition tasks in congenitally blind subjects and their perception can be ascribed to involvement of cingulate and temporal areas.

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