The neural correlates of illusory face perception: An fMRI study

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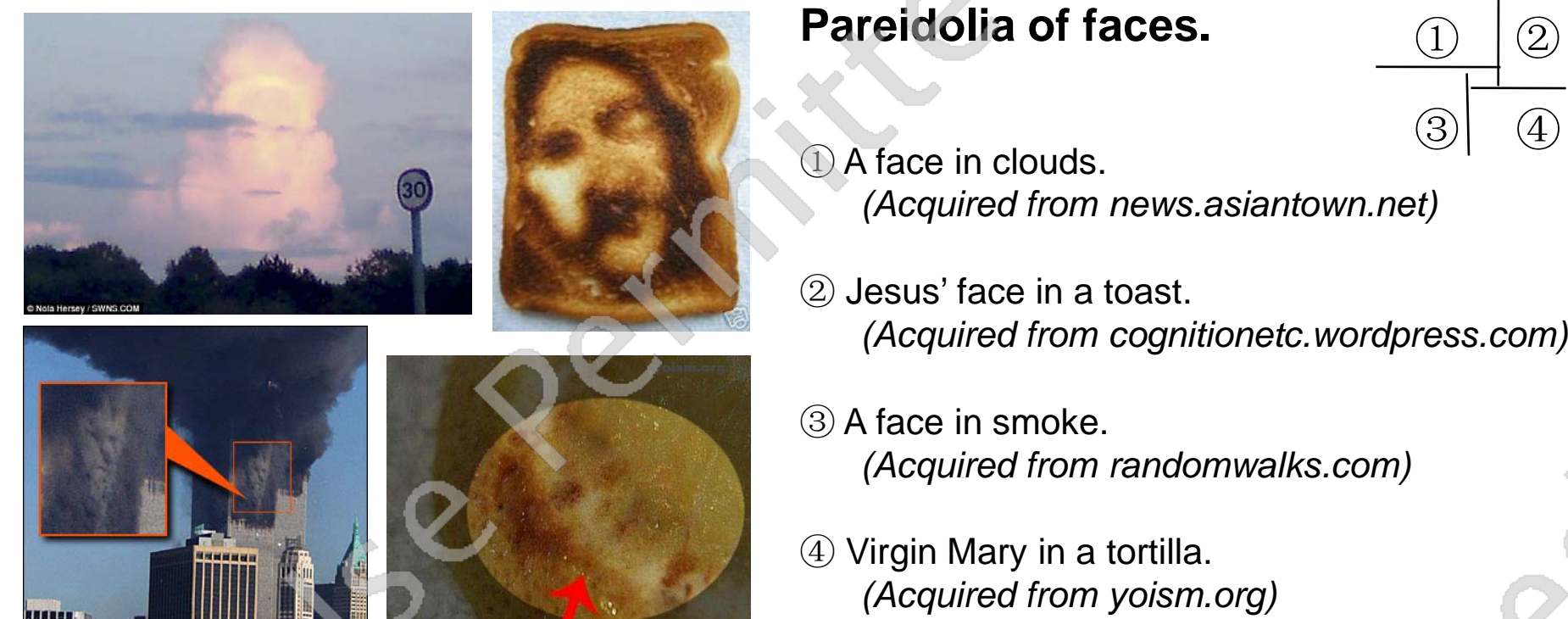
Introduction

Illusory perception of a non-existent visual object or sound is a common occurrence. In general, this is called 'pareidolia' although the most well recognized form occurs with faces: individuals often report seeing a face in the clouds, Jesus in toast, or the Virgin Mary in a tortilla. These informal observations suggest that our visual system is highly tuned to perceive faces, potentially due to the high social importance of faces or our face processing expertise. The present study using a method analogue to reverse correlation [1] to explore the neural mechanism of face pareidolia.
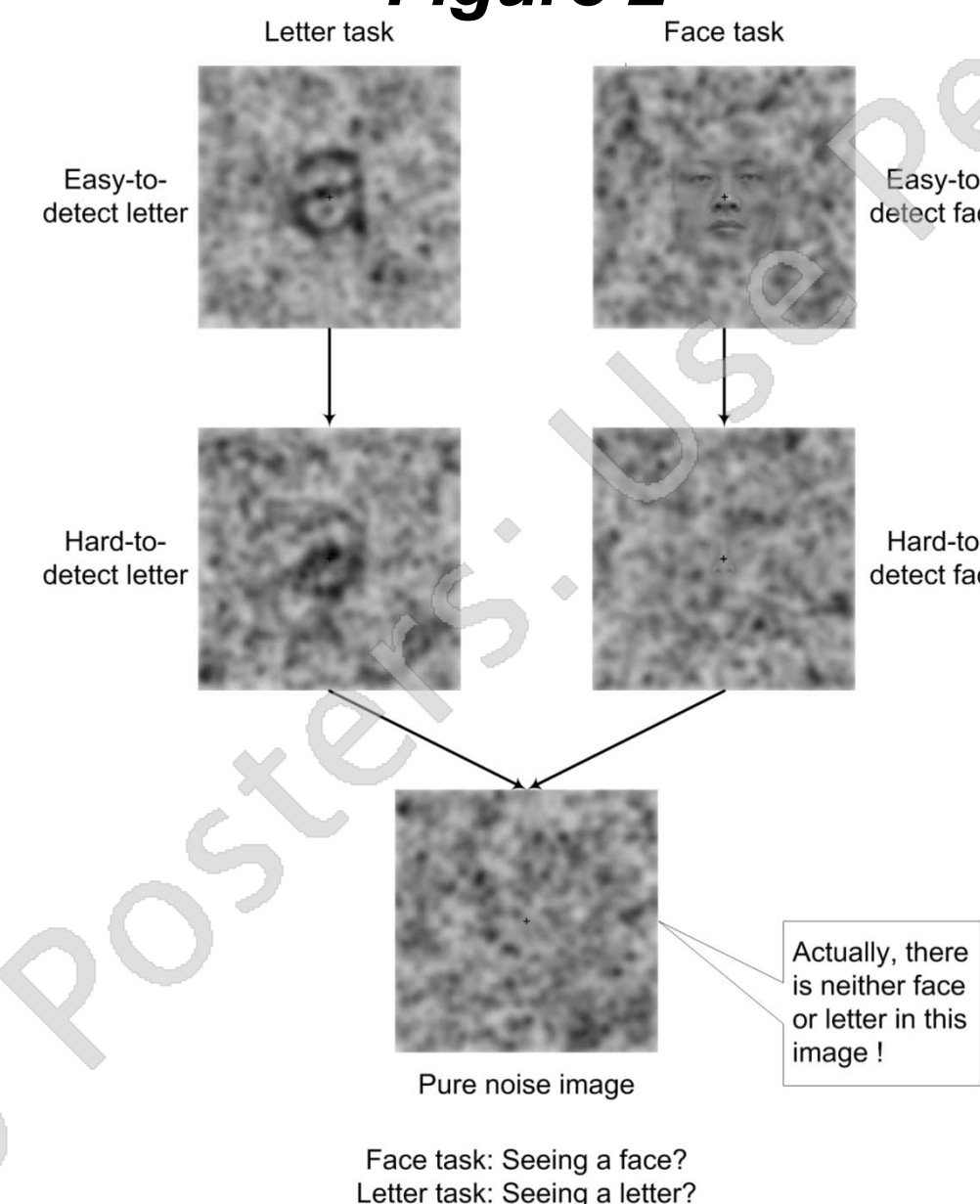
Figure 1

Pareidolia of faces.

① A face in clouds.
   (Acquired from news.asiantown.net)
② Jesus' face in a toast.
   (Acquired from cognitionetc.wordpress.com)
③ A face in smoke.
   (Acquired from randomwalks.com)
④ Virgin Mary in a tortilla.
   (Acquired from yoism.org)

Methods

Experimental paradigm

Figure 2

Letter task   Face task

Easy-to-detect letter   Easy-to-detect face

Hard-to-detect letter   Hard-to-detect face

Pure noise image

Actually, there is neither face or letter in this image !

Face task: Seeing a face?
Letter task: Seeing a letter?

Participants   Twenty healthy adults.

Experimental conditions

Based on the participants' responses to the pure-noise images.
(1) Face response: 'Seeing' a face;
(2) No-face response: Not 'seeing' a face;
(3) Letter response: 'Seeing' a letter;
(4) No-letter response: Not 'Seeing' a letter.

Scanner model and scanning parameters

T2*-weighted gradient-echo planar imaging (EPI) sequence (TR/TE = 2000/30 ms; 32 slices; 4 mm thickness; matrix = 64×64) covering the whole brain with a resolution of 3.75× 3.75 mm^2.

FMRI data analyses

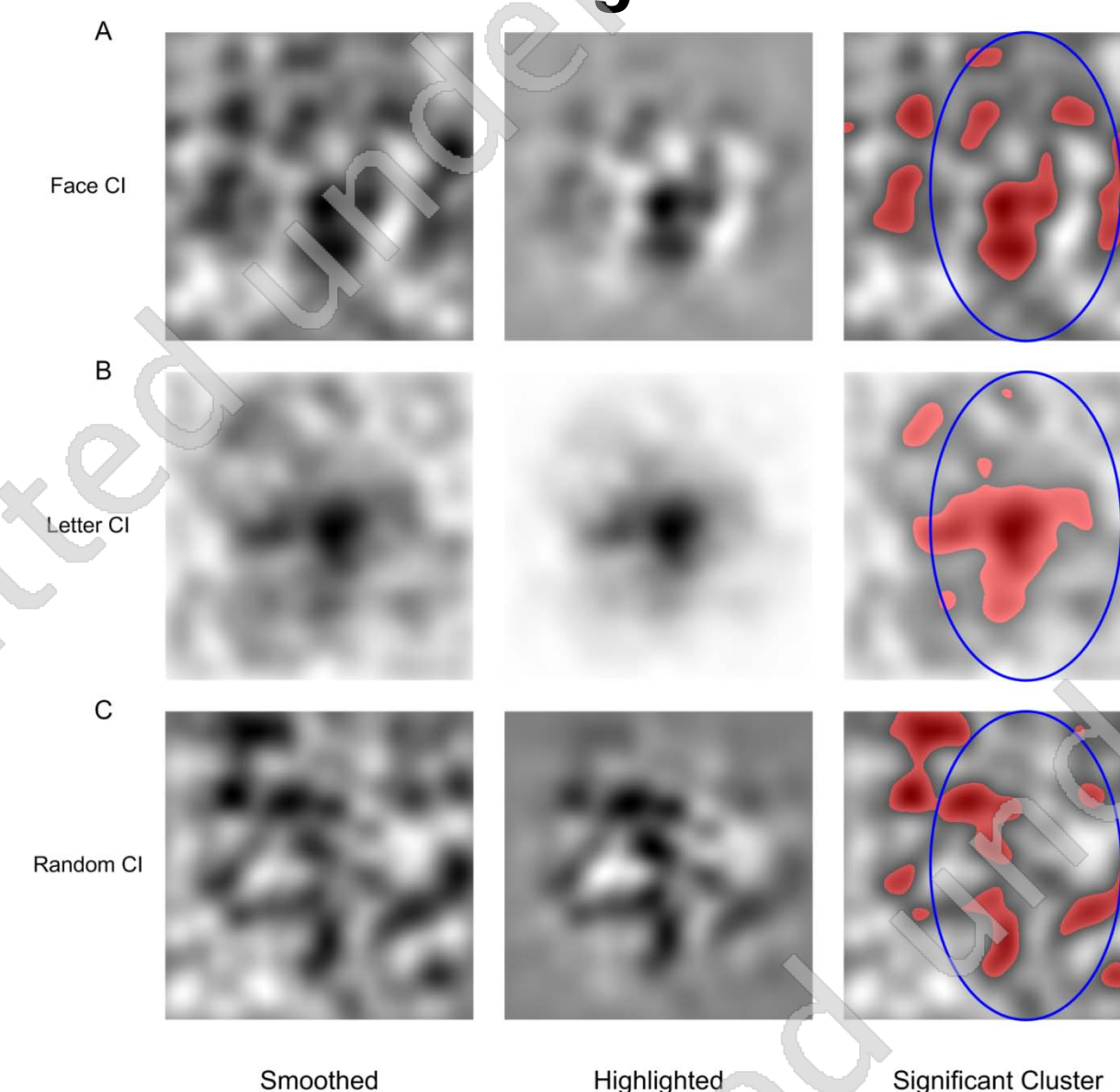General Linear Models (GLM) [2].

Results

Behavior results

Ratio of face response: 34.23% (SD = 15.95%)
Ratio of letter response: 38.27% (SD=18.40%)

Categorization Image (CI)

Figure 3

A Face CI

B Letter CI

C Random CI

Smoothed   Highlighted   Significant Cluster

Note: The significance of the cluster of each CI was tested using "Stat4Ci Matlab toolbox" [3]

Results of ROI analyses

The interaction of task (face task vs. letter task) by detection (face or letter response vs. no such response) is observed only in the right FFA.
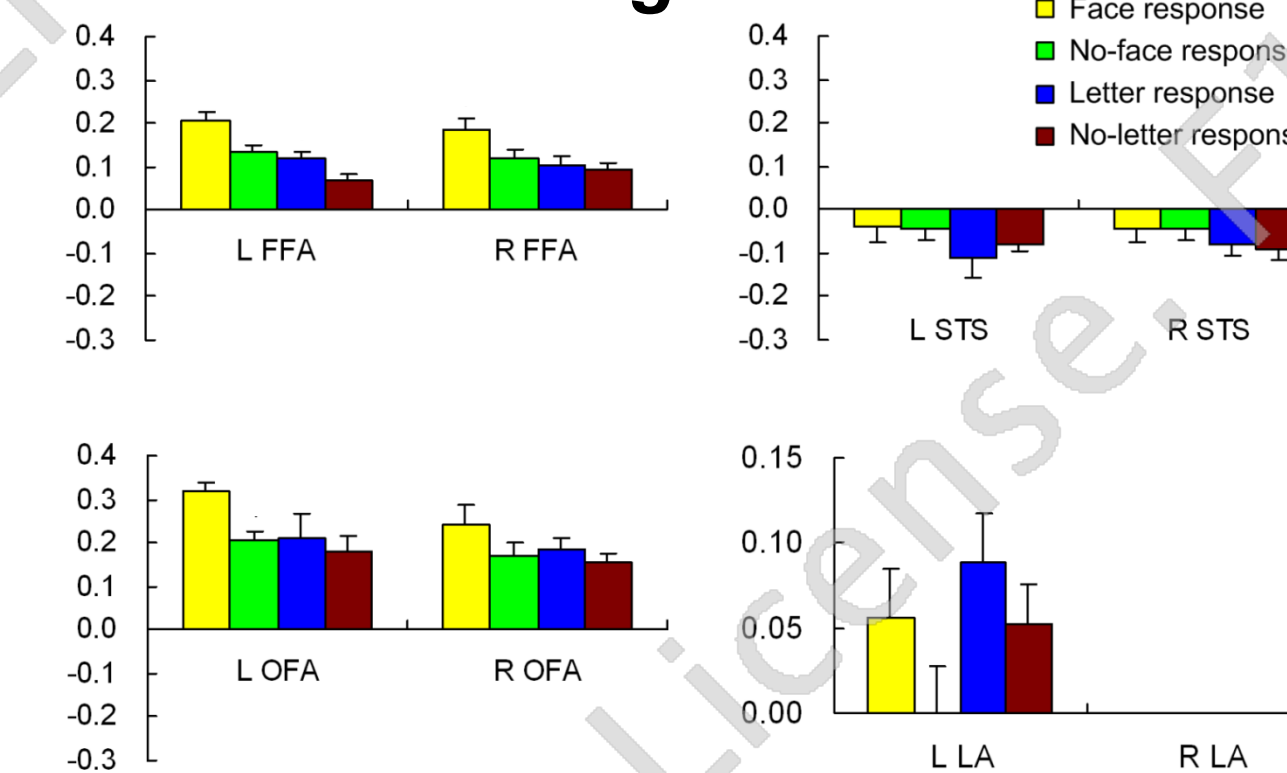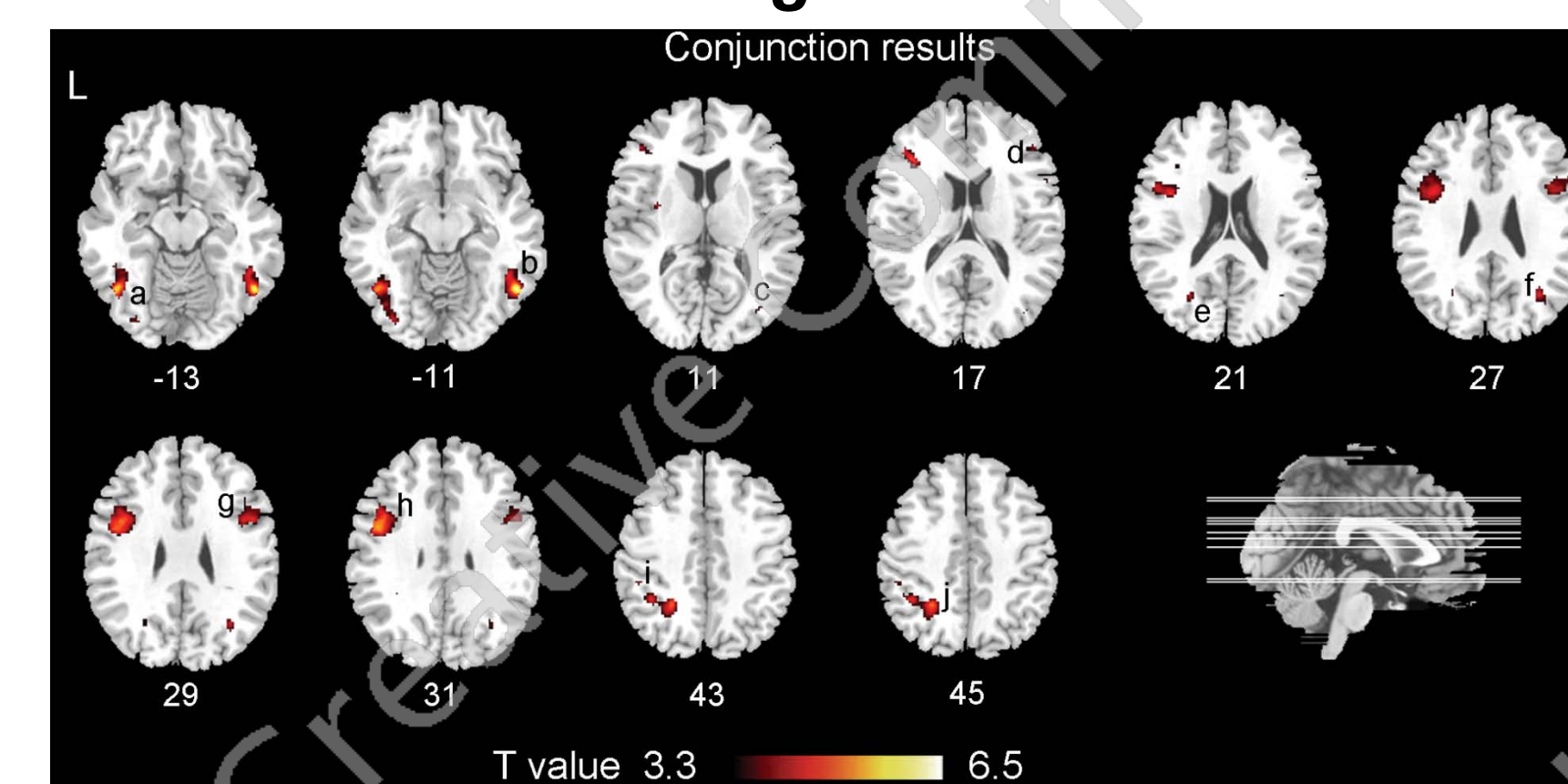
Figure 4

Face response
No-face response
Letter response
No-letter response

Table 1

Region	Interaction	Main effect	
		Task	Detection
Right FFA	***	Face > Letter	Detection > No Detection
Left FFA	N.S.	Face > Letter	Detection > No Detection
Right OFA	N.S.	N.S.	Detection > No Detection
Left OFA	N.S.	N.S.	Detection > No Detection
Right STS	N.S.	N.S.	N.S.
Left STS	N.S.	Face > Letter	N.S.
Left LA	N.S.	Face < Letter	Detection > No Detection

*** $p < .001$, N.S. = not significant

Results of Whole brain analysis
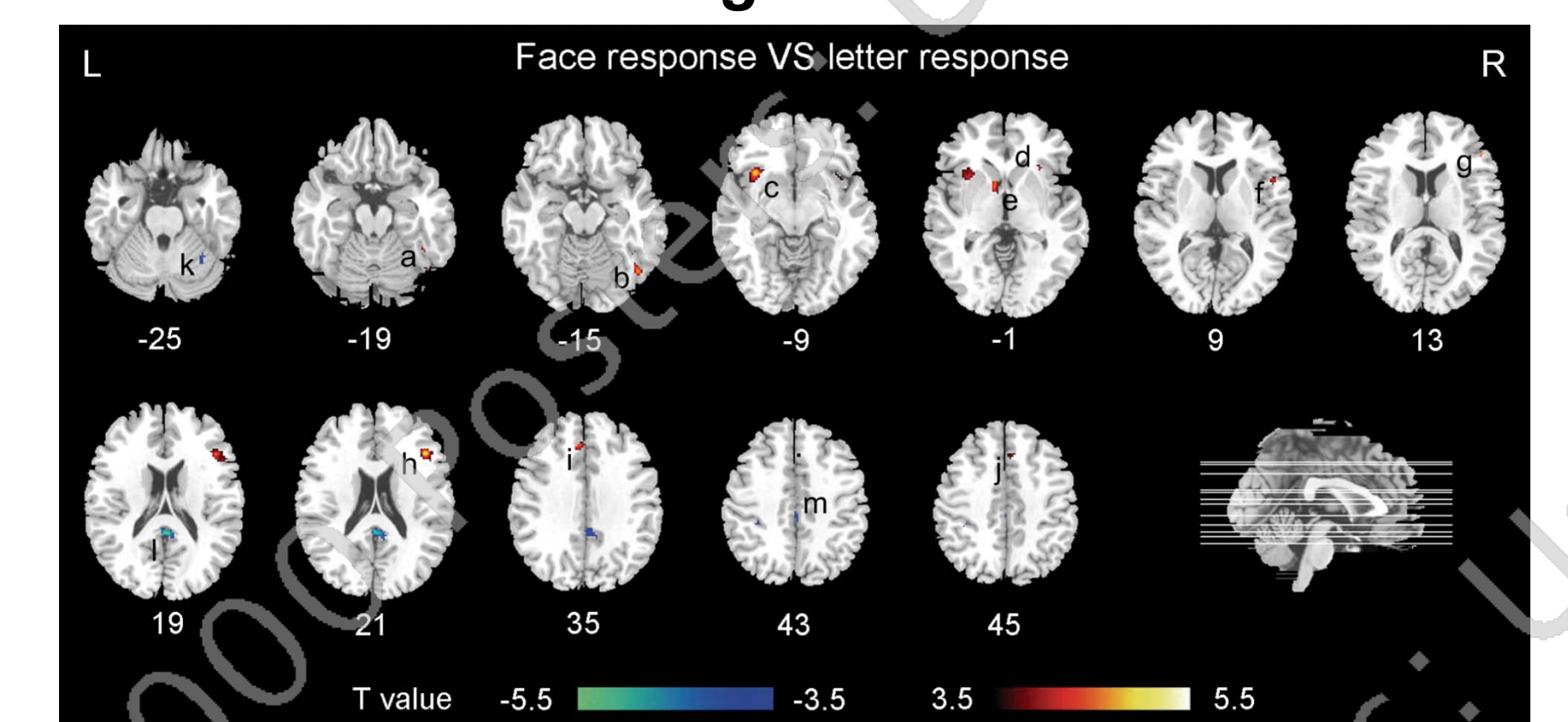
Conjunct activation of face response minus no-face response and letter response minus no-letter response.

Figure 5

Conjunction results

T value 3.3 6.5

Activation comparison of face response vs. letter response.

Figure 6

Face response VS letter response

T value -5.5 -3.5 3.5 5.5

Conclusions

The ROI results indicate
(1) The right FFA may play a specialized role in face pareidolia;
(2) The left FFA may be involved in the pareidolia of both face and letter.

The whole brain results indicate
(1) There is a neural network specialized in illusory face detection;
(2) Such network includes not only the conventional face-preferential regions (e.g., the right ventral occipitotemporal cortex), but also some high level cognitive regions within the prefrontal cortex and subcortical regions.

Our findings suggest that the right FFA may be a meeting point that play a significant role in the integration of top-down modulation (coming from the prefrontal cortex) and bottom-up input. The top-down modulation may facilitate us to detect a face even based on very slight clue. This tendency to perceive a face from ambiguous visual background is perhaps highly adaptive given the supreme importance of faces in our social life and a high cost when failing to detect a true face.

Bibliography

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3. Chauvin, A., Worsley, K.J., Schyns, P.G., Arguin, M., Gosselin, F., 2005. Accurate statistical tests for smooth classification images. *J. Vis., 5 (9)*, 659–667.