Lateral Occipital Cortex Represents Axis Structure

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Background

• Object structure can be defined by specifying the relationships between the medial axes of an object's parts.
•Lesions to the ventral stream can produce an agnosia for object structure but leave intact the perception of the shapes of the individual parts (Behrmann et al., 2006).
•Although there have been some human fMRI studies investigating object representations in ventral visual areas, these studies have not addressed object structure specifically. With stimuli that vary in color, texture, and evolutionary significance (e.g., Haxby et al., 2001; Kriegeskorte et al., 2008), one cannot make inferences about the role of object structure—or even object shape—in determining ventral stream response patterns.
• PROBLEM: Could the BOLD signal in ventral visual areas distinguish groups of objects that differed only in their axis structures?

Methods

• Stimuli were nine (3 objects x 3 views) or fifty-four (9 objects x 6 views) images of novel objects (see above).
• Images appeared for 750 ms (3 objects) or 1000 ms per trial (9 objects x 6 views) with 250 ms inter-stimulus intervals (ISI). One image appeared on each trial.
• MRI parameters: whole-brain scan of 2x2x2 mm voxels (3 object) or 2x2x2.5 mm voxels (9 object), 31 slices, TR = 2 s.
• Regions of interest were defined for each subject in independent localizer scans.
• For each region of interest, a support vector machine (SVM) classifier was trained on 7 runs of the data and tested on the 8th run, in order to test whether common axis structure and/or common body orientation produced consistently differentiable patterns in each region.

Results:

3 Objects x 3 Views

Classify by Axis Structure

Classify by Cone Position

Classify by Body Orientation

Classification Accuracy

Relative SVM

Support Vector Machine Classifier Training

Train Classifier

Test Classifier

Classification Accuracy

Subject Performance

Classification Accuracy

Conclusions

• The Lateral Occipital (LO) area encodes not only an object's parts (Hayworth & Biederman, 2006) or local features (Op de Beeck et al., 2008), but also its medial axis structure.
• LO is more sensitive to the medial axis structures of objects than to their global orientation, and this coding of axis structure is independent of local parts or features.
• The coding of axis structure in LO is modulated by attention, but the response pattern in LO is not wholly determined by attention.

References: