MODULATION OF THE BRAIN ACTIVITIES DURING 3D OBJECT PERCEPTION FROM 2D OPTIC FLOW

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Introduction

Two dimensional optic flow is a strong cue to reconstruct the shape of the 3D object in motion. Recent studies revealed the involvement of the parieto-occipital junction (POJ), the intra-parietal (IP), and the ventral posterior inferior-temporal (pIT) areas as well as the motion sensitive area MT in the perception of 3D structure from 2D motion of random-dots (3D-SFM) [1]. In this study, we parametrically controlled the coherence of the random-dot motion to elucidate the changes of the brain activities in these regions between different 3D percepts.

Methods

Eight normal right-handed healthy subjects (22-43 years) were participated in the study. The visual stimuli consisted of 1000 random dots. The coherence of the motion was controlled from 0 to 100 %. A stimulus that is fully (100 %) coherent had all the dots moving as if they belonged to a rotating spherical surface with a radius of 10 degree in visual angle which generates robust percepts of a rotating sphere. The other conditions, the 80, 60, 40, 20, and 0 % coherence conditions, contain dots having the same speed as the fully coherent stimuli but the directions of the 20, 40, 60, 80, and 100 % of the dots were randomized, respectively.

The fMRI scanning was conducted using a 3 Tesla MR scanner. For functional imaging, the single shot echo-planer imaging sequence was used with the imaging parameters TR 3000 ms, TE 40 ms, FA 90 deg, 40 axial slices, 3 mm thickness, 64x64 matrix, and FOV 220 mm, which covered the entire brain. Three 14-min functional scans were divided into 12 s phases, randomly alternating between different stimulus conditions and resting periods. Within each phase, motion stimuli were presented every 4 s.

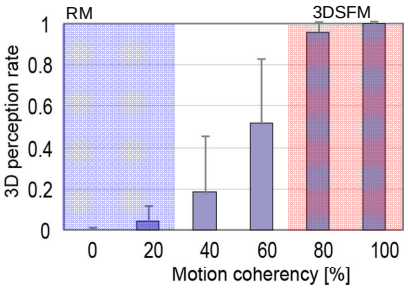

Fig. 1 Subjects' behavioral performance during fMRI experiments

Results

Subjects' response collected during the fMRI sessions showed that the perception of 3-D structure was dominant in the 80 and 100 % conditions whereas 3-D object was rarely perceived in the 0 and 20 % conditions (Fig. 1). Figure 2 shows the results of the fMRI group statistics, in which fMRI contrasts between the 3-D perception condition (100 and 80 % coherent conditions) vs. the random motion condition (0 and 20 % coherent conditions) were depicted. Significant increases of BOLD signal were observed in the MT, POJ, IP, and pIT regions in the 3-D perception condition.

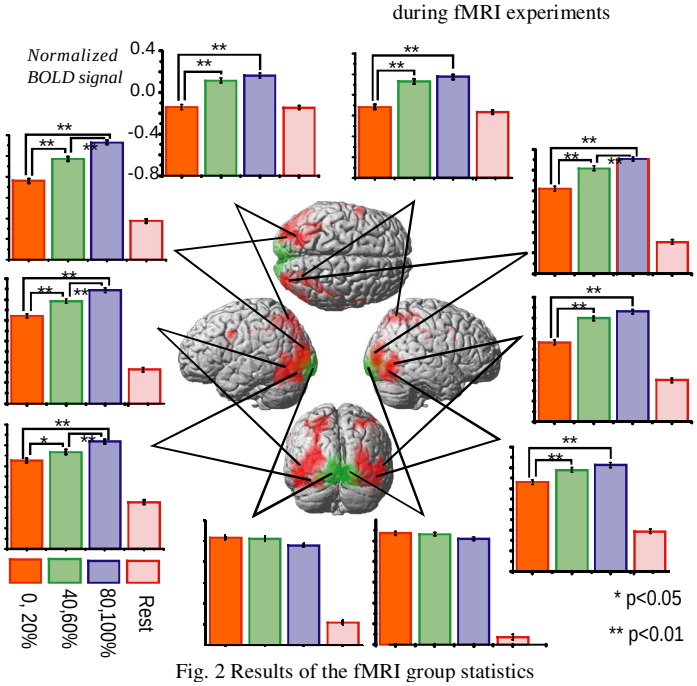

Fig. 2 Results of the fMRI group statistics

Discussion

The change in the activation in the MT area in conjunction with the perception of global motion is also reported in the previous fMRI studies [2], and the IP area was reported to be activated during the mental imagery processing [3], which suggests that the perception of moving 3-D object from 2-D motion includes both perception of global motion and 3-D mental image processing, that are accomplished by the cooperative activation in the ventral and dorsal visual pathways. The decreased activities in V1 possibly reflect the activation of V1 neurons with a wider range of motion selectivities and smaller receptive fields compared to neurons in extra-striate regions [4].

References

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