Brain activity reflecting social values associated with faces during binocular rivalry

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Introduction

Previous studies have shown behavioral evidence that social information can affect the degree of accessibility to conscious visual awareness [1][2].
However, whether and how information acquired through repeated social interactions affect visual perception of social stimuli, and the potential interactions between the neural mechanisms of social associative learning and social perception are understudied.
Here, we used functional magnetic resonance imaging (fMRI) to investigate the neural mechanisms underlying social associative learning and its impact on perceptual selection.

Methods

Participants

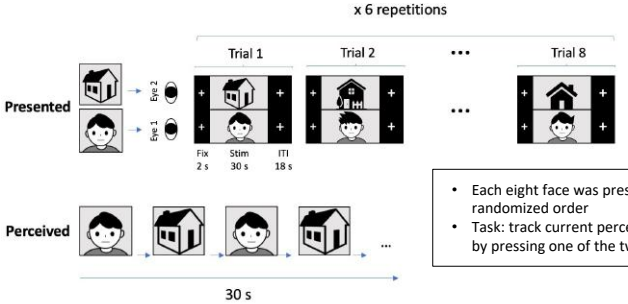
- 29 participants (12 females; age: 20-33)

Condition	Payback ratio
Generous	50-60%
Intermediate	30-40%
Selfish	10-20%
New	N/A

Stimuli

- Eight images of male faces and eight images of scenes (2.28° x 2.28°; grayscale)
- Four conditions : Generous, Intermediate, Selfish, New(Control)
- Six face images except "new" faces were presented during the Trust Game (TG)

Session1 (Behavioral) : Pre-learning Binocular Rivalry (BR)



- Each eight face was presented in a pseudo-randomized order
- Task: track current percept (face or scene?) by pressing one of the two assigned keys

Session2 (fMRI) : TG & Post-learning BR

((9~13 sec)+RT) < 16 sec

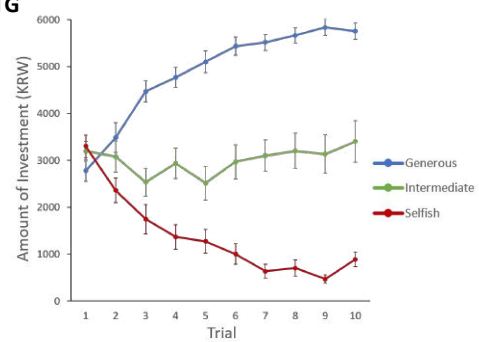
- In each trial, participant received 6000₩ and decided the initial investment amount among four options.
- 6 partners x 10 repetitions = 60 trials in total

Functional localizer scan

- Independent functional localizer scan was performed to localize face-selective region of interest (ROI)
- 1-back task using block-design (Face block, scene block)
- Voxels that responded significantly more to faces than scenes ($p < .001$, uncorrected) were grouped into clusters and face-selective ROIs were defined using 5 mm radius sphere centered onto the group peack activation of each cluster.

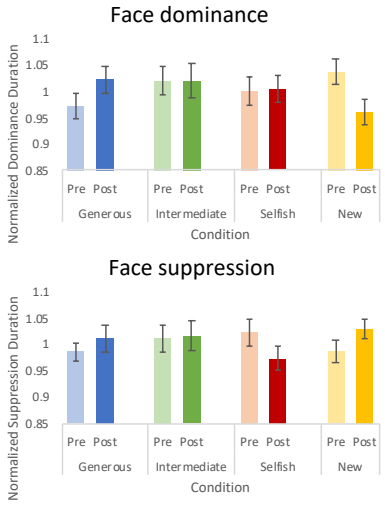
Behavioral Results

TG



- 2-way repeated measures ANOVA
- Factors: trial (1~10), condition (generous, intermediate, selfish)
- Significant condition x trial interaction was revealed ($F(7.64, 206.268) = 22.968$, $p < .001$),
- In the first two trials, no significant difference in investment amount was observed across conditions
- In the last two trials, the two conditions exhibited greatest difference (9th trial: $t = 5.571$, $p < .001$; 10th trial: $t = 5.001$, $p < .001$)

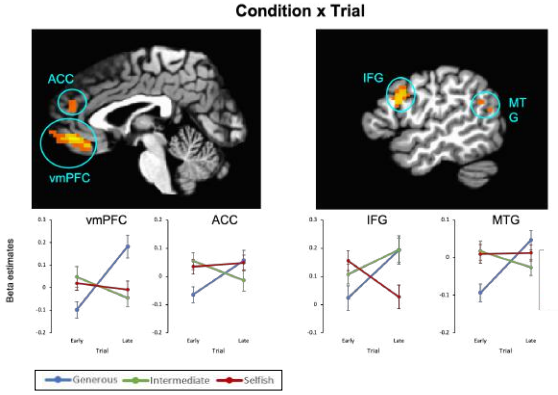
BR



- Mean face dominance duration refers to the mean of all durations when face was exclusively dominant over scene; vice versa for the mean face suppression duration.
- In order to pool data across the participants, individual dominance durations of faces and scenes were normalized to average dominance durations of faces and scenes respectively per participant.
- 2-way repeated measures ANOVA (factors: session, condition) revealed no significant main effect of condition nor the interaction effect.
- Post-Pre dominance duration showed statistically significant difference in "new" faces ($t(28) = -2.666$, $p = .013$) and marginally significant difference in "generous" faces ($t(28) = 2.035$, $p = .051$).

fMRI Results

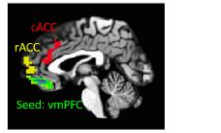
- fMRI results during TG

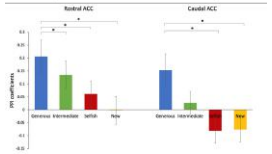


TG whole-brain group analysis
Cluster-based corrected, p < .005, 40 voxels

- Two fixed factors: condition (3 levels: generous, intermediate, selfish), trial (2 levels: early, late)
- Beta coefficients of each condition in "early" trials did not differ across conditions. However, difference between conditions were observed in the "late" trials.
- In the late trials, the vmPFC showed greater activation in the generous than in the intermediate ($t = 4.344$, $p < .001$) and selfish ($t = 3.657$, $p < .01$) conditions.

PPI results

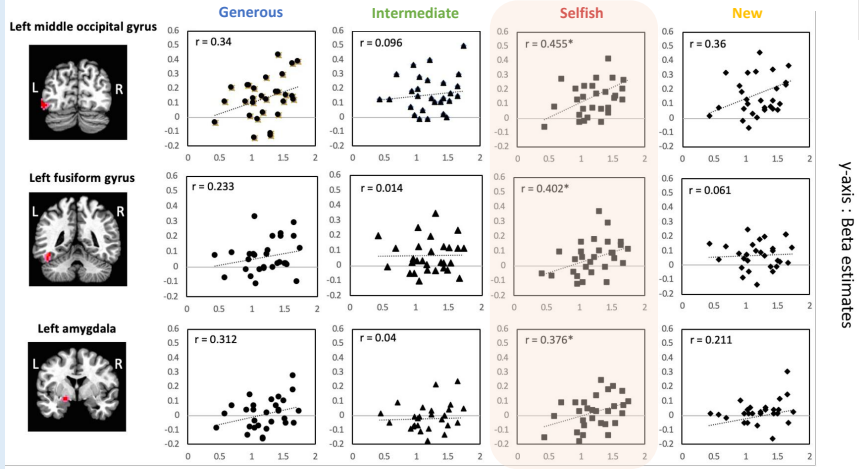




PPI analysis
Cluster-based corrected, p < .005, 40 voxels

- Brain region that showed different activation across conditions after learning has occurred in the TG was selected as the seed region. -> vmPFC
- When "generous" faces were perceptually dominant during the BR, vmPFC exhibited greater functional connectivity with rACC and cACC compared to other conditions.

- Brain-Behavior Correlation results
  : Activation in face-selective regions during BR & degree of learning during TG



Correlation analysis

- A marker termed as Learning index (LI) was defined to consider the potential influence of individual differences in the degree of associative learning on activation of face-selective region during the BR.
- LI = (Amount of Investment$_{Generous}$ – Amount of Investment$_{Selfish}$) / Amount of Investment$_{Average}$
- Greater LI indicates better learner.
- A positive correlation was observed between the LI and estimated beta coefficients in "selfish" condition in the left MOG, left FFA, and the left amyg.
- The better participants learned the association between each face and the amount of return, the greater these regions tend to be activated during the selfish faces were perceptually dominant.

Conclusion

- The current results show brain activation reflecting social values of faces acquired through associative learning and activation in face-relevant regions modulated by the learned social value, which implies potential linkage between social associative learning and social perception.
- The coupling of the vmPFC and the ACC may play an important role when processing social values of faces, especially when those faces deliver social values that are positive.

References & Acknowledgment

[1] Anderson, E., Siegel, E. H., Bliss-Moreau, E., & Barrett, L. F. (2011). The visual impact of gossip. Science, 332(6036), 1446-1448.
[2] Lee, M. Y. (2015). The impact of social associative learning on conscious visual awareness during binocular rivalry (Unpublished master's thesis). Korea University, Korea.

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