Does inversion abolish the left chimeric face processing advantage?

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Experiments using chimeric stimuli have shown that the right hemisphere is more influential in processing facial information. Here, again, we found clear evidence that study participants used the information from the left side of the face to inform their gender decisions when chimeric male/female, female/male stimuli were presented. Most interestingly though, this effect was not only present for upright faces but also for inverted (flipped) faces (although the effect was significantly reduced). We propose that the chimeric bias effects found here argue against the idea that inversion destroys the right hemisphere superiority for faces. If this was indeed the case, flipping the chimeric faces should have resulted in a loss of the left face bias. This was not the case. NeuroReport 16:1991–1993 © 2005 Lippincott Williams & Wilkins.

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Introduction

A right hemisphere bias for face processing has been consistently reported in the literature within both cognitive [1] and neuroimaging [2,3] research. Moreover, experiments using chimeric stimuli, in which the left and right side of the face differ on a given dimension (e.g. the left side female and the right side male), have shown that the observer’s right hemisphere is not only more influential in processing facial identity than the left but also predominates in other areas of facial processing such as expression, age, sex and attractiveness [4,5].

More controversy exists, however, on the processes that may drive the face processing advantage. It is well established that upright faces are recognized more accurately and faster than inverted faces (the ‘face inversion effect’: [6–8]). It has even been demonstrated that previously learned upright faces can be recognized more accurately than features alone from these faces [9], an advantage for whole faces which is not demonstrated when the stimuli employed are inverted faces and features. The recognition advantage for upright faces has been attributed to ‘expertise’ with a homogenous class of stimuli seen in one orientation in everyday life [10,11]. Gauthier and Tarr [8] devised a novel stimuli group named ‘Greebles’ to study the effect of expertise on sensitivity to changes in nonface stimuli. Greebles are three-dimensional homogenous sets of nonface stimuli defined by a central body with four protruding parts. Changes to these four parts allow categorization at the individual, gender and family level. Six functional magnetic resonance imaging sessions, Gauthier et al. [12] reported that an upright advantage for Greebles was induced in their participants in a sequential matching task, complementing the advantage enjoyed by faces. This preference for upright Greebles was demonstrated by their participants following the development of expertise for these kind of stimuli. Moreover, the effect of the development of expertise appeared to be localized to the right hemisphere.

Sergent [13] suggests that facial inversion causes a disruption of the ability to process a face’s configurational aspects. Related to this, it has also been speculated that the right hemisphere has the advantage in holistic processing and the left hemisphere in part processing. This would mean that the right hemisphere employs holistic processing on the upright configuration of a face but that the inverted face destroys this normal configuration, thus requiring the face to be assembled piecemeal, a task more efficiently carried out by the left hemisphere [14]. Neuroimaging studies further suggest that face inversion may shift the focus of activation from face-specific to object-specific systems [15,16].

So taken together, there is a strong suggestion that inverted faces are processed differently from upright ones. In the present study, we found clear evidence that participants used the information from the left side of the face to inform their gender decisions when upright chimeric male/female, female/male stimuli were presented, in line with previous research [4,5]. Interestingly, this effect was not only present for upright faces but also for inverted (flipped) faces (although the effect was significantly reduced).

Materials and method

Participants
Twenty participants (10 female and 10 male, mean age 20.3 years, SD=1.3) took part in the study on a voluntary basis.
They were all right-handed as assessed by the Annett Handedness Inventory [17] and had normal or corrected-to-normal vision. Ethical approval was given by the University of Glasgow Ethics Board and all participants gave written consent.

Procedure and stimuli
Forty faces were used in the study: 10 pairs of male and female blended stimuli and 10 pairs of chimeric male/female and female/male stimuli. Stimuli were similar to the set described in Butler et al. ([5], see Fig. 1 for example), although reduced to an 8-bit format to satisfy the requirements of the Experimental Run Time System software used to conduct the study [18]. Chimeric and whole faces were presented on an IBM 17" computer screen with a participant chin rest situated at a distance of 57 cm.

Four blocks of 40 trials of upright faces and four blocks of 40 trials of inverted faces were presented. The inverted faces were the same stimuli but flipped so that the left side remained the left side in each trial. After an initial fixation point, the face was presented and the participant indicated the gender decision by pressing one of two response buttons located centrally in front of the participant (one above the other, marked male and female). Response buttons were reversed for half the participants and face presentation was also counterbalanced in that half the participants saw the inverted faces first and then the upright faces and the other half vice versa.

Accuracy levels (percentage correct) for whole male and whole female faces were recorded for both upright and inverted faces. Male and female responses to chimeric faces were converted into left and right bias responses, again separately for upright and inverted faces.

Results
A paired sample t-test revealed a significant accuracy difference between the upright and inverted whole faces \([t(19)=9.7, P<0.05]\) but, considering that faces were blended and thus appeared androgynous (see [5]), accuracy levels were high for both (85% and 74%, respectively). With regard to response bias in relationship to the chimeric faces, a paired sample t-test showed that there was a significant difference between the bias for upright and inverted stimuli \([t(19)=2.3, P<0.05]\), in that the left perceptual bias was larger for upright (57%) than for inverted faces (53%). Additionally, one-sample t-tests against chance showed that the left bias for upright chimeric faces did differ significantly from chance performance \([t(19)=4.3, P<0.05]\) but the one for the inverted chimeric faces did not.

Inspection of individual participant data revealed that two participants showed chimeric face biases with values more than 2 SDs away from the average mean. When these participants were excluded from subsequent analyses we again found a significant accuracy difference between upright and inverted whole faces \([t(17)=9.0, P<0.05]\), although, again, levels were high for both upright and inverted stimuli (86% and 74%, respectively). Further, the response bias in relationship to the chimeric faces showed that there was a significant difference between the bias for upright and inverted stimuli \([t(17)=2.6, P<0.05]\) in that the left perceptual bias was again larger for upright (58%) than for inverted faces (54%). This time, however, one-sample t-tests against chance showed that the left bias for both upright and inverted faces differed significantly from chance performance \([t(17)=7.4, P<0.05\) and \(t(17)=3.3, P<0.05\), respectively\] (see Fig. 2).

Discussion
Using subtly blended chimeric images, we found clear evidence that participants used the information from the left side of the face to inform their gender decisions. This result replicates the gender effect obtained with similar stimuli by Burt and Perrett [4] and Butler et al. [5]. It is also in line with other findings of a left perceptual bias for sex, age, attractiveness and emotion [4,19–21].

Most interestingly though (and we believe for the first time), we found that this chimeric face bias was not abolished when the faces were flipped. Once the experimental outliers were removed, significant leftward face biases were found for both the upright and inverted faces although, as expected, the biases were significantly larger for the upright faces. In line with this, participants also produced high accuracy scores on the inverted faces, although again, as expected, judgements of upright faces were significantly more accurate (see [22,23] for similar effects). We would propose that both the accuracy and chimeric bias effects found here argue against the idea that inversion destroys the right hemisphere superiority for faces [14]. If this was indeed the case, flipping the chimeric faces should have resulted in a loss of the left face bias. This was, however, not the case although the effect was reduced.

This then begs the question, as to what is driving this (albeit reduced) effect? Our participants were clearly not guessing, as indicated by our accuracy levels for single gender stimuli. They were also more likely to base their decision on the gender information available to the left side of the image.

Faces can be processed (configurally or otherwise) to a number of different ends; that is, recognition, determination of age, determination of emotional state and so on. The task in the present study was a simple determination of sex. Some time ago Fellous [24] reported that only five measures
(distance between the outermost corners of the eyes, distance between the cheek bones, width of the nose, distance between the eyes and the eyebrows and distance between the eyes and the mouth) could accurately predict the gender of 57 faces in his test set. Accuracy was considerable, at 87.1% for males and 92.3% for females. All five measures used were either horizontal or vertical measures. Thus, although inversion disrupts our ability to take advantage of configurational information, it may be possible that our participants developed a strategy that consciously employed some simple form of configurational judgement to aid their decisions. Such a strategy may in turn have led the participants to display a right hemispheric, and hence leftward, bias.

Conversely, Brown and Perrett [25] reported that facial features can convey gender information alone or with regard to their configuration, and that gender information is not exclusively carried configururally. When viewed in isolation they found, for example, that the brows and eyes carried the maximum gender information in their study, whereas when viewed in the context of other (opposite sex) features, it was reported that the jaw had the strongest influence on gender selection. Their data thus imply that single features can convey gender information, and it is possible that our participants were able to extract meaningful gender information from a single feature viewed in isolation. Identifying the sex of an inverted face is, even intuitively, more difficult than determining the sex of an upright face. Therefore, our participants may have adopted a strategy of focusing on a particular feature that carried gender information in order to simplify the task.

This latter explanation requires the assumption that our participants preferentially viewed the left features. In fact, in line with this argument, in a previous study employing several types of chimeric stimuli [5], we found that a significant proportion of initial saccades made to these chimeric stimuli were to the left side of the face. Moreover, using the so-called ‘Bubbles Technique’ [19], Schyns et al. reported a complementary finding of left lateralization for face processing in gender identification tasks, implicating processing of the left eye in particular.

Conclusion
We found that the left processing bias apparent in chimeric faces is not abolished when the face is inverted, although it is reduced. We think that this finding does not support the idea that inversion destroys the right hemisphere superiority for faces.

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References