Neural mechanisms underlying face memories modulated by context-dependent impression of trustworthiness for others

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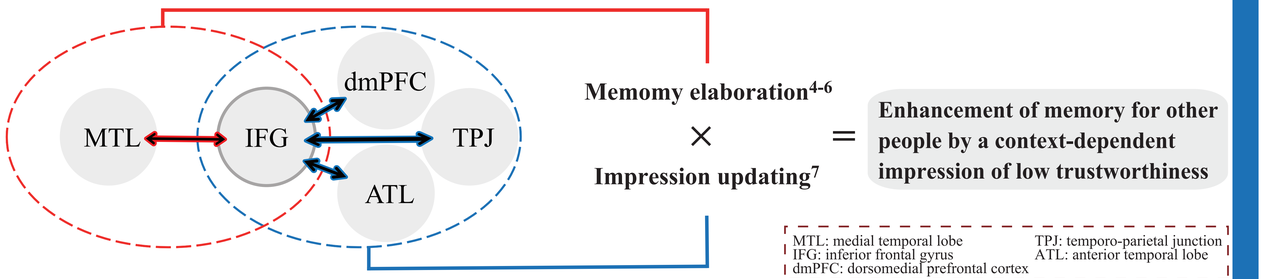
Introduction

The first impression of face-dependent trustworthiness is updated by a context such as daily behaviors in social situations. Previous studies have demonstrated that face memories are remembered more accurately when the face-dependent trustworthiness is low[1], and the memory enhancement is involved in interacting mechanisms between the hippocampus and the insula[2]. In addition, there is psychological evidence that memory for persons with the context-dependent impression of low trustworthiness is significantly enhanced, compared to those with the context-dependent impression of high trustworthiness[3]. However, little is known about the neural mechanisms underlying the enhancing effect by a context-dependent trustworthiness on memory for persons. The present fMRI study investigated this issue.

Hypothetical model



Methods

Participants

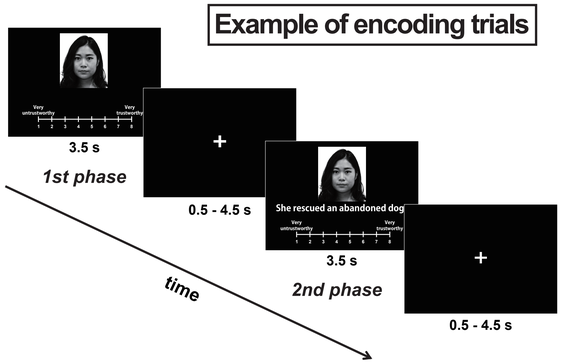
38 right-handed healthy females (mean age: 21.82 years, SD: 2.00) participated in the present study. All participants gave informed consent to the protocol approved by IRB of the Graduate School of Human and Environmental Studies, Kyoto University (19-H-1).

Stimuli

1) Faces. We prepared 216 pictures of unfamiliar female faces, which were selected from previous studies[8,9]. These stimuli were devided into 4 lists, in which 3 lists of target stimuli included 72 low, 36 middle and 72 high trustworthy faces, and the other list of distractor stimuli included 12 low, 12 middle, and 12 high trustworthy faces.

2) Sentences. 180 English sentences describing hypothetical actions were collected from a previous study[10], and were translated into Japanese sentences. These sentences included 72 low, 36 middle and 72 high trustworthy sentences, each of which was randomly paired with a target face.

Example of encoding trials



Task procedures

1) Encoding (with fMRI). In a trial of encoding, participants were initially presented with an unfamiliar face, and rated the first impression of face-dependent trustworthiness (*1st phase*). After the *1st phase*, participants were presented with the face paired with a sentence describing the hypothetical action, and rated the overall impression of context-dependent trustworthiness modulated by the sentence (*2nd phase*). Participants were not instructed that memory of faces was tested in the later retrieval task (incidental encoding).

2) Retrieval (without fMRI). During retrieval, participants were randomly presented with target and distractor faces one by one, and were required to recognize whether each face was previously learned or not in two levels of confidence (*DO: Definitely Old, PO: Propably Old, PN: Probably New, DN: Definitely New*).

MRI acquisition and analyses

All MRI data were acquired by a Siemens Verio 3T scanner in Kokoro Research Center, Kyoto University. Functional images were scanned by the multi-band technique of a gradient-echo EPI sequence (TR = 2 s, TE = 49.4 ms, FA = 75 degree, FOV = 22.4 cm, 112 × 112 matrix, 72 horizontal slices, 2.0 mm slice thickness, Multiband factor = 4).

SPM12 was employed for the pre-processing and statistical analyses of fMRI data. All encoding trials were categorized into three conditions of the *Low* (levels 1-3), *Middle* (levels 4-5) and *High* (levels 6-8) trustworthiness by the subjective rating scores in the *2nd phase*, and were subdivided into three conditions of subsequent hits with high confidence (*HH*), subsequent hits with low confidence (*HL*) and subsequent misses (*Miss*).

Activation reflecting the decreasing impression of context-dependent trustworthiness

In the subject-level analysis, trial-related activation in both *1st* and *2nd phases* were modelled. In addition, activation reflecting the decreasing impression of trustworthiness in the *2nd phase* were identified by the parametric modulation analysis with a liner regressor (*Low* = 3, *Middle* = 2, *High* = 1). In the group-level analysis, activation patterns in a paired t-test of *2nd phase* vs. *1st phase* were inclusively masked by activation patterns in a one-sample t-test for contrasts related to the decreasing trustworthiness in the parametric modulation analysis.

Activation reflecting the successful encoding

In the subject-level analysis, *HH*, *HL*, and *Miss*-related activation in the *2nd phase* was modelled. In the group-level analysis, activation in a one-sample t-test for *HH* vs. *Miss* was inclusively masked by activation in a one-sample t-test for *HH* vs. *HL*.

Functional connectivity analysis

Region-to-region functional connectivity was analyzed by the gPPI toolbox in SPM12. In the gPPI analysis, we employed the conjunction analysis for the PPI regressor contrasts to identify significant functional connectivity shared among three conditions of the *Low*, *Middle* and *High* trustworthiness in the *2nd phase*. In addition, functional connectivity specific in the context-dependent *Low* trustworthiness was identified in the PPI regressor contrasts for *Low* masked exclusively by the PPI regressor contrasts for *Middle* and *High*. In the gPPI analysis, seed VOIs were defined in the left IFG and hippocampus.

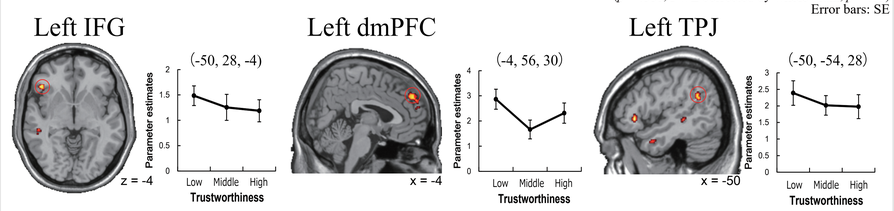
Behavioral results

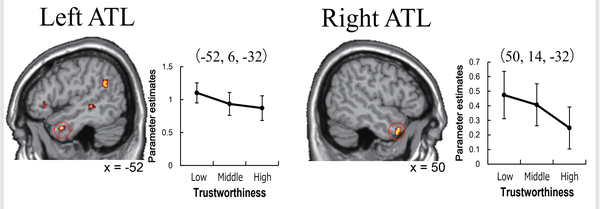
A one-way ANOVA for the *HH* rates showed a significant effect of context-dependent trustworthiness (*Low*, *Middle*, and *High*) [$F(2,56) = 7.45$, $p < .01$, $\eta^2 = .21$]. Post-hoc tests showed that the *HH* rates in *Low* were significantly higher than those in *Middle* and *High* ($p < .01$ for all comparisons).

fMRI results

Activation reflecting the decreasing impression of context-dependent trustworthiness

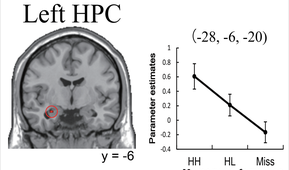
($p < .001$, FWE corrected by whole brain, $p < .05$)
Error bars: SE





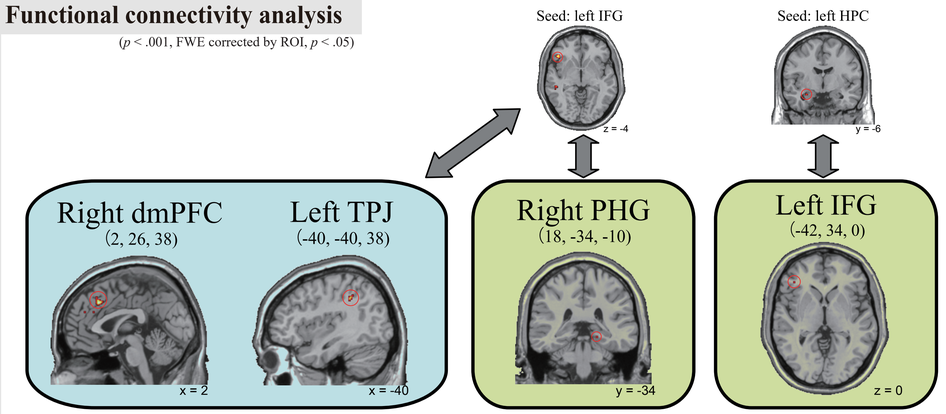
Activation reflecting the successful encoding

($p < .001$, FWE corrected by ROI, $p < .05$)



Functional connectivity analysis

($p < .001$, FWE corrected by ROI, $p < .05$)



IFG:
inferior frontal gyrus

dmPFC:
dorsomedial prefrontal cortex

TPJ:
temporo-parietal junction

ATL:
anterior temporal lobe

HPC:
hippocampus

PHG:
parahippocampal gyrus

Conclusion

These findings suggest that the enhancement of memory for other people by a context-dependent impression of low trustworthiness could be modulated by interacting mechanisms between systems of the memory elaboration including the left IFG and MTL and of the context-dependent trustworthiness including the left IFG, dmPFC and TPJ.

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