Semantic object grouping in the visual cortex seen through MVPA

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Semantic encoding in perception of visual objects
- The hierarchy of semantic information encoded in the brain is unclear.
- Huth (2012) proposed a subset of categories to predict voxel-level firing for semantic properties; Sudre (2012) proposed a larger set of semantic properties to predict MEG activity in broader cortical regions.
- We study semantic properties of Sudre (2012), using representational dissimilarity analysis (Kriegeskorte 2008) and more fine-grained BOLD MVPA.
- We identify more spatially-localized ROIs in mid-level vision with a subset of studied semantic representations, partially consistent with Sudre (2012).

fMRI study
- Participants shown photos of 60 real-world objects, 6 each, passive viewing.
- BOLD signals recorded with slow event-related design (2 sec TR, partial coverage) for 3 subjects.

Representational dissimilarity analysis
- Representational dissimilarity: use pairwise distance matrix to show how stimuli are grouped by each neural and computational representation.
- ROIs with semantic groupings:
  - Lateral occipital (LO)
  - Fusiform (Fus)
  - Inferior parietal (IP)
  - Inferotemporal (IT)

Cross-subject consistency
- Can you hold it in one hand? - INCONSISTENT
- Consistent properties (from 20 tested):
  - Is it taller than a person?
  - Is it taller than a car?
  - Is it hollow?
  - Is it a vehicle?

Same semantic groupings in multiple regions of mid-level vision

Comparing semantic groupings
- Representational distance matrix (RDM) computed for comparing 60 objects using each of 317 semantic questions.
- We compute the pairwise correlation among RDMs (compare pairs of semantic questions; matrix to the right).

Pairwise comparisons among semantic RDMs

Same semantic groupings across different regions

Comparison with prior MEG data
- Regions consistently predicted in MEG were common match regions for single MVPA subjects.
- 50% of consistent match regions in MVPA were consistently predicted in MEG.
- Under 50% of consistently predicted MEG regions were consistent matched in MVPA.

Discussion
- Lateral-occipital cortex groups objects consistent with diverse semantic properties.
- Semantic property groupings observed in other mid-level visual regions.
- Noun-category, size, and action groupings prominently match cortical groupings, emotional and touch-sensation groupings less prominent.
- RDM MVPA results only partially consistent with analysis of prior MEG data.

References

Acknowledgments
Fordham University Faculty Research Grants; Carnegie Mellon University Shared data from labs of Michael Tarr (Leeds et al. 2013) and Tim Mitchell (Sudre et al., 2012).