Learned social values modulate neural representations of faces

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Introduction

Values drive behavioral choices. Ample research has examined the cognitive and neural underpinnings of monetary value-based computations (for review, see Kable & Glimcher, 2009). However, values attributed to biological stimuli are typically not monetary. How are more abstract values associated with naturalistic stimuli, such as social values of different people? Given distinct areas of the brain that process face and social value information, how are these pieces of information associated?

The present study tests whether learned social values modulate the similarity of neural responses in face-selective brain areas, as well as across the brain, and how such re-structuring is related to behavior.

Methods

Generosity	20	20	20	50	50	50	80	80	80
Points	15	45	75	15	45	75	15	45	75
Point Pool	75	225	375	30	90	150	19	56	94

Value learning

(modified from Hackel et al. 2015)

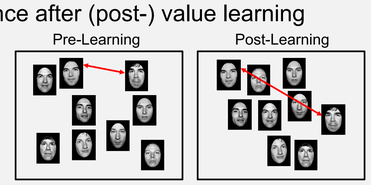
- 4 days of training
- **Task:** choose 1 of 2 players, receive feedback about that players' point allocation. Noise added to average values on each trial
- **Goal:** maximize points received by players for monetary bonus
- Social value (generosity) and reward value (points) were orthogonally assigned to each face
- Generosity was average proportion of point pool shared (20%, 50%, or 80%)

Behavioral similarity

- **Free sorting task:** organize faces such that spatial organization reflects their similarity
- Performed once before (pre-) and once after (post-) value learning

Post-learning measures

- Social preference ratings
- Social value similarity ranking
- Reward value similarity ranking



fMRI Methods

- **Two scan sessions:** one before & one after value learning (analyzed separately)
- **Task:** one-back repeat detection
- Face images presented one at a time (2 s), at the center of the screen
- Order of stimuli determined by a De Bruijn sequence

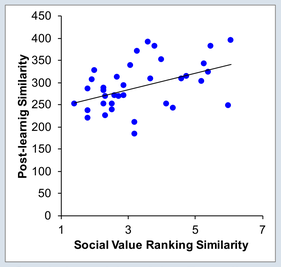
- **GLM** to estimate voxel responses to each face (beta weights used as input in multi-voxel pattern analyses)
- **Face-selective ROIs** defined by data from independent localizer runs
- **RSA** to match neural response similarity to a similarity matrix of:
  - Social Value
  - Reward Value
  - Perceptual similarity
  - Preference ratings
  - Behavioral similarity

CoSMo MVPA

Results

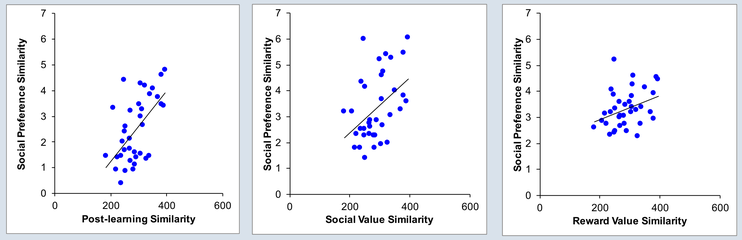
N = 15

Behavioral similarity



Social ranking Vs. Pre distance: R = -0.01, p = 0.97
Social ranking Vs. Post distance: R = 0.44, p = 0.1
Difference between corr's: Z = -1.6, p = 0.06
Reward ranking Vs. Pre distance: R = -0.01, p = 0.97
Reward ranking Vs. Post distance: R = 0.35, p = 0.2
Difference between corr's: Z = -1.2, p = 0.11

Marginally significant interaction between correlations of social value ranking and pre- vs. post-learning distances.



Pref ratings Vs. Pre distance: R = -0.02, p = 0.94
Pref ratings Vs. Post distance: **R = 0.58, p = 0.02**
Difference between corr's: Z = -2.19, p = 0.01
Pref ratings Vs. Social ranking: **R = 0.84, p < 0.001**
Pref ratings Vs. Reward ranking: R = 0.46, p = 0.08

Preferences for future social interaction correlated with post-learning distances and social value rankings.

Significant interaction between correlations of preference and pre- vs. post-learning distances.

Neural similarity: face-selective ROIs

Left FFA	Pre	Post
Perceptual	**0.22**	0.02
Preference	0.04	**0.14**
Social Value	0.06	**0.17**
Reward Value	0.19	0.15
Behavioral	-0.15	-0.16

Right FFA	Pre	Post
Perceptual	**0.24**	0.06
Preference	0.00	**0.17**
Social Value	0.08	**0.19**
Reward Value	-0.44	-0.55
Behavioral	0.02	-0.14

Neural responses in FFA related to perceptual similarity prior to value learning, while after value learning responses are related to social value similarity and social preferences.

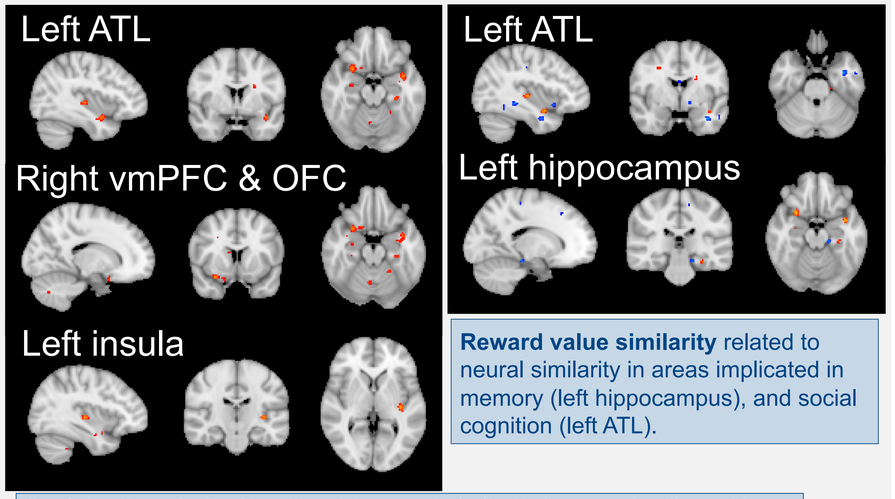
These trends were not found in left or right OFA

Classification of face identity was at chance performance in FFA.

Results

N = 11

Neural similarity: whole-brain searchlight



Reward value similarity related to neural similarity in areas implicated in memory (left hippocampus), and social cognition (left ATL).

Social value similarity related to neural similarity in areas implicated in value processing (vmPFC, OFC), social cognition (left ATL), and emotional responses (left insula)

Conclusions

- After value information is learned, organization of faces in similarity space is driven by social values and relates to future social preferences.
- Social value information is encoded in neural response patterns of areas within the face and value processing systems, when merely viewing faces and performing a repeat detection task.
- Responses in FFA are related to expectations of future social behavior, however do not encode face identity information.
- Whether specific areas contain integrated representations of social value and face identity, or whether network-level interactions underlie such associations, remains to be established.

References

- Original face images from PICS database: pics.stir.ac.uk
- Hackel, Doll, & Amodio (2015) Instrumental learning of traits versus rewards: dissociable neural correlates and effects on choice. *Nature Neuro, 18(9): 1233-1225.*
- Kable, J. W., & Glimcher, P. W. (2009). The neurobiology of decision: consensus and controversy. Neuron, 63(6), 733-745.

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