

## An fMRI study of two types of tool-use gestures: Body-parts-as-object and pantomime

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### Introduction

Patients with brain damages [1] or schizophrenia [2] often make body-parts-as-object (BPO) errors instead of accurate pantomime (MIME). For example, when asked to show how to brush one's teeth, the patient moves the index finger as a toothbrush (BPO) instead of grasping an imaginary toothbrush (MIME). While previous activation studies reported the involvement of the left parietal lobe during MIME-gestures [3, 4], the neural process of BPO-gestures has not been investigated in detail. In this study, we compared the brain activation in normal volunteers during MIME- and BPO-gestures using fMRI. Although MIME- and BPO-gestures are the same in that they use the imaginary tools, MIME-gestures manipulate the imaginary tool while BPO-gestures need to replace one's hand with the tool before manipulating it. The activation in the parietal lobe was specifically focused, because this area was related to tool concepts [3, 4].

### Methods

**Subjects:** Twelve healthy volunteers (all right handed, eight females, and age 20-39) participated in this study. All subjects gave written informed consent.

**Experiment design and tasks:** Four conditions were investigated in separate fMRI series; BPO by right hand, MIME by right hand, BPO by left hand, and MIME by left hand. Each fMRI series comprised of task (T: 30s), control (C: 30s), and rest (R: 30s) blocks (RTCTCTCTCR, total 5 minutes). In the task blocks, six tool names (e.g. scissors) were presented one by one every 5s for 2s. Then participants pantomimed to use the tool for 3s in a manner specified according to the task conditions (BPO/MIME). In the control blocks, six non-tool words (e.g. sea) were presented. In this case, participants performed repetitive nonsense arm movements comprised of adduction and abduction with grasping movements for 3s.

**Data acquisition:** A T2\*-weighted gradient recalled echo spiral k-space trajectory sequence[5] was employed for functional studies on a 3T MR scanner (GE, Signa VH/i 3.0T). The imaging parameters were TR5000msec, TE30msec, FA70 degree, 30 axial slices, FOV22cm, and 4mm thick interleaved. To minimize motion artifacts, we used a clustered volume acquisition technique. As this technique could reduce an acquisition time to first 2s of 5s (TR), participants could move their hand during last 3s, namely, blank periods.

**Statistical Analysis:** The fMRI data were analyzed using SPM2 (<http://www.fil.ion.ucl.ac.uk/spm/spm2.html>). The data were realigned, spatially normalized into MNI template, and smoothed (FWHM 8mm). A random-effect model was applied for comparison between each condition with the height threshold of  $p=0.001$  at voxel level (uncorrected).

### Results and Discussion

In all conditions, the superior parietal lobule, inferior parietal lobule, supplementary motor area, and premotor area in the left hemisphere were activated. These results confirmed those of previous studies concerning MIME-gestures [3, 4]. We successfully demonstrated that not only MIME-gestures but also BPO-gestures activated the left parietal lobe, which is reported to be a critical area for praxis generation. In addition, the BPO condition activated the right and left inferior parietal lobule (Fig. 1; yellow arrows), whereas MIME condition activated predominantly the left inferior parietal lobule (Fig. 1; pink arrows) irrespective of the hand used (right/left, Fig. 1; top and bottom). These results suggested that the right inferior parietal lobule played an additional role for production of BPO-gestures. This area is related to visuospatial transformation and body image, and lesions with this area can induce the hemiasomatognosia (somatognosic disorders to one side of the body). The activation of this area in BPO condition might reflect the process of switching body parts (hand) image to tool image.

### Conclusion

Productions of body-parts-as-object (BPO) and pantomime (MIME) gestures activated similar areas, specifically the left parietal lobe in normal subjects. BPO-gestures additionally activated the right inferior parietal lobule. These results suggested that the right inferior parietal lobule had a relationship to translation from body parts image to tool image.

### Reference

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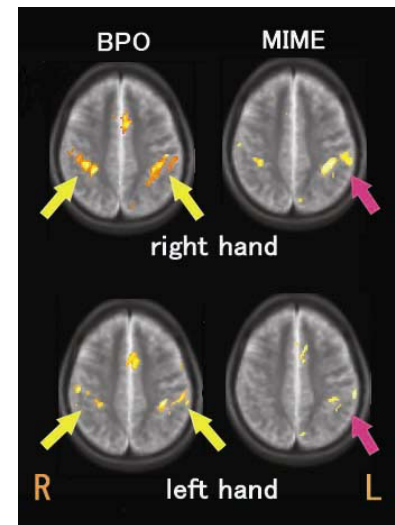


Fig.1 Activations in each condition (Talairach coordinates Z=40).