Task demands and stimulus normalization in face perception

An fMRI study

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Introduction

- A core network of occipitotemporal regions underlie visual perception and face recognition in particular, in addition to an extended network of frontal and subcortical regions.
- Many questions remain, including the extent to which the ability to read out specific properties (e.g. face race) from activity in these regions depends on task and stimulus properties
- [1] found that race was decodable from BOLD activity in a fusiform face-selective area (FFA) only when participants categorized faces based on a learned team, but not while they categorized based on race.
- These authors concluded that processing in FFA is dependent on the behavioral process of individuation, whereas early visual cortex is unaffected by task.
- We attempt to replicate and extend this finding, adding a third gender task to ask whether task complexity, rather than mandatory identification, may drive race decoding in FFA, explicitly manipulating stimulus luminance normalization to determine the dependance of cortical face property decoding on low-level properties, and analyzing more ROIs and whole-brain searchlights.

Method

- Scanned 18 subjects at UMass Amherst
- Subjects assigned to team (Leopards or Tigers) and learned to categorize faces of 6 identities per team.
- Subjects performed three tasks in separate blocks within a run, 2X each for orig. and normalized images: 6 blocks/run, 8 runs.
- 2 mm^3 voxels, 1s TR, coverage of VOTC (anterior temporal pole missed in first 5 subs).
- General linear models were fit to fMRI time courses split by neither, one, or both of {task, stimulus normalization}, and beta-weights were converted to t-statistics for (univariate) noise-normalized decoding.
- V1-V3 were acquired from surface topology [2], and OFA and FFA-all were drawn manually (FFA-all = FFA1 + FFA2). ROIs were combined across hemispheres.
- Searchlight analyses used 200 voxel spheres in native volumetric space, combined in *fsaverage* surface-space for group analysis with 6mm FWHM surficial smoothing.
- CoSMoMVPA software [4] was used for decoding with linear support vector machine using leave-one-run-out CV.
- Error bars: +/-1.69 s.e. of group mean. Stars indicate FDR corrected significance against chance or 2nd sample (behav): >*** q<.0001, *** q<.001, ** q<.01, * q<.05

Results: task demands

Fig 1. Race Decoding in ROIs, Influence of Task (n=18)

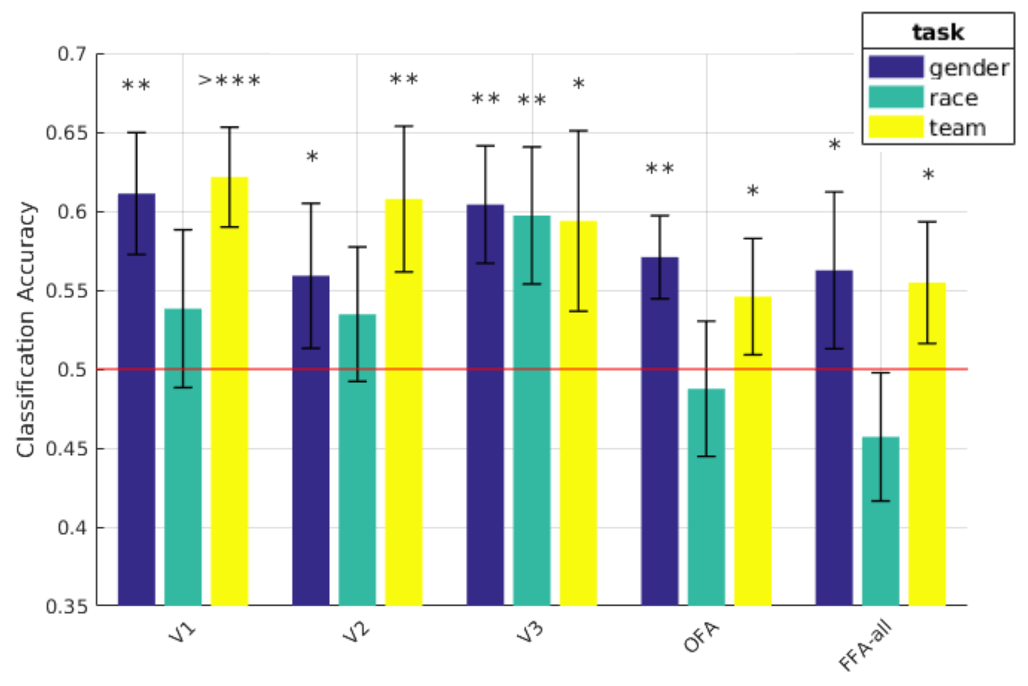
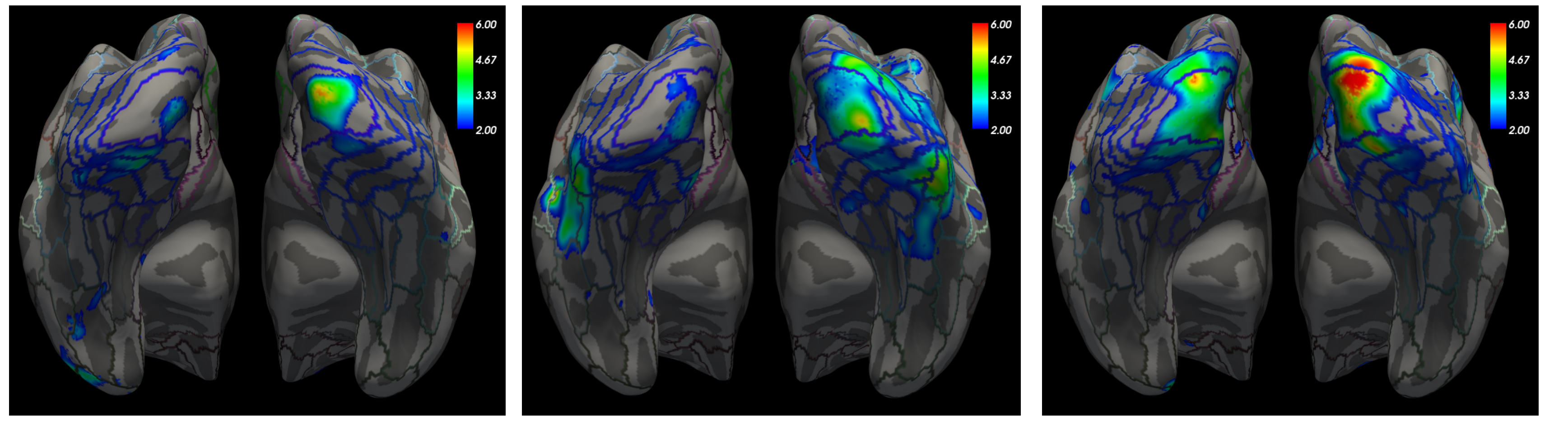


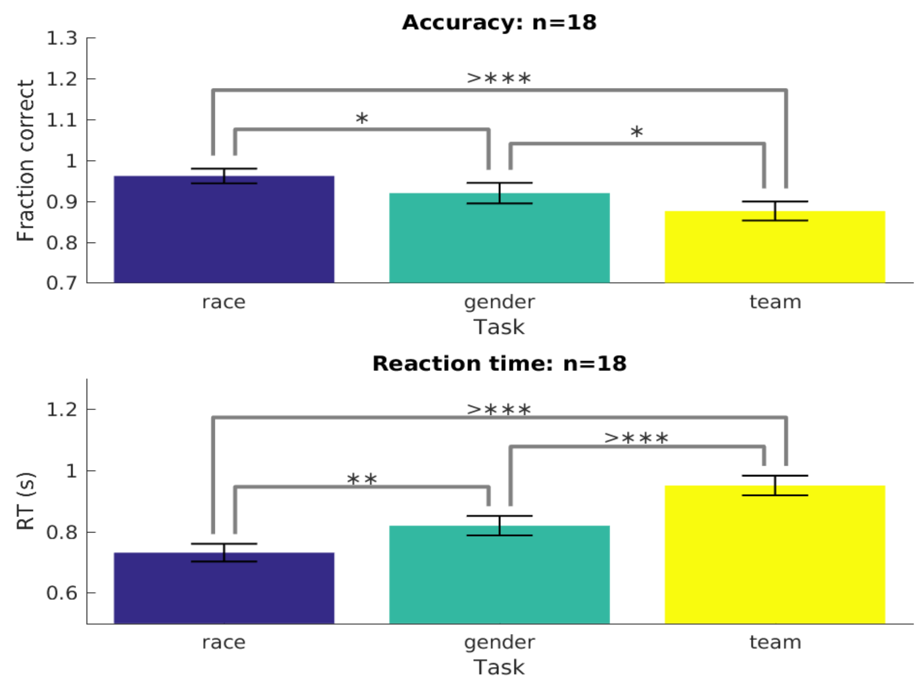
Fig 2. Race Decoding in Searchlights, Influence of Task (n=18), -log(p) scale



2a. race task 2b. gender task 2c. team task

- Influence of task on gender decoding is not shown as gender was not decoded from OFA or FFA ROIs under any task, and searchlight decoding in individual tasks was similarly weak.

Fig 3. Behavioral Results



Results: stimulus normalization

Fig 4. Race Decoding in ROIs, Influence of Stim. Norm. (n=18)

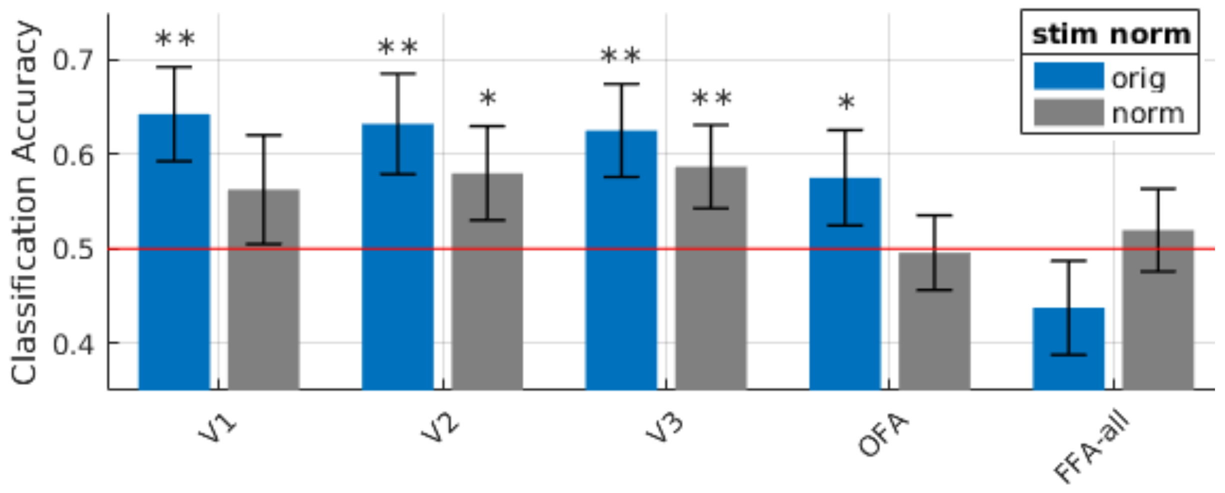


Fig 5. Gender Decoding in ROIs, Influence of Stim. Norm. (n=18)

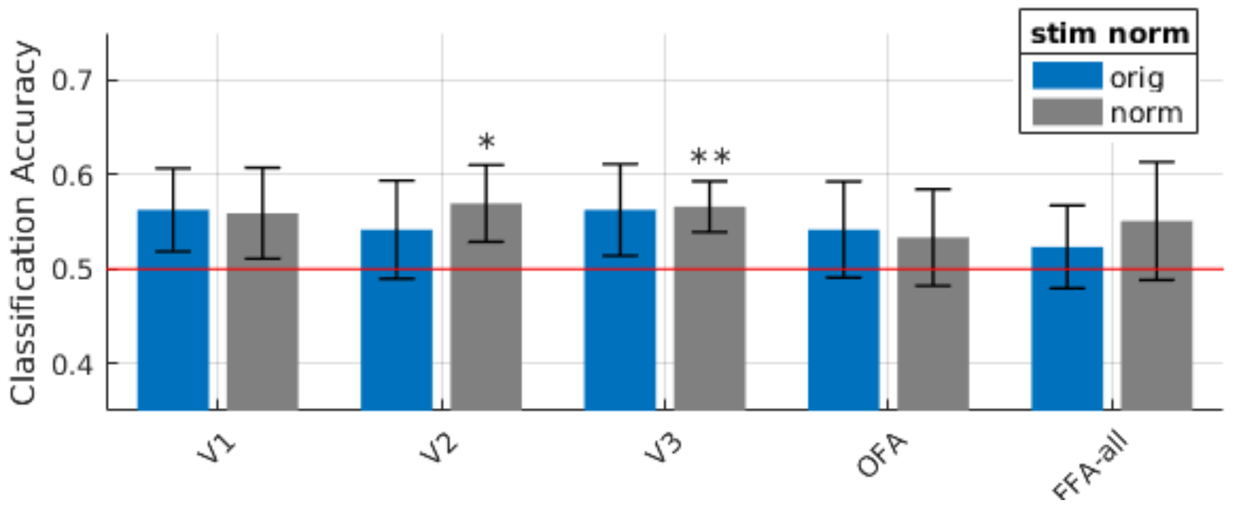
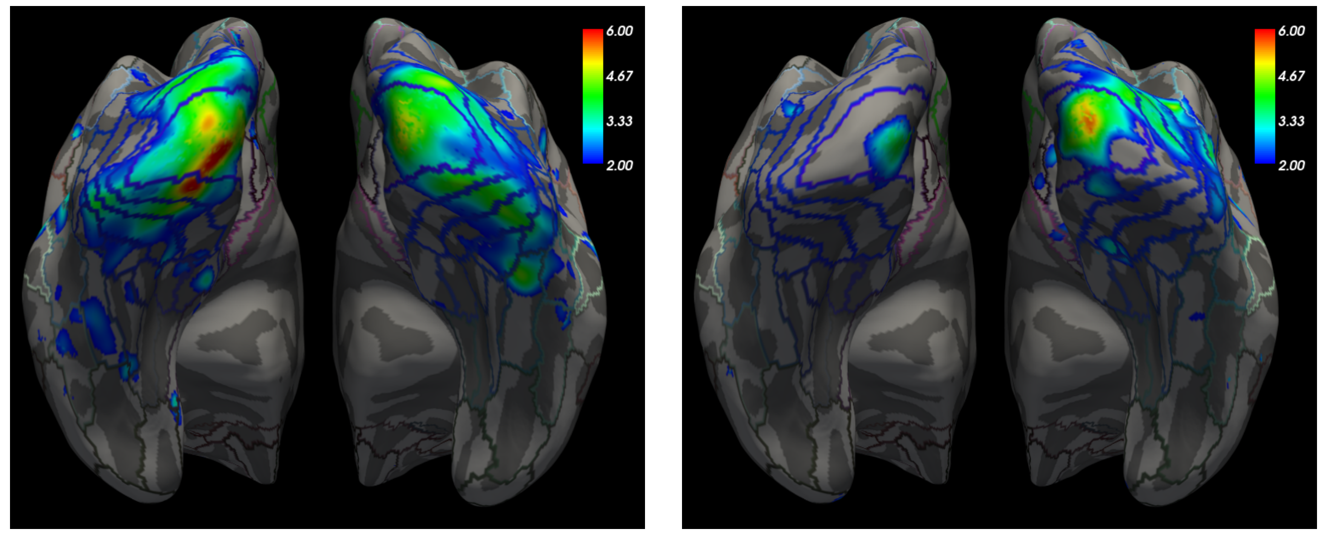
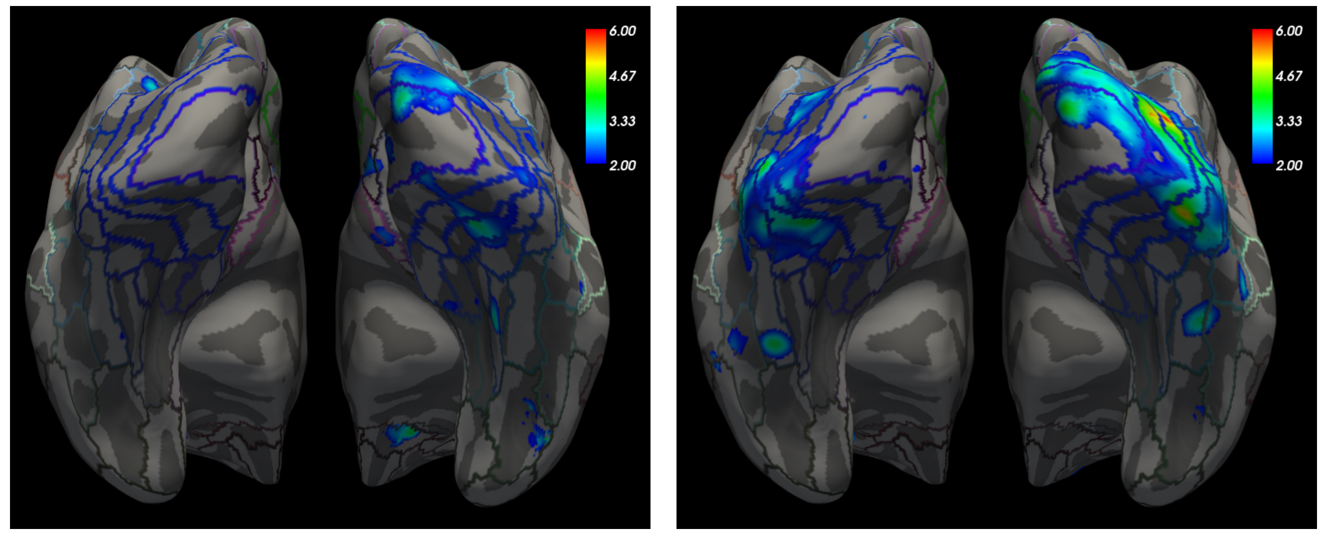


Fig 6. Decoding in Searchlights, Influence of Stim. Norm. (n=18), -log(p) scale



6a. race decoding, norm. off 6b. race decoding, norm. on



6c. gender decoding, norm. off 6d. gender decoding, norm. on

Summary

- Effects of task are not limited to FFA, but are broadly distributed across VOTC (Figs 1 & 2), yielding benefits for both gender and team tasks vs. race task.
- Effects of stimulus normalization dissociated across tasks, with an advantage for unnormalized images for race decoding, and for normalized images for gender decoding (Figs 4,5,6).
- Behaviorally, discrimination of team is harder than gender, which is harder than race (Fig 3).
- Our results suggest that, in the absence of overt societal cues (hair, facial hair, makeup, jewelry, etc.), gender discrimination demands higher-level processing than race discrimination of black and white faces.
- Our results point to task complexity/difficulty rather than mandatory identification as a driver of race decoding in high-level visual regions including OFA and FFA, as well as early regions such as V1 and V2.

References

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