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Are the perceptual biases found in chimeric face processing reflected in eye-movement patterns?

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Abstract

Studies of patients with focal brain lesions and neuroimaging indicate that face processing is predominantly based on right hemisphere function. Additionally, experiments using chimeric faces, where the left and the right-hand side of the face are different, have shown that observers tend to bias their responses toward the information on the left. Here, we monitored eye-movements during a gender identification task using blended face images for both whole and chimeric (half female, half male) faces [Neuropsychologia 35 (1997) 685]. As expected, we found a left perceptual bias: subjects based their gender decision significantly more frequently on the left side of the chimeric faces.

Analysis of the first saccade showed a significantly greater number of left fixations independent of perceptual bias presumably reflecting the tendency to first inspect the side of the face better suited to face analysis (left side of face/right hemisphere). On top of this though, there was a relationship between response and fixation pattern. On trials where participants showed a left perceptual bias they produced significantly more left saccades and fixated for longer on the left. In contrast, for trials where participants showed a right perceptual bias there was no reliable difference between the number, or total fixation duration, on the left or the right.

These results demonstrate that on a trial-by-trial basis subtle differences in the extent of left or right side scanning are related to the perceptual response of the participant, although an overall initial fixation bias to the left occurs irrespective of response bias.

Keywords: Chimeric faces; Eye-movements

1. Introduction

A right hemisphere bias for face processing has been consistently reported in the literature both within cognitive (Dutta & Mandal, 2002; Hugdahl, Iversen, & Johnsen, 1993) and neuroimaging (De Renzi, Perani, Carlesimo, Silveri, & Fazio, 1994) research. Since Wolff (1933) first observed that the right side of the human face shows more correspondence to "the impression caused" by the full face, the finding of a robust left perceptual bias for chimeric images has been reported with chimeric stimuli employing emotion (David, 1993), gender (Luh, Rueckert, & Levy, 1991), age and attractiveness (Burt & Perrett, 1997). When the left and the right-hand side of a face are different (chimeric), observers tend to bias their responses toward the information contained in the left side of the face. Recently, Failla, Sheppard, and Bradshaw (2003) presented evidence that the perceiver bias induced by chimeric faces is detectable from 5 years of age but weakened in subjects over 60. Interestingly, the left bias for the processing of facial stimuli has been demonstrated to be so robust that it can be generated when the facial stimulus is passed behind a narrow vertical slit, allowing only a fraction of the image to be seen at any one time, thus requiring the perceiver to recreate the whole image internally (Grega, Sackeim, Sanchez, Cohen, & Hough, 1988).

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Despite these strong effects, it has been argued that the left perceptual bias may not purely reflect a right hemisphere processing advantage but rather an interaction between a long practised directional scanning bias of the participants and cerebral lateralisation (Vaid & Singh, 1989). Although Gilbert and Bakan (1973) reported a left perceptual bias in the processing of their chimeric stimuli amongst native Hebrew readers, the magnitude of the effect was reduced in this population. Vaid and Singh (1989) further suggest that similarities between English and Hebrew such as similar direction in arithmetical and musical notation may make Hebrew unsuitable for studying cerebral lateralisation. Using smiling-neutral chimeric faces, they examined perceptual biases in readers of Hindi (scanned from left to right), Urdu (scanned from right to left, but considered as bi-directional readers due to exposure to Hindi) and Arabic (scanned from right to left) and reported a significantly greater leftward bias in left to right Hindi readers compared to the other two groups.

Clearly further research into how scanning influences the left perceptual face bias is warranted and one obvious approach is the on-line study of eye-movements during chimeric face processing. Surprisingly though, to date little research has been undertaken to examine the relationship between perceptual biases apparent in chimeric face processing and accompanying eye-movements. The limited research there is has so far yielded equivocal results.

Gallois et al. (1989) exposed participants to facial images composed of one side of the face and its mirror image and requested subjects in one condition to simply gaze at the images for 7 s and in a second condition to gaze for 7 s and report the emotional state of the face. In both conditions more first fixations were made to the left and significantly more time was spent fixating on the left.

Mertens, Siegmund, and Grüsser (1993) reported that subjects spent more time fixating on the left-hand side of face stimuli regardless of whether the faces were presented normally or left/right inverted. However, other results do not complement such findings. Grega et al. (1988) obtained a significant left perceptual bias in a task involving similarity judgements between whole faces and left-mirror left and right-mirror right composite chimeric stimuli. However, when examining eye-movements to the whole faces, no consistent directional bias to the first eye-movement, no relationship to subsequent perceiver bias, and no asymmetry in gaze duration was found. Using simple, monochrome and emotionally neutral, facial stimuli Phillips and David (1997) reported that their healthy subjects examined the left half of the face first more often when analysed across stimuli. Alternative analysis revealed that this trend remained but was non-significant across subjects. Unfortunately, when exposing participants to chimeric (happy/sad) line drawings of faces they failed to find a leftward perceptual bias, although eye-movement analyses again revealed a significant bias to view the left side of the face first more often across stimuli.

So to summarise there is some evidence that the left side of chimeric faces is inspected first and/or for longer, although in one of those studies non-chimeric faces were used (Mertens et al., 1993) and in another no consistent leftward perceptual face bias was reported (Phillips & David, 1997). The study that found a strong left perceptual bias in chimeric face choice failed to find systematic scanning effects to whole faces (Grega et al., 1988).

One of the reasons for this lack of consistency may be that the studies described employed either simple line drawings or spliced photographs as chimeric faces, thus creating some uncertainty over whether these distorted stimuli are processed in a normal manner. Recent innovations with computer graphics software allows for realistic manipulations of images (Benson & Perrett, 1993; Burt & Perrett, 1995; Frigerio, Burt, Montagne, Murray, & Perrett, 2002), ensuring that chimeric face stimuli retain as many characteristics of normal faces as possible, in order to maximise the likelihood that subjects engage in normal face processing when exposed to such stimuli. In the current study, we employed such subtly blended chimeric images and examined saccadic eye-movements during gender based chimeric stimulus presentation. We aimed to replicate the left perceptual face bias previously reported (Burt & Perrett, 1997; David, 1993; Luh et al., 1991). More importantly though, we wanted to establish if there is indeed an overall leftward scanning bias for chimeric faces and if there is a relationship between perceptual bias and eye-movement bias. We assessed this by measuring the direction of the first saccade and the number and duration of left and right fixations overall and in relation to the perceptual response made (i.e. whether subjects based their decisions on the right or left half of the chimeric face).

2. Method

2.1. Participants

Twenty participants (16 female and 4 male, mean age 22.5, S.D. = 3.4) took part in the study on a voluntary basis. They were all right handed as assessed by the Annett Handedness Inventory (Annett, 1970) and had normal or corrected to normal vision.

2.2. Materials and stimuli

2.2.1. Manufacture of stimuli

Forty faces were created for use in the study: 10 pairs of male and female blended stimuli and 10 pairs of chimeric male/female and female/male stimuli.

Each gender blend was composed of photographs of a number of different individuals, with both the photographic conditions and the age of people photographed in each pair of blends approximately matched. Each blend image was rotated and scaled to match eye position across the pair, stretched vertically to match the middle of the mouth and made symmetrical across the midline.