ELSEVIER

Psychiatry Research: Neuroimaging Section 83 (1998) 127–138

PSYCHIATRY RESEARCH
NEUROIMAGING

Investigation of facial recognition memory and happy and sad facial expression perception: an fMRI study

Mary L. Phillips[a,*], Edward T. Bullmore[a], Robert Howard[c], Peter W.R. Woodruff[a], Ian C. Wright[a], Steven C.R. Williams[b], Andrew Simmons[b], Christopher Andrew[b], Michael Brammer[a], Anthony S. David[a]

[a] *Department of Psychological Medicine, Institute of Psychiatry, Denmark Hill, London SE5 8AF, UK*
[b] *Department of Clinical Neurosciences, Institute of Psychiatry, De Crespigny Park, London SE5 8AF, UK*
[c] *Section of Old Age Psychiatry, The Maudsley Hospital, London SE5 8AZ, UK*

Received 11 March 1998; received in revised form 29 June 1998; accepted 30 June 1998

Abstract

We investigated facial recognition memory (for previously unfamiliar faces) and facial expression perception with functional magnetic resonance imaging (fMRI). Eight healthy, right-handed volunteers participated. For the facial recognition task, subjects made a decision as to the familiarity of each of 50 faces (25 previously viewed; 25 novel). We detected signal increase in the right middle temporal gyrus and left prefrontal cortex during presentation of familiar faces, and in several brain regions, including bilateral posterior cingulate gyri, bilateral insulae and right middle occipital cortex during presentation of unfamiliar faces. Standard facial expressions of emotion were used as stimuli in two further tasks of facial expression perception. In the first task, subjects were presented with alternating happy and neutral faces; in the second task, subjects were presented with alternating sad and neutral faces. During presentation of happy facial expressions, we detected a signal increase predominantly in the left anterior cingulate gyrus, bilateral posterior cingulate gyri, medial frontal cortex and right supramarginal gyrus, brain regions previously implicated in visuospatial and emotion processing tasks. No brain regions showed increased signal intensity during presentation of sad facial expressions. These results provide evidence for a distinction between the neural correlates of facial recognition memory and perception of facial expression but, whilst highlighting the role of limbic structures in perception of happy facial expressions, do not allow the mapping of a distinct neural substrate for perception of sad facial expressions.

Keywords: Face; Functional; Neuroimaging; Positive; Negative; Emotion

* Corresponding author. Department of Psychological Medicine, King's College School of Medicine and Dentistry and Institute of Psychiatry, 103, Denmark Hill, London SE5 8AZ, UK. Tel.: +44 171 7405078; fax: +44 171 7405129; e-mail: spmamlp@iop.bpmf.ac.uk

0925-4927/98/$ - see front matter
PII S0925-4927(98)00036-5

1. Introduction

Intact processing of faces is critical in social interaction, in view of the enormous amount of information contained in a face (Sergent, 1988). Such processing can be subdivided into various dissociable categories: for example, the recognition of facial expression and the recognition of facial familiarity.

Whilst the role of the right hemisphere in facial perception has been highlighted by neuropsychological and functional imaging studies (Etcoff, 1984a,b; Sergent, 1988; Sergent et al., 1992; Puce et al., 1995, 1996; Kanwisher et al., 1997), there is evidence for the dissociation of facial recognition memory and facial expression perception in terms of the neural substrate underlying these two tasks (George et al., 1993; Sergent et al., 1994). The exact nature of the neural substrate underlying each task remains, however, unclear. Facial familiarity perception and unfamiliar face matching have been linked to the right hemisphere (Young et al., 1993), and facial recognition memory for previously unfamiliar faces has been associated with left hippocampus activity (Kapur et al., 1995). Facial working memory has been linked with the left hemisphere (McIntosh et al., 1996), bilateral occipital (extrastriate) cortex (Courtney et al., 1996, 1997), and right prefrontal cortex (Haxby et al., 1996), the latter confirming previous studies linking right prefrontal cortex with episodic memory retrieval (Tulving et al., 1994a,b; Shallice et al., 1994; Moscovitch et al., 1995; Fletcher et al., 1995; Buckner et al., 1996).

There has been much recent interest in the role of the amygdala in perception of fearful facial expressions (Adolphs et al., 1994, 1995; Young et al., 1995; Morris et al., 1996; Breiter et al., 1996; Whalen et al., 1998). Studies of perception of facial expression per se, however, have yielded conflicting results. Lesion studies have implicated both the left hemisphere (Young et al., 1993) and the right hemisphere (Adolphs et al., 1996) in the task, with the latter study demonstrating the role of the right hemisphere in perception of negative emotions, in particular sadness and fear. Functional imaging studies have implicated the right hemisphere (Gur et al., 1994; George et al., 1996), bilateral cingulate cortex (Sergent et al., 1994), and right anterior cingulate and bilateral inferior frontal cortex (George et al., 1993) in recognition of positive and negative facial expressions. Furthermore, bilateral limbic and paralimbic structures have been implicated in induction of sad emotion, with widespread decreases of cortical blood flow during induction of happy emotion (George et al., 1995). More recent studies have demonstrated activation in the amygdala in response to unpleasant emotional stimuli (Lane et al., 1997), and during induction of both happy and sad emotions (Schneider et al., 1997).

The nature of the neural substrate underlying happy and sad facial expression perception, and the distinction between this and the neural substrate for facial recognition memory thus remains unclear. In the current study, we used functional magnetic resonance imaging (fMRI) to investigate brain function during the two tasks of facial recognition memory (for previously unfamiliar faces) and facial expression perception, and to investigate more closely the neural correlates of perception of happy and sad facial expression. On the basis of the literature reviewed above, it was hypothesized that:

1. Facial recognition memory and facial expression perception would activate different brain regions;
2. facial recognition memory would activate left hippocampus, in addition to right prefrontal cortex and bilateral occipital cortex;
3. perception of sad facial expression would specifically activate bilateral limbic structures, right hemisphere more than the left.
4. Finally, the existing literature does not permit a clear prediction for the neural substrate underlying perception of happy facial expressions. In light of earlier research (George et al., 1995), we hypothesised that the pattern of activation would be distinct from that for sad facial expression perception.