PhD graduate

Position Invariance and Object Affordances in Human Parietal Cortex

In the dorsal stream, the parietal cortex is implicated both in the control of one's actions as well as understanding the actions of others. These two functions, however, place different demands on the necessary action representation: performing an action (e.g. grasping) on two tools located at different locations entails entirely different motor plans, and therefore a representation of the specific target location is crucial for self-action control. When observing actions, on the other hand, it hardly matters where the action is taking place ? action understanding is essentially conceptual (e.g. "this person is opening a bottle"), generalizing across variations in location.

In our study we used functional MRI multivoxel pattern analysis (MVPA) to shed light on properties of regions that are active during action observation. To this end, we characterized the information available in the patterns of fMRI activation when viewing object-grasping actions in early visual cortex (EVC), lateral occipital complex (LOC), posterior intraparietal sulcus (pIPS) and anterior intraparietal sulcus (aIPS). We found that patterns in both parietal regions carry information regarding the hand and tool identity. This information is maintained regardless of the visual field location of the seen action. Position information, however, is gradually lost in the visual hierarchy.
Learned recognition of degraded object-images is reflected by a corresponding change in the multivoxel activation patterns of Lateral Occipital Complex.

One feature of visual processing in the ventral stream is that cortical responses gradually depart from the physical aspects of the visual stimulus and become correlated with perceptual experience. Thus, unlike early retinotopic areas, the responses in the object-related lateral occipital complex (LOC) are typically immune to parameter changes (e.g. contrast, viewpoint, etc.) when these do not affect recognition.

We used a complementary approach to highlight changes in brain activity following a shift in the perceptual state (in the absence of any alteration in the physical image). Specifically, we focus on LOC and early
visual cortex (EVC) and compare their fMRI responses to degraded object-images prior to, and following fast perceptual learning that renders initially unrecognized objects identifiable. We found, using 3 different methods of analysis, that in LOC, unlike EVC, learned recognition is associated with a change in the multi-voxel response pattern to degraded object images, such that the response becomes significantly more correlated with the pattern evoked by the intact version of the same image.

These results provide further evidence that the coding in LOC reflects the Gestalt, perceptual level of representation of visual objects.

We expect recognition to cause a pattern of response more similar to that evoked by the original “intact” image (& less similar to the “noise” image).

Publications

Fingerprints of Learned Object Recognition Seen in the fMRI Activation Patterns of Lateral Occipital Complex

Position and Identity Information Available in fMRI Patterns of Activity in Human Visual Cortex

Functional MRI Representational Similarity Analysis Reveals a Dissociation between Discriminative and Relative Location Information in the Human Visual System

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