

Probing into specificity of neuronal circuits through fMRI refractory response

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Introduction

It is difficult directly to probe into specificity of neuronal circuits by fMRI because of the limitation of spatial resolution. It is possible to get the information for the specificity through a refractory suppression. The refractory suppression is signal reduction in fMRI response to the second stimulus when two stimuli are successively given with short inter stimulus interval. The suppression depends on interaction between neuronal circuits which process the stimuli. It is known that there are specialized areas for object categories in the ventral visual pathway. But it is not clear where objects are categorized and identified. There is a possibility that neuronal circuits sensitive to a category have strong interaction in their responses to individual elements in a same category but neuronal circuits sensitive to each individual element in the category have weak interaction. To find functional areas which have these neuronal prosperities through the refractory suppression, we devised a paired stimulus paradigm. We identified two functional regions, one had neuronal circuits responded broadly to the category of face and the other had neuronal circuits responded specifically to individual faces.

Materials and Methods

Seventeen healthy volunteers participated in the study. They all signed the informed consent. The consent form and the protocols have been approved by the IRB of the foundation. All MRI experiments were performed with an Allegra (Siemens, Germany) with a standard head coil operating at 3 Tesla. Visual stimulation was provided with a screen over the head through a projector. Face pictures were used for the visual stimuli. The initial control state of 40-s period was followed by stimulus state of 108-s period and the post-stimulus control state of 40-s period. In the control state a face picture was presented at every two seconds. Stimulus state consisted of three blocks. Paired faces were presented at every two seconds in all blocks. Pairs in the first and third blocks consisted of different face pictures with the same size and pairs in the second block consisted of same face pictures with different sizes. Each stimulation block consisted of 18 paired stimuli with varying ISI from 0ms to 540ms. The on-duration of each picture was 33ms.

Results

There was no significant difference between different faces pair and the same face pair in early visual areas. But ventral occipitotemporal region, especially lateral occipital and fusiform gyrus showed significant reduction in fMRI response to the same face pair. There was a trend of interaction in the region. The interaction became weak from the posterior to the anterior (Fig. 1).

Discussion

The response reduction to the same face pair at the occipitotemporal region in spite of different sizes indicates the discrimination of difference between the same and the different was done there. The interaction indicates that the neuronal circuits in the posterior part had broad sensitivity to the category of faces rather than sharp sensitivity to each individual face and that the neuronal circuits in the anterior part had sharp sensitivity to each individual. This means that the posterior part is related to the categorization and the anterior part is related to the identification.

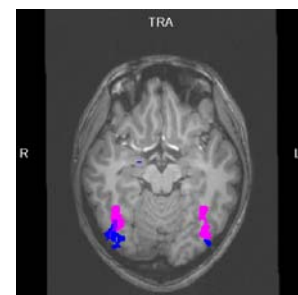


Figure. 1 Map of interaction:
Blue > Pink