Integration of visual and motor object features in human cortex

Ariana M. Familiar, Heath Matheson, Sharon L. Thompson-Schill

Department of Psychology, University of Pennsylvania

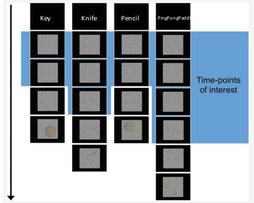
CENTER FOR COGNITIVE NEUROSCIENCE

Introduction

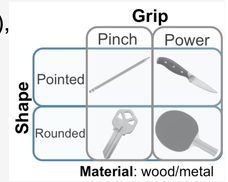
Left anterior temporal lobe (ATL) has been implicated in encoding integrated visual object features corresponding to object identity (e.g. shape/color; Coutanche & Thompson-Schill, 2015). Damage to bilateral ATL typically impairs memory of object features across sensory and motor modalities (Patterson, Nestor, & Rogers, 2007).

The present study tested whether ATL encodes integrated visual and motor object features corresponding to object identity.

Methods



Task: target object cued (2 s), then a series of pure-noise images presented (12-24 s), then object-in-noise (2 s) & response to whether object was the cued target or not.



Objects employed uniquely defined by a combination of shape, material, and grip.

12 blocks per object across 4 runs (pseudo-random order)

GLM to estimate voxel responses during pure-noise time-points (beta weights used as input in multi-voxel pattern analyses (MVPA))

Searchlight MVPA decoding:

- 4-way classification of object identity (unique combo. of material/shape/grip)
- 2-way classification of grip

ROI-based MVPA decoding:

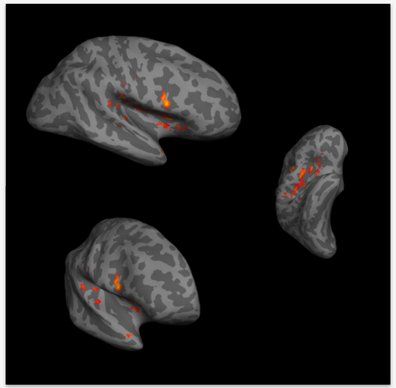
- 2-way classification of shape
- 2-way classification of material

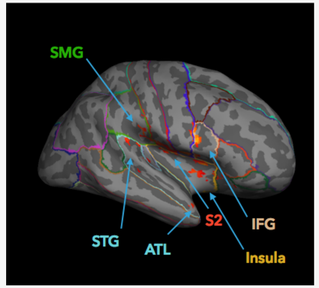
Statistical significance assessed with permutation procedures.

Results

N = 22

Searchlight: identity decoding

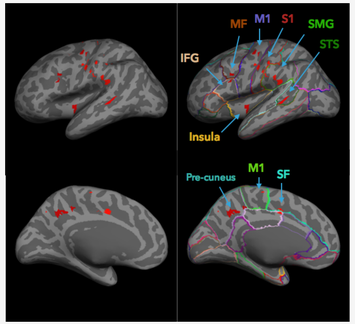


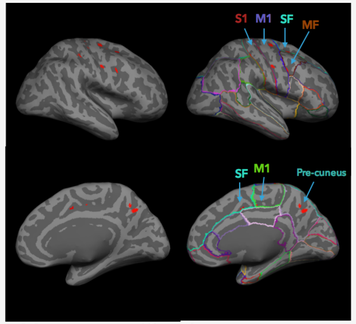


p = 0.002

Mean classification accuracy: 27% (SEM = 0.02)

Searchlight: grip decoding





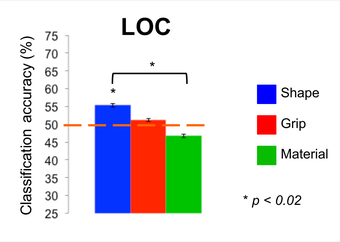
p < 0.01

Mean classification accuracy: 53% (SEM = 0.03)

Results

N = 22

ROI: shape decoding



ROI: material decoding

No above-chance decoding of material in any ROI tested.

Information selectivity

Only successful classification of the given property (identity, grip, or shape) was found in each identified region.

Conclusions

- Successful identity decoding was found in the right ATL as well as parietal (SMG; S2), temporal (STG), and frontal (IFG) regions. Former work has related these areas to tactile object recognition, object manipulation, and action planning (e.g. Gallivan et al., 2013; Reed, Shoham & Halgren, 2004)
- Successful grip decoding was found in motor and action-related regions
- Successful shape decoding was found in a shape-selective visual region
- Further analyses will test the dependence of identity decoding on simultaneous grip and shape decoding, on a block-by-block basis, to establish the convergence of these features in identity-coding areas.

References

- Coutanche & Thompson-Schill (2015) Creating concepts from converging features in human cortex *Cerebral Cortex* doi: 10.1093/cercor/bhu057
- Gallivan, McLean, Valyear, & Culham (2013) Decoding the neural mechanisms of human tool use *eLife* doi: 10.7554/eLife.00425
- Patterson, Nestor, & Rogers (2007) Where do you know what you know? The representation of semantic knowledge in the human brain *Nat Reviews Neuro* doi: 10.1038/nrn2277
- Reed, Shoham, & Halgren (2004) Neural substrates of tactile object recognition: an fMRI study *Human Brain Mapping* doi: 10.1002/hbm.10162

Work supported by NIH R01EY021717 & R01DC015359

Reprints https://web.sas.upenn.edu/schill-lab/publications/posters/