

An fMRI Study of Self and Other Perspectives in the Observation and Imagination of Actions.

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Introduction

It has been suggested that the brain uses shared representations to make sense of actions performed by self, observed being performed by others, or simply imagined. This idea is strengthened by evidence of neural overlap between such tasks, notably in SMA, premotor cortex, and superior parietal lobe (Grezes et al. 2001). This being said, self-performed actions are clearly distinguished from those generated by others. How might such a distinction be made, while a common representation for the action is held, without any consequent confusion between self and other? There is evidence that the parietal cortex has a key role in this process. The right inferior parietal lobule is activated when a subject imagines actions from another's perspective but not from their own (Ruby et al. 2001). Decety et al. 2001 replicated this finding in a PET study of reciprocal imitation. Parietal activity may mediate the internal "perception" of the sensory consequences of an action, allowing clear distinction between self and other (Blakemore et al. 2003). Patients with left parietal lobe lesions may confuse their hand movements with those of another (Sirigu et al. 1999). Such lack of self-awareness would begin to explain the self-other confusion that is seen in psychiatric disorders such as schizophrenia and autism. The present study further explores agency in relation to action observation and imagination by creating tasks in both modalities from self and other perspectives.

Methods

So far, five healthy right-handed subjects (ages 21 - 45 years, mean age 28 years) have completed the fMRI protocol. Further healthy subjects are currently completing the protocol, as are a clinical group of subjects with Early Onset Psychosis. Subjects received 20 minutes pre-scan training and completed the Edinburgh Handedness Inventory (Oldfield 1971) and the Vividness of Visual Imagery Questionnaire (VVIQ) (Marks 1973). Functional images encompassing the whole cerebrum were acquired using blood oxygenation level-dependent (BOLD) contrast T2*-weighted echoplanar MRI (TR (repetition time), 3s; TE (echo time), 40 ms; α (flip angle), 90°; FOV (field of view) 24 cm, slice thickness 5 mm, 22 slices) on a 1.5 T LX/Nvi neuro-optimised system (GE, Milwaukee, Wisconsin). Prior to the collection of T2* images, T1 weighted images (24 slices) were collected using a conventional spin echo pulse sequence (TR = 500 ms, TE = 14 ms) in positions identical to the functional scans, as an anatomical reference for echoplanar images. In addition, high resolution anatomical images of the entire brain were obtained by using a strongly T1-weighted 3D inversion recovery prepared gradient echo (TE = 5.4 ms, TR = 12.3 ms, TI = 450 ms, 1.57 mm slice thickness, FOV = 20 cm, 256 x 192 matrix). Instructions were presented to subjects from a PC running Presentation® software (Version 0.53, 2002) via an LCD projection screen viewed by a mirror assembly attached to the headcoil. The data were analysed using SPM99. Group analysis was performed using a conjunction model corrected at $p < 0.001$.

The experiment employed a pseudo-randomised and counterbalanced block design. Blocks each lasted 30 seconds, comprising three 10-second stimuli. A 15-second rest condition (fixation) followed each block. Active conditions were egocentric observation, allocentric observation, "self" imagination and "other imagination". During observation tasks, subjects watched video clips of familiar actions being performed, whereas during imagination tasks subjects imagined actions being performed whilst watching a still image from the video. For self-imagination tasks, subjects were trained to imagine themselves performing the task and to "superimpose" themselves on the hands in the photograph. Subjects were asked to choose a person they knew well for other-imagination tasks. They were instructed to imagine them sitting across a table performing the tasks in the same position as in the photograph. Stimuli were varied to minimize learning effects. The same actions were presented in both action observation and imagination conditions. The experimenter's hands were anonymised so subjects could project their own identity or that of the "other" onto the actions during imagination. Subjects were instructed to keep their eyes open during imagination tasks, in order not to miss the next task, and to place their hands together in the midline, so as to minimize movement. A post-experiment questionnaire evaluated task performance.

Sample Stimuli:



Results and Discussion

Scores for all subjects on the VVIQ and post-scan questionnaires demonstrated that all were able to imagine clearly and vividly during the experiment. Strikingly, a number of lateralised activations in relation to agency were found in both imagination and observation modalities. Firstly, self-imagination demonstrated left parietal activity, but for other-imagination parietal activity was more right-sided (consistent with Ruby et al. 2001). In addition, self-imagination activated left-sided pre-motor cortex, left-sided fusiform gyrus and left-sided cuneus, whereas other-imagination activated right-sided pre-motor cortex, right-sided fusiform gyrus and right-sided precuneus. In action observation, allocentric observation activated right inferior parietal lobule in a similar way to that previously described for other-imagination. Moreover, egocentric observation activated left-sided premotor and parietal cortex, right-sided fusiform gyrus and left-sided middle occipital gyrus, whereas allocentric observation activated left-sided premotor cortex and bilateral parietal cortex, fusiform gyri and middle occipital gyri. A further analysis directly compared the two "other" and "self" perspective conditions. Right inferior parietal lobe activity appeared greater for the "other" observation task than for the "other" imagination task, perhaps reflecting the increased complexity of this task. "Self" observation showed activations in the left superior parietal lobule and right inferior temporal gyrus, whereas "self" imagination activated bilateral superior frontal gyri and left lingual gyrus. Bilateral middle occipital gyrus (V5) activity was present for other-imagination only, perhaps reflecting that this task could be construed as the "imagined watching" of the action of the other person. In common with previous work, both action observation and imagination shared activation in parietal cortex and premotor cortex (Grezes et al. 2001). Imagination tasks also activated SMA, whereas action observation conditions activated middle occipital gyrus (V5) (Grezes et al. 2001, Howard et al. 1995).

In summary, preliminary findings from this study confirm the role of parietal areas in self-other distinctions and suggest that self-other perspective is a significantly lateralised function in relation to several neural areas in both imagination and observation modalities.

References

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