Multi-voxel pattern analysis of face and object exemplar discrimination in occipital cortex.

Ipek Oruc¹, Jason Barton¹,²

¹ Department of Ophthalmology & Visual Sciences and ² Division of Neurology, University of British Columbia

Background

Contrasting fMRI activity for different visual stimulus categories has revealed cortical areas that respond to specific classes of stimuli such as faces (e.g. FFA, OFA and STS) and generic objects (e.g. LOC). It is yet unclear what specific function is served in these areas with some hypotheses proposing OFA as an early stage, feeding into FFA for identity, and STS for identity-invariant expression processing for faces. To test this and explore further, we examined whether spatial patterns of fMRI activity in these regions of interest contained information sufficient to differentiate individual faces and objects.

Questions

Can we predict from the pattern of fMRI activity across voxels which face (or car) the observer is viewing? Which cortical regions support this information? If FFA is involved in identity processing for faces only, then prediction accuracy should be high for faces, but low for cars.

Results

Classification accuracy was significantly better than chance (50%) for the between (face/car) task, and both within-category tasks (face1/face2, car1/car2) in all eight regions of interest. Between-category classification accuracy was better than within in left and right LOC and left FFA, but did not differ in any other regions.

Regions of interest

OFA FFA STS LOC

Correlation coefficient

Percent correct

Results

Conclusions

All areas in the core face network as well as LOC contain information necessary to individuate faces and cars. Although the easier of the two tasks, between-category discrimination was comparable to within in most areas, with LOC showing better between-category discrimination consistent with its hypothesized role in object processing.

Voxel weight magnitude correlations suggest that early processes common to both tasks may use overlapping neural populations giving rise to the positive correlations in OFA and LOC, which are not seen in FFA or STS, in which more specialized processes may recruit relatively distinct neural sub-populations.

Selection of stimuli

For the comparison of the accuracy measure between the face and the car tasks to be meaningful, we need to make sure the task difficulty for these are comparable. We first picked the two car exemplars, and then searched for a face pair with the same degree of confusability, or similarity, between the exemplars. We used ideal observer luminance contrast thresholds in a 2-alternative forced-choice task as an index of similarity.

Stimuli: two faces and two cars (i.e., 4 classes: face1, face2, car1, car2) displayed at random sizes (approx. 4.5 - 9°) for 0.5s followed by 1.5s blank screen (TR = 2s).

Each scan contained 16 stimulus blocks, four of each class, ordered randomly. Stimulus blocks consisted of 6 video clips, five novel, one repeated. Eight subjects participated, and performed a 1-back task. GLM contrast for FFA, OFA, STS: Faces > Objects, LOC: Objects > Phase-scrambled objects.

Only top 200 of significant voxels (5% FDR) were included for each ROI.

A repeated measures ANOVA with hemisphere (L, R) and area (FFA, OFA, STS, LOC) as factors show a significant main effect of area. There was no main effect of hemisphere, nor a significant interaction, reflecting similar correlation structure in the two hemispheres. collapsing the two hemispheres reveal significant correlations for STS (<0), LOC (>0), and OFA (>0).

DO successful classification of faces and cars depend on different sub-regions of a given cortical area e.g., right FFA?

To test this, we computed correlations between the magnitude of the voxel weights in the face and car tasks.