Human perception of faces and face cartoons: an fMRI study

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BACKGROUND: Humans perceive both pictures of real faces and cartoon faces as faces although the features of these objects differ substantially. Previous fMRI studies have demonstrated the role of the fusiform gyrus in face perception (1) and in object expertise (2). However, it is unclear if activity in these brain areas changes when different face models are viewed

OBJECTIVE: To determine with fMRI whether the neural substrates underlying face perception change when processing faces that vary gradually in feature complexity, from face pictures to very simple face cartoons (see Figure).

METHODS:

Subjects and stimuli: Healthy adult subjects (2 females, 2 males, ages 18-23) participated in passive viewing tasks during fMRI scanning. All subjects were right-handed and had corrected-to-normal vision. We used three stimulus sequences: a face localizer consisting of two-tone face and house pictures (1), face and house cartoons, Brunswik faces (3) and house cartoons. Subjects were novice to the stimuli. The stimulus sequences had identical timing: six 30sec stimulus epochs interleaved with seven 20sec fixation epochs. Stimulus epochs alternated between the two different conditions (faces and houses) being compared in each sequence. Stimulus presentation rate was 2.5 Hz and visual angle ~3°. Stimuli were displayed on a monitor which the subjects could see through mirrors. The stimulus sequences were presented pseudo-randomly 2 or 3 times for data averaging.

FMRI: Whole brain single shot T_2*-weighted spiral functional images were acquired using the manufacturer's head birdcage coil on a 1.5-Tesla scanner (General Electric Signa, Milwaukee, WI). Imaging parameters were: TE=50ms, TR=2500ms, 3.125 x 3.125 mm in plane resolution, 4mm-thick axial slices, 1mm slice gap.

Data analysis: Data were processed using standard procedures in SPM99b (4). Before statistical analysis, data were motion corrected, Tailarach normalized, and spatially smoothed. The data were analyzed using a fixed-effects statistical model comprising subject-specific effects (signal change during face viewing and signal change during house viewing). Activation is defined as the difference in the signal changes between the two conditions. For each subject, data were scaled to the global brain mean and analyzed separately to locate the areas which responded more to faces than to houses during the different stimuli sequences. The strength of the effect was then averaged in these areas across subjects for each condition.

RESULTS: All subjects reported perceiving the face and house stimuli (pictures and cartoons) as faces and houses, respectively. The data from two subjects data had to be discarded due to extensive motion. The remaining subjects showed clear activation (face > house) in both the lateral occipital (LO) cortex ($p<0.001$, uncorrected) and in the purported fusiform face area (FFA, $p<0.001$, uncorrected) during the face localizer scan. LO activity was bilateral whereas FFA was significant on the right side only. In both of these areas, activation decreased during the presentation of the cartoons and was not observed with Brunswik faces. The Figure summarizes our results for activation in the FFA. The contrast between face and house signal changes in the FFA decreased as the stimuli became simpler. Similar results were found for the LO

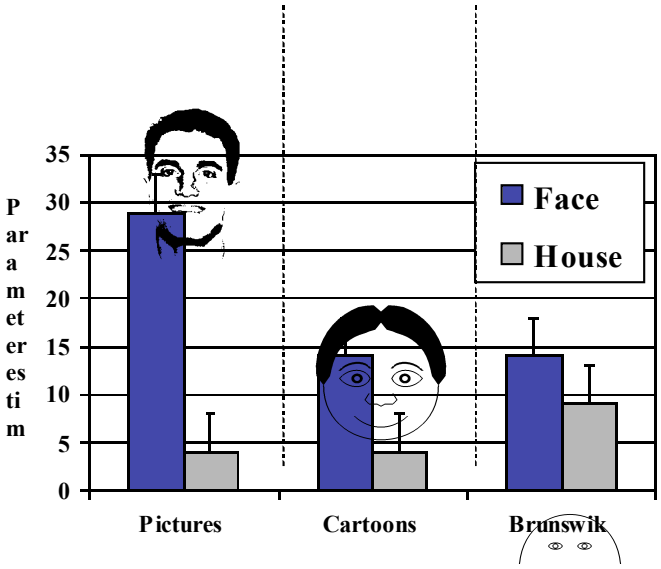

Figure: Average face and house activity in the FFA. The height of the bars represent the estimate of the parameters fitted to model the brain response using the linear model.

DISCUSSION: Activation in the lateral occipital cortex may reflect differences in feature processing between the face and house stimuli. With simpler, more abstract stimuli the activation becomes insignificant. Likewise, activation in the fusiform gyrus becomes insignificant for the simpler Brunswik faces even though they were perceived as faces. This may reflect a lack of expertise effect as subjects were novice to the cartoons but naturally better trained for recognizing face and house pictures. However, an expertise effect would not fully explain the differences observed between cartoons and Brunswik faces. Future studies will evaluate the effects of training.

References:

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