The role of radial frequency components in face recognition: an fMRI study

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Background: A novel class of synthetic face stimuli with radial frequency components have been recently introduced to vision science. Synthetic faces are extracted from digital photographs of individual faces on 37 perceptual dimensions and band-pass filtered after converting into radial frequencies for the head shape (fig. 1). The present study was motivated by recent fMRI studies, which have shown that human ventral V4v area and fusiform face area (FFA) were selectively activated by radial gratings and face stimuli. Here, we have used fMRI to determine whether these visual areas are consistently activated by synthetic faces. We also investigated the characteristics of the underlying neural mechanisms in face categorization.

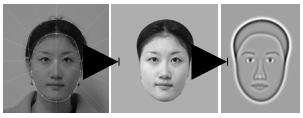

figure 1. construction of a synthetic

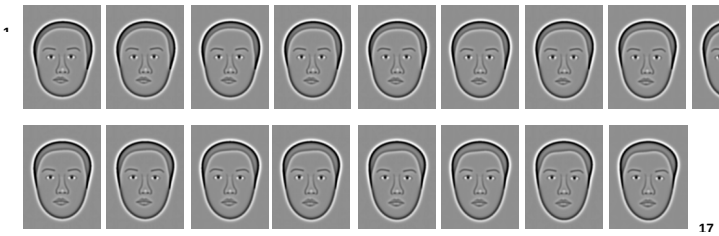

figure 2. stimuli used in expt. 2.

Method: In expt. 1, a block design was used in which nine participants viewed the photographic face (PF), synthetic face (SF), and mean-gray inter-stimuli for 9 secs each in a block. Six blocks consisted of identical PFs/SFs and other six blocks consisted of different ones. Participants were scanned in a 3.0T MRI system (Oxford magnet, Varian console built up by ISOL) with a quadrature headcoil. During the scan, participants pressed a mouse button to indicate whether two stimuli in each block were identical person's faces. Using BrainVoyager for data analysis, the activation of V1, V4v, and FFA were examined. In expt. 2, two faces were chosen and 15 faces equally spaced in 37 dimensions between these two faces were created (fig. 2). Seventeen synthetic faces were then sequentially presented for 9 secs. Participants indicated by pressing a mouse when the face on the screen is different from the previously displayed one. The order of presentation is reversed in two different sessions.

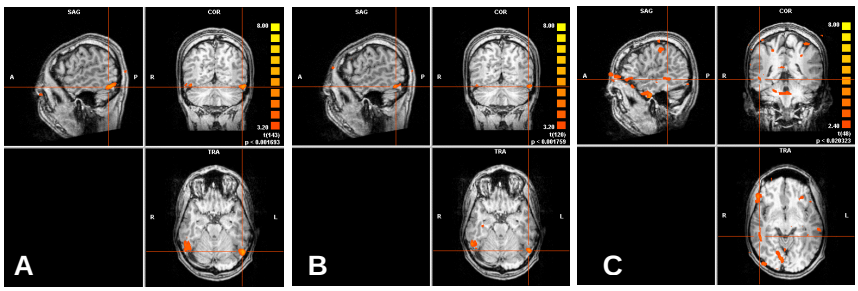

figure 3. relative activation by PF and control stimulus (A), SF and control stimulus (B) in FFA, and by SF and PF in V4v (C)

Results and discussion: Expt. 1: In all brain areas examined, the PF and SF produced strong activation relative to the mean luminance control condition. Different activation by the PF and SF was observed in V1 and V4v. However, there was no difference in activation by both face stimuli in FFA (fig. 3). Consistent with a previous psychophysical study, these results suggest that the synthetic faces capture a significant portion of the geometric information that individuates faces and that the radial frequency information contained in the SF is important at the intermediate form vision level. **Expt 2:** The result (fig. 4) showed that there is a hysteresis in categorizing two faces. Wherever subjects started to see the faces, they perceived two different faces, but discriminated at a different point depending on the starting face. Also, it has been observed that the strength of selective activation in FFA gradually decreased after the recognition of the starting face but there was a brief increase of activation just in the point of categorization and then gradual decrease again after making the decision. These results clearly showed the neural characteristics of the dynamics in face categorization.

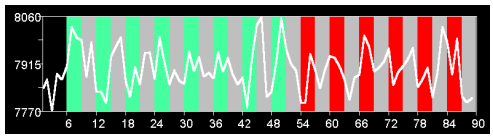

figure 4. activation pattern in FFA

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