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One of the most basic questions of cognitive science is how do we sort objects, people, events, actions and ideas in the world into their proper categories? How do concepts and categories come to be represented in our brain, and to what extent does our own motor experience shape these representations? The focus of my research is on visuo-motor body representation, and on the occipito-temporal and parietal brain systems that are thought to underlie it.

Recent Projects:

Are there any clear governing principles that determine the functional clustering of voxels which are selective to specific object categories within the occipito-temporal cortex (OTC)? Previous studies, attempting to tackle the basis for these object representations typically used static images of objects. However, this clearly ignores the obvious fact, that some object categories (e.g. hands) have characteristic motion patterns. For example, the selectivity in the EBA, a body-selective region within OTC, has been largely thought to be driven by sensitivity to shape aspects that develop along the ventral visual stream.

We tested these classical hierarchy schemes, by estimating the level of functional connectivity (FC) between spatially distinct regions. This estimate serves as a proxy measurement of potential feed-forward inputs from mid-level visual areas (e.g. hV4) to object-selective areas within the OTC. We find that the degree of OTC voxels' selectivity to rigid, typically inert objects is positively associated with their strength of functional connectivity with mid-level shape-selective areas (i.e. V4 / LO-1). Thus, representations of these objects within the OTC are likely to obey the accepted visual hierarchy scheme.

Contrary to this scheme, we show that greater preference of OTC voxels to static pictures of upper-limbs coincides with their stronger functional connectivity with hMT+ (but not hV4 / LO-1). This suggests a tight link between upper-limb selectivity and motion processing.

To corroborate this working hypothesis we created a set of natural arm movement videos, in which kinematic patterns were parametrically manipulated, while keeping shape parameters constant (Movie 1). We then defined a region (termed here extrastriate arm area, EAA), in the OTC, which shows clear preference to static images of human upper-limbs when compared to other body-parts or to other object categories. Using multivariate pattern analysis, we show that the degree of (dis)similarity in arm velocity-
profiles predicts, to a significant extent, the degree of (dis)similarity in multivoxel activation patterns, in both EAA and hMT+ (Figure 1).

Together, these results suggest that the functional specificity of EAA is at least partly determined by articulated visual motion, beyond selectivity to shape. We propose that selectivity to static upper-limb images in the OTC may result from experience-dependent association between shape elements, which characterize upper-limbs, and upper-limb-specific motion patterns. This finding challenges the traditional view on body- and body-part selective OTC regions as strictly 'ventral-stream' areas.

**Movie 1. Examples of arm movements used in the experiment.** Four arm movements with different extension/flexion speed ratios are shown, one after another (the extension/flexion speed ratios are 4, 1.5, 0.67 and 0.25, respectively).

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**Figure 1.** The degree of (dis)similarity across multivoxel activation patterns in hMT+ and ULSA is predicted by the degree of movement kinematics (dis)similarity.

(A) Group averaged correlations matrices in hMT+ (left) and EAA (right). X and Y axes indicate four movement conditions in the two data halves. Color bar: the level of correlation between multivoxel activity patterns evoked by the videos with different extension/flexion speed ratios (see Movie 1) in the two dataset-halves. (B) Red and gray bars indicate averaged correlations for the same videos (i.e. the main diagonal of the matrices in A) and different videos (other correlations in the matrices), respectively. The error bars indicate S.E.M. (C) The amount of variance explained by the kinematic (dis)similarity predictor (as calculated across video pairs, insert on the right) in the correlation matrices, for each ROI. Asterisks denote levels of significance as follows: *p<0.05; **p<0.01; ***p<0.001.
Hands in motion: an upper-limb-selective area in the occipitotemporal cortex shows sensitivity to viewed hand kinematics

Topographic representation of the human body in the occipitotemporal cortex

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