Unsupervised dimensionality reduction of fMRI reveals widely distributed and massively redundant representation of gender during face processing

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**1 Introduction**

Human face identification is a complex, yet highly efficient, computation known to involve a network of brain regions along the ventral visual processing stream. Recent evidence using supervised multi-voxel pattern classification has suggested activity in the fusiform face area (FFA) corresponds to the detection of faces, while anterior portions of IT are engaged for identification (Kriegeskorte et al., 2007).

Supervised techniques force a pre-defined structure onto the data. If the representational structure in the data does not match the enforced structure, the analysis can fail. Unsupervised methods, on the other hand, can extract structure in an unbiased manner, and so may better reflect the true underlying structures of neural representations. Here, we applied unsupervised dimensionality reduction to functional imaging data (3T fMRI) and distinguished cortical responses elicited by the presentation of pictures of famous men and women.

Our analyses recovered a widely distributed representational structure for gender. Region of interest analyses revealed that gender-specific representational structure is not limited to ventral visual processing areas. We discovered that this structure is recovered best by analyzing group-averaged BOLD signal rather than obtaining similarity measures from single-subject data sets, and then averaging them. Together the results suggest a widely distributed and redundant neural code for gender that cannot be discovered by standard GLM or supervised multivariate techniques.

**2 fMRI task design**

N=10 (7 men) from Lewis-Peacock & Postle (2008)

**3 Dimensionality reduction of stimulus similarity matrix: avgBOLD vs. avgSimilarity**

Field-effect task design:

- **Cue:** Judge the famous face
- **Stimulus:** 30 famous faces (15 women / 15 men)
- **Judge:** 1, 2, 3, 4, 5
- **ITI:** 1=2=3=4=5

**Avg. BOLD signal across subjects**

**Avg. Similarity matrix across subjects**

**AvgBOLD > avgSimilarity**

Result - Multi-dimensional scaling of the similarity matrix created from the group-averaged BOLD signal — rather than from the average of single-subject similarity analyses — yielded the best separation by gender in the neural representations of faces. This result suggests that there is shared representational structure for gender, coded in similar brain areas, across individuals.