Configural and Featural Face Discrimination: Event Related fMRI study

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Despite the intense studies of face processing in the past few decades, we know little about what neural correlates are involved in the configural and featural face processing. The aim of the study was to find whether the neural correlates for configural and featural face processing is different and if so, where and how their neural correlates operate for the face recognition. We found inferior temporal gyrus

Introduction

Mechanisms of face perception have been known from fMRI studies of the fusiform face area (FFA). However, there is considerable disagreement in the literature concerning both the nature of the processing that occurs in the FFA and the question of whether the FFA is exclusively involved in face perception. Furthermore, we know little about what neural correlates are corresponding to the widespread view that face perception can be dissociable into configural and featural processings. Recently, using block designed fMRI study, Yovel and Kanwisher reported no difference in the activities of FFA between during the configural and the featural face processing. With the results, they insisted that face perception is domain specific not process specific. Given that there have been other suggested brain regions such as superior temporal gyrus or occipital gyrus even for simple face perception and Yovel and Kanwisher did not include other brain areas for the analysis, we performed event-related fMRI study to find whether the neural correlates for configural and featural face processing is distinguishable and if so, where and how their neural correlates operate for the face recognition.

Method

12 healthy normal participants were recruited for the study. For the stimuli used for the fMRI paradigm, two sets of faces that differentiated configural from featural processing were created (Fig.1a, b).

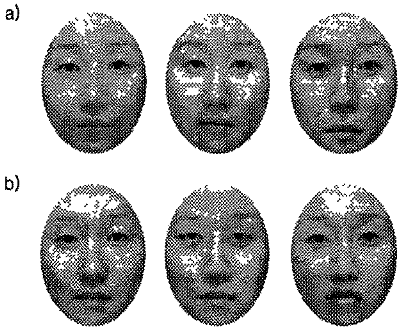


Figure 1. The face stimuli a) Configural stimulus set shows variations in spacing of the eyes and between the nose and mouth. b) Featural stimulus set shows variations in individual features (eyes and mouth).

The software package Presentation (Neurobehavioral Systems Inc., http://www.neuro-bs.com/) was used to present stimuli and record responses. Stimuli were presented through overhead-mirror reflecting the projected image on white screen and responses were recorded using two buttons of a mouse. During each 10 min, 4 s functional run, each of the 40 pairs of configurally different faces, featurally different faces and same faces were presented in a random sequence +optimized and counterbalanced using the optseq algorithm (http://www.surfer.nmr.mgh.harvard.edu/optseq/), which provides temporal jitter to increase signal discriminability Each of the two runs consisted of a different optimized random sequence. The interstimulus intervals varied from 2 to 12 seconds, with an average of 4 seconds. The fixation stimulus was a gray question mark (?) centered on a black background. Each picture of the pair that was to be judged as same or different face was presented for 1200 ms with a 450ms gap between each picture presentation.

MRI data will be acquired on a 1.5 Siemens (Erlangen, Germany) system equipped with a head volume coil. Structural images will be acquired with a T1-weighted sequence and functional images with a gradient echo-planar T2* sequence using BOLD (blood oxygenation level-dependent) contrast. Each functional image comprise 25 transverse slices (4 mm thickness, no gap, 64 × 64, 3 × 3 mm2 pixels, TE = 40 ms) covering the whole brain. A total of 320 functional volumes in one scan will be acquired twice continuously with an effective repetition time (TR) of 2s. Data will be analyzed using the general linear model for event related designs using SPM2 software (Wellcome Dept. of Cognitive Neurology, London, UK; http://fil.ion.ucl.ac.uk/spm). After all scans are realigned, normalized, time-corrected, and spatially smoothed by an 8 mm FWHM (full-width half-maximum) Gaussian kernel, a high-pass frequency filter (cutoff 128 s) and corrections for auto-correlation between scans will be applied to the time series. Visual display will be done using AFNI and SUMA.

Results

The behavioral performance was not different among the 'configural', 'featural' and 'same' discrimination tasks (Fig.2).

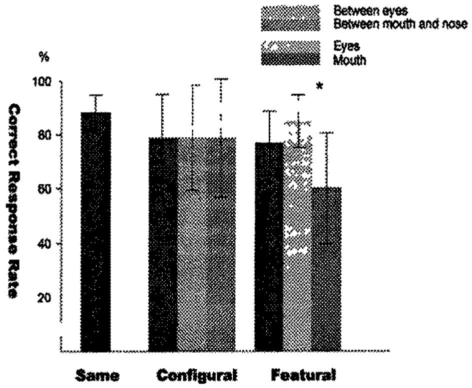
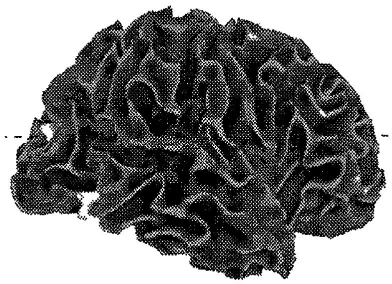


Figure 2. The percentage of correct response rate among the 'configural', 'featural' and 'same' discrimination tasks. The gray bars represent average correct response percentage. In case of featural face processing, the shapal chages in mouth were harder to discriminate compared to the changes in the eyes ($p<0.05$).

Figure 3 shows that the inferior temporal gyrus, occipito-parietal junction and middle frontal gyrus manifested greater activation for 'configural' discrimination task compared to the 'same' control discrimination task.

a)



b)

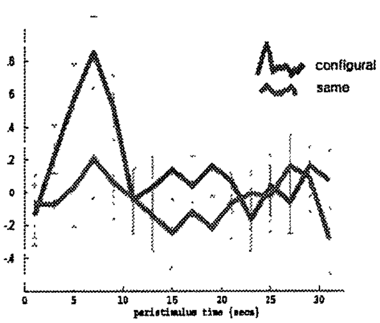


Figure 3. a) The inferior temporal gyrus, occipito-parietal junction area and middle frontal gyrus showing greater activation for configural discrimination compared to the same control discrimination task. b). The pattern of activation at the inferior temporal gyrus during the peristimulus time.

Of those areas, especially inferior temporal gyrus showed greater activation for 'configural' discrimination compared to both the 'same' control and the 'featural' discrimination tasks (Fig.4).

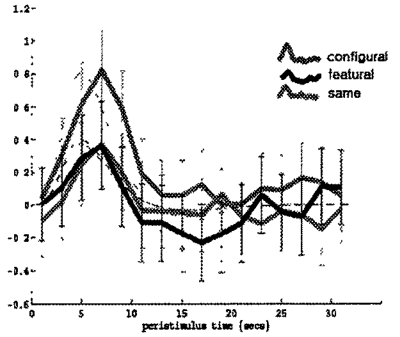


Figure 4. The pattern of activation during the peristimulus time at the inferior temporal gyrus showing greater activation for 'configural' discrimination compared to both the 'same' control and the 'featural' discrimination tasks.

Discussion

We found that several areas other than FFA were involved in the face recognition processing. The exclusion of FFA is surprising even considering that the areas were only identified by the closely-matched contrasting tasks, in which subjects had to discriminate image pairs of faces that differ in only the spatial relations between parts or in only the shapes of parts. The claim by Kanwisher group that the face perception is not process-specific can be right, but only right in FFA area. As our results showed, the certain areas of inferior temporal gyrus react to face stimuli with a distinct gradient according to the differences in face recognition processing. This finding of process -specific area suggest that FFA is necessary but not sufficient for the recognition of faces.

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