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Research report

Examining the effects of inversion on lateralisation for processing facial emotion

*Victoria J. Bourne**

School of Psychology, University of Dundee, UK

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ABSTRACT

There is an increasing amount of evidence which suggests that each hemisphere is differently specialised for processing facial stimuli, with the right hemisphere specialised for the processing of configural information and the left hemisphere specialised for the processing of featural information. While there is evidence for this distinction from studies of face recognition, it has not been shown in studies of lateralisation for processing facial emotion. In this study the chimeric faces test was used with faces expressing anger, disgust, fear, happiness, sadness or surprise, presented in either an upright or an inverted orientation. When presented upright, a significant right hemisphere bias was found for all six emotions. However, when inverted, a significant left hemisphere bias was found for the processing of happiness and surprise, but not for the processing of negative emotions (although the analysis was approaching significance for anger). These findings support the hypothesis that each hemisphere is differently specialised for processing facial emotion, but contradicts previous work that examined the effects of inversion on chimeric face stimuli.

1. Introduction

It is quite widely accepted that there are hemispheric differences in the ability to process faces with the right hemisphere being specialised to a greater extent than the left hemisphere. In terms of processing facial emotion, this right hemisphere dominance has been shown in a wide range of studies using chimeric face stimuli. This behavioural paradigm presents vertically split half faces in which one hemi face is neutral and the other hemi face is expressive. Participants tend to rate a face as more emotive when the emotional expression is shown in the left hemi face (their left visual field) than when the emotional expression is shown in the right hemi face (their right visual field). This left visual field bias is interpreted as reflecting the right hemisphere superiority for face processing and has been shown in a large number of studies (e.g., Levy et al., 1983; Bourne, 2005, 2008, in press; Burt and Perrett, 1997).

Evidence for the left visual field bias found in the chimeric faces test reflecting right hemisphere superiority for the processing of faces has been shown in two studies of visual field biases in participants with unilateral brain lesions (Bava et al., 2005; Kucharska-Pietura and David, 2003). In both studies, participants with left hemisphere lesions showed the usual right hemisphere bias on the chimeric faces test, whereas those with right hemisphere lesions showed no clear visual field bias. Although there is considerable evidence for the right hemisphere being dominant for the processing of facial emotion, it is important to acknowledge that there are contrasting theories regarding the lateralisation of emotional face processing. The right hemisphere hypothesis suggests that the processing of all facial emotion is lateralised to the right

* School of Psychology University of Dundee, Park Place, Dundee, UK.
E-mail address: v.bourne@dundee.ac.uk
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hemisphere (Borod, 1992) whereas the valence hypothesis proposes that the processing of positive emotion is lateralised to the left hemisphere and the processing of negative emotion is lateralised to the right hemisphere (Davidson, 1992). Overall there is more support for the right hemisphere hypothesis than the valence hypothesis (see Bourne, in press), but it is important to include both positive and negative emotions in any study of lateralisation for the processing of facial emotion to enable the comparison of these two theoretical standpoints.

Although the chimeric faces test tends to show a right hemisphere bias for the processing of emotion presented in the left visual field, it is important to note that this does not preclude the possibility of left hemisphere mechanisms being capable of processing facial stimuli. Indeed, a great deal of work examining the lateralisation of face recognition has shown that both hemispheres are able to process facial stimuli, but that processing is more efficient in the right hemisphere. For example, prosopagnosia (loss of the ability to effectively process faces) may occur as a result of unilateral damage to either the right hemisphere (e.g., De Renzi et al., 1968; Inoue et al., 2008; Schiltz et al., 2006; Yin, 1970) or the left hemisphere (e.g., Barton, 2008; Hamsher et al., 1979; Meadows, 1974; Wright et al., 2006). Further, it has been suggested that unilateral lesions only cause selective deficits to face processing and that bilateral lesions are necessary to entirely disrupt face processing (Boeri and Salmaggi, 1994; Warrington and James, 1967). This possibility indicates that each hemisphere makes a distinct contribution to the processing of faces.

One of the main accounts for the different hemispheric specialisations in face processing is that each hemisphere is specialised for processing distinct forms of facial information: the left hemisphere being specialised for processing featural information and the right hemisphere being specialised for processing configural (the relative distances between the features) information (see Bourne et al., 2009). A number of studies have examined this distinction using manipulations of one or both forms of information. One of the most frequently used manipulations is face inversion. Face inversion reduces the ability to effectively process a face and this impairment is of a greater magnitude than is found with other classes of stimuli (Yin, 1969). The generally accepted explanation for the face inversion effect is that, when presented in the upright orientation, faces are processed primarily on the configural information contained within them, while inverted faces are processed on the basis of their featural information (e.g., Yin, 1969; Bartlett and Searcy, 1993; Leder and Bruce, 2000).

Research on patients with prosopagnosia following right hemisphere lesions has shown that the face inversion effect is reduced (e.g., Yin, 1970; Boutsen and Humphreys, 2002; Farah et al., 1995; Rouw and de Gelder, 2002) and some have even shown a face inversion superiority effect (e.g., de Gelder et al., 1998; de Gelder and Rouw, 2000; Boutsen and Humphreys, 2002; Marotta et al., 2002; Rouw and De Gelder, 2002). That is that some patients with prosopagnosia are actually better at processing inverted faces than they are at processing upright faces. This research suggests that the processing of faces on the basis of the configural information contained within them is not possible due to the damage acquired and instead processing is reliant on the left hemisphere featural mechanisms. This pattern has also been shown in behavioural studies using the divided visual field paradigm (Leehey et al., 1978; Rhodes, 1993), event related potential studies (Jacques and Rossion, 2007; Rossion et al., 1999) and functional neuroimaging studies (Passarotti et al., 2007). It therefore seems that the typical right hemisphere dominance for face processing is eliminated or reversed when faces are inverted.

While a large number of studies using the chimeric faces test have found right hemisphere superiority for processing facial emotion, few have considered how inversion might change this pattern of lateralisation. Two studies used happy/neutral chimeras (the most typical two-face version of the chimeric faces test) in both upright and inverted orientations and found that inversion reduced the right hemisphere bias, but there was still a significant right hemisphere bias for inverted faces (Luh, 1998; Coolican et al., 2008). However, using an identity version of the chimeric faces test in which left–left or right–right chimeric faces have to be matched to the original face, Coolican et al. (2008) found that inversion did not reduce the right hemisphere bias. The effect of inversion on chimeric face stimuli has also been considered in two studies using a one face gender version of the chimeric faces test in which the chimeric faces are formed from one male half face and one female half face (Butler and Harvey, 2005; Parente and Tommasi, 2008). Butler and Harvey found that the right hemisphere bias was significantly reduced with inversion. Their initial analysis showed no right hemisphere superiority for the processing of inverted faces, but the removal of two outliers revealed a significant right hemisphere bias. In contrast Parente and Tommasi found no significant difference in the laterality bias between upright and inverted faces with both showing a right hemisphere bias.

Predictions about the lateralised effects of face inversion seem to differ between the face recognition and the chimeric faces test literature. The research using whole faces, which typically use identity recognition tasks, show that inversion either eliminates the right hemisphere bias or reverses it and shows left hemisphere superiority. In contrast, the work using chimeric faces tends to show that inversion reduces the strength of the right hemisphere bias, but does not eliminate it. This study provides a more detailed examination of the effects on inversion on the chimeric faces test by examining the lateralised bias for chimeric faces across all six of the basic emotions (anger, disgust, fear, happiness, sadness and surprise) for upright and inverted chimeric faces. It is important to examine both positive and negative facial expressions of emotion as there are contrasting theories regarding their lateralisation (see Bourne, in press). It is predicted that inversion will reduce the magnitude of the right hemisphere dominance, but it is unclear whether right hemisphere superiority will remain, whether no clear lateralisation pattern will be found, or whether the processing of inverted chimeric faces will elicit a left hemisphere bias.

2. Method

2.1. Participants

There were 40 participants in this study (15 males) with a mean age of 25 years (SD = 8.5, range 18–49 years). All were