The cortical representations of objects as a function of the interaction space size

Wilma A. Bainbridge (1), Laura K. Levin (1), Aude Oliva (2)

1- Department of Brain and Cognitive Sciences, MIT
2- Computer Science and Artificial Intelligence Laboratory, MIT

Neuroimaging work has shown that real-world object representations are spread over several regions of the cortex that are sensitive to different physical or functional properties of the object, such as their shape (Grill-Spector et al, 1999), their real-world size (Konkle & Oliva, 2012) or their manipulability (Lewis, 2006). Here, we examine whether higher-level visual regions in the brain are sensitive to an ecologically important property of objects: the way in which we interact with them. Specifically, are objects that we primarily interact with using our hands (e.g., a cup) represented differently from objects we primarily interact with using our bodies (e.g., a chair)? We conducted an fMRI study with eight right-handed human observers, where they performed a 1-back task while viewing object images presented in blocks, while being asked to think about how they interact with each object. 600 images of objects were grouped into five categories of interaction – objects you interact with using your 1) fingers (e.g., a pushpin), 2) one hand (e.g., an apple), 3) two hands (e.g., a keyboard), 4) body (e.g., a canoe), and 5) "wall-like" objects (e.g., a tree). Using a whole-brain random effects analysis, we looked at differential activity for hand interactions contrasted with body interactions. Regions in the lateral occipital complex (LOC), the left occipito-temporal sulcus (small-OTS; Konkle & Oliva, 2012) and the left inferior parietal lobule (IPL; see review by Lewis, 2006) showed significantly greater activation to hand than body interaction objects. In contrast, regions in the parahippocampal cortex (PHC), the retrosplenial cortex (RSC) and the transverse occipital sulcus (TOS) showed significantly greater responses for body than hand interaction objects. Additional whole-brain parametric analyses suggest a gradient of activity for objects of increasing interaction space size (from hand to body) in a region of the TOS and sub-regions in the PHC. In addition, functionally defined scene-related regions of interest (the PPA, RSC, and TOS) also showed increasing activity for body objects, while other functional regions (visual areas and the FFA) showed no differences across objects. These results suggest that distinct cortical regions are differentially selective to objects of different interaction space sizes, and that higher-level visual regions may incorporate representations of how the object is used by a specific agent (i.e., hand or body).

Abstract: 2029 characters. Total: 2248

Acknowledgments

National Eye Institute EY020484 to A.O.

Leventhal Graduate Fellowship NDSEG to W.A.B

The Athinoula A. Martinos Imaging Center at McGovern Institute for Brain Research, MIT