Observed manipulation induces object representations in fronto-parietal cortex

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INTRODUCTION

The organization of conceptual knowledge is a central question in neuropsychological research.

Modality-specific theories (e.g., Warrington & McCarthy, 1983) propose a modality-specific organization of semantic knowledge depending on the differential weighting of dominant types of experience (e.g., “sensory” or “manipulation”) with objects from natural or artificial categories. They assume that active manipulation of artificial objects (e.g., tools) should lead to neural representations in sensory-motor brain regions.

Indeed, it has been shown that viewing familiar tools leads to activations in posterior parietal and prefrontal cortex (Craen-Rogier & Lee, 2005). However, it is unclear if these activations are elicited by prior active manipulation.

Learning from observation enables to gain semantic knowledge about manipulable tools without active manipulation experience.

The aim of this study is to elucidate how neural representations of novel manipulable objects are formed through observation of manipulation. It was hypothesized that observed manipulation also leads to object representations in fronto-parietal brain regions.

RESULTS

IMRI

Interaction in 2x3 full factorial design (pre | post x VTO | MTO | NTO)

RESULTS

behavioral

Observation of manipulation of novel tools leads to neural representations in sensory-motor brain regions.

Viewing MTOs activates BA 44/45, known to be active during sight of tools (Ba44; Chao & Martin, 2000) and associated with action observation but not imitation (Ba45; Molnar-Szakacs et al., 2005). Furthermore, MTOs activate fusiform gyrus (BA 20) that has been shown to be involved in matching manufactured objects in previous studies (Chao et al., 1999) and that is associated with visual object recognition (Whatmough et al., 2002).

On the contrary, viewing VTOs activates left posterior cingulate cortex that is related to processing of visually salient stimuli (Dean et al., 2004).

In summary, object observation is sufficient to induce representations of novel tools in sensory-motor related brain areas. Furthermore, the dominant modality of object experience (observed manipulation, visual exploration) seems to modulate brain activity when merely viewing the stimuli.

METHOD

Thirty-six novel objects were constructed with K’nex® (design similar to Weisberg et al., 2007). In three training sessions 18 participants (13 female) visually explored one set of objects and observed the experimenter during object manipulation with another object set (figure 1). A third set was not part of the training (control condition).

CONCLUSION