Preprint of

PERCEPTUAL ASYMMETRIES IN JUDGEMENTS OF FACIAL ATTRACTIVENESS, AGE, GENDER, SPEECH AND EXPRESSION.

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Abstract -- Lateralization of perception of various facial attributes (age, attractiveness, gender, lip-reading and expression) was studied using chimaeric faces in which the sides of the face differed along one dimension (e.g. the left side was male and the right side female). Computer graphics were used to eliminate naturally occurring physical asymmetries (e.g. those present in the mouth during speech and spontaneous smiles) and obvious vertical mid-line joins in the photo-realistic chimaeric stimuli. Following previous studies, we found that subjects' judgements of gender and expression were influenced more by the left than the right side of the face (viewer’s perspective). This left of face stimulus bias extended to judgements about facial attractiveness and facial age. This was not true of lip-reading stimuli; for these stimuli subjects were influenced more by the right than the left side of the face. Thus using free fixation, it appears possible to demonstrate in normal subjects that brain processes underlying judgements of facial speech display different lateralization from the judgements of other facial dimensions.

Keywords -- face, hemisphere, lateralization, free-vision, chimaeric, lip-reading

INTRODUCTION

It has long been part of folklore that the side of the face to the viewer's left looks more like the owner than the side to the viewer's right. This bias was first investigated scientifically by WOLFF [25] who observed that chimaeric face stimuli produced by combining the left and mirror left of peoples’ faces were thought by subjects to look more like the original people than chimaeric faces produced by combining the right and mirror right (Figure 1, Normal Condition). This bias was first thought to arise as a property of the face owner rather than a property of the viewer. It was speculated that the left side of a person’s face was more 'public' in character; i.e. more representative of the individual. GILBERT and BAKAN [10] dispelled this speculation by training subjects to name unfamiliar faces, some of which had been mirror reversed (Figure 1, Reversed Condition). They found that judgements of likeness of chimaeric stimuli to training stimuli depended on which side of the face was on the observer’s left side during training. Thus GILBERT and BAKAN found the bias in facial likeness was due to asymmetries in the perception of faces rather than arising from physical asymmetries expressed by individual faces. Several authors define the sides of a person’s face with respect to the face owner [25,10,27] but since the perceptual bias described above is due to asymmetries in the viewer we will refer to the sides of face stimuli from the viewer’s perspective (except where stated explicitly otherwise).

Visual perceptual asymmetries may be due to the predominance of the right hemisphere in facial identification since it is more intimately connected to primary visual areas responsible for the processing of visual information from the left hemifield [10]. Experiments using chimaeric stimuli have also 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 including perception of facial expression [6,21,18] and gender [14].

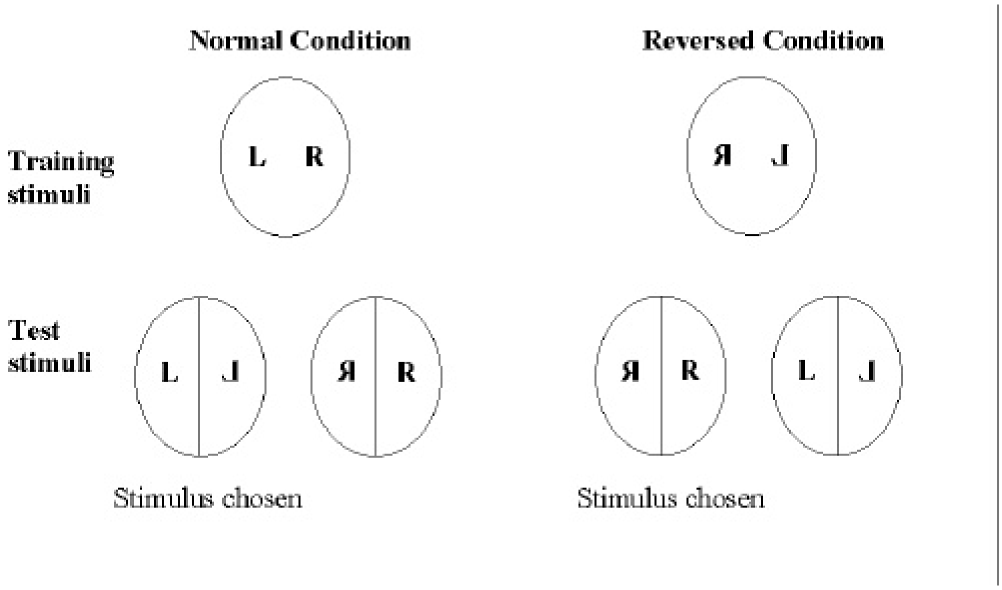

Fig. 1 - Training stimuli: ovals represent facial stimuli, L and R denoting the sides of the face to the *left and right for the viewer, as originally photographed*. Test stimuli: split ovals represent chimaeric faces made from one half of the training face and its mirror reflection joined at the vertical midline. WOLFF (1933) found that subjects trained on the Normal Condition thought that the chimaeric stimulus made from the side of the face falling to the left (L) looked more like the training face than the chimaeric made from the side of the face falling to the right (R). In the Reversed Condition subjects were trained with a mirror image of the whole training face. Note that reversed L and reversed R denote the sides of the training stimulus in relation the *original photographic image.* GILBERT and BAKAN (1973) showed that the bias in matching identity was due to perceptual asymmetries in the viewer because subjects trained on the Reversed Condition still chose the chimaera made from the half face which was on their left during training (denoted by a reversed R).

Why the right hemisphere predominates in the processing of facial identity, expression and facial gender is unclear. Neurological evidence implicates the right hemisphere in the processing of faces. For example, most, if not all, prosopagnosic patients have sustained damage to their right hemisphere [7]. The selective attention to the left of faces found when testing facial chimaeras may be a reflection of the right hemisphere being more efficient than the left hemisphere at the processing of facial material *per se*. Alternatively, the right hemisphere may be better at the analysis of the spatial configuration of *any* visual pattern and, because of this, predominates in face processing [18]. A different explanation is that asymmetrical patterns of eye scanning from left to right (arising from reading habits) may result in the left hemifield receiving more attention than the right hemifield (see RHODES [19] for review). This scanning bias should result in preferential attention to the left hand side of all visual stimuli.

Judgements on facial dimensions could also be biased by inspection of the side of the owner's face which normally portrays more physical information relevant to a given judgement. Facial movements made both during spontaneous expressions and during talking are asymmetrical in the amount of information portrayed (Figure 2*a, b*). Facial expressions are more intense on the lower left half of emitter's faces [2] and the right side of the brain has been argued to play a greater part in the control of emotional expression [2]. Indeed it may be through the stronger contralateral motor outputs that the right hemisphere predominates in influencing the lower left half of the owner's face (see Figure 2*a*). Since posed smiles tend to be symmetric and spontaneous smiles asymmetric, the left side of the owner's face will also be informative as to whether a smile is genuine [23]. So from a viewer's perspective the right half of face images should be more important in the judgement of real emotions. Previous studies [6,21,18] have, however, found that perception of facial expression is biased towards information occurring on the left side of face images (see Figure 2*c*).

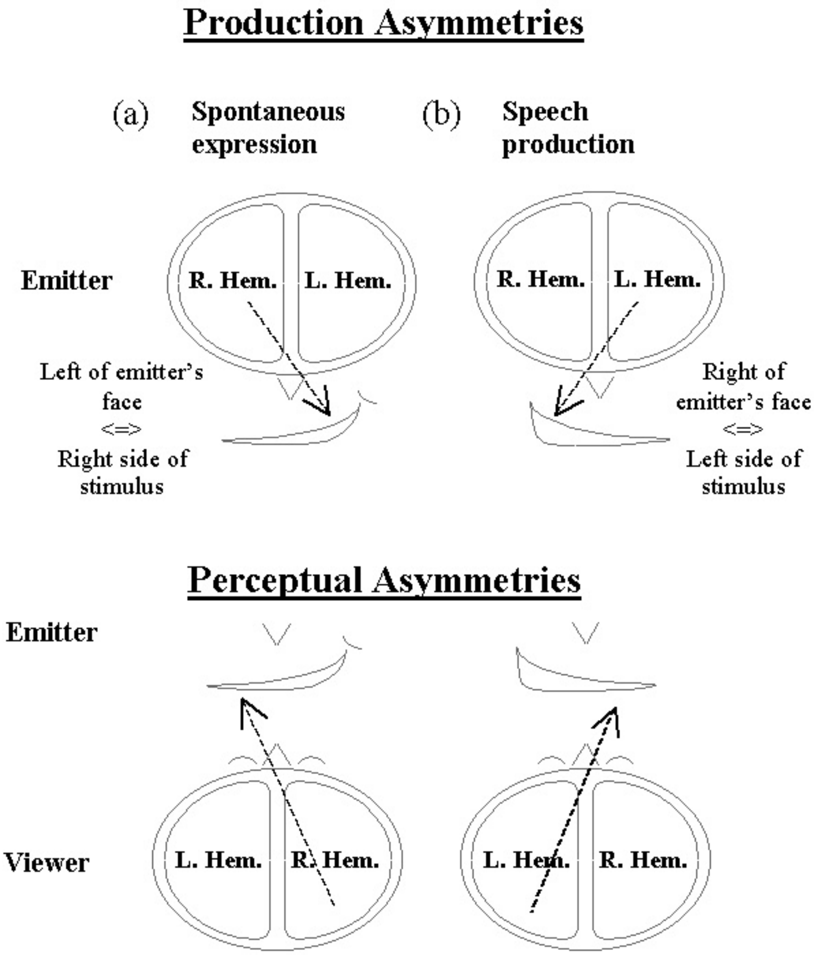

Fig. 2 - The main direction of information flow in emitter and observer. Both spontaneous expression and speech production are asymmetrical. This is caused in (a) by the stronger motor outputs to the contralateral side of the face from the 'more expressive' right hemisphere (R. Hem.) and in (b) by the stronger outputs to the contralateral side of the face from the 'more linguistic' left hemisphere's (L. Hem.). Rather than taking note of the side of the face which contains the most information, perception of expression (c) is biased to material on the right of the emitter and visual perception of speech (d) is biased to information on the left side of the emitter. This is caused in (c) by the dominant role of the viewer's right hemisphere in face perception and the stronger inputs from the left side of the image to this hemisphere and in (b) by the dominant role of the viewer's left

hemisphere in visual speech analysis and the stronger inputs from the right side of the image to this hemisphere.

Facial movements during talking are biased to the right side of the owner's face (Figure 2*b*). Most people (76%) tend to talk with a greater amplitude of mouth movements on the right side of their mouth than on their left. This is presumably due to the greater involvement of the speaker's left hemisphere in language production and the stronger connection between left hemisphere motor control systems and the musculature of the left side of the speaker's face [11,24]. As the speaker's right falls to the left of the viewer, the left side of the face images should be more informative about speech sounds when talking and it may be expected that viewers would attend more to the left side of stimuli when lip-reading.

This idea is supported to some extent by the results of one previous paper investigating the laterality of lip-reading. In two experiments, CAMPBELL [5] demonstrated a right hemisphere advantage (left visual hemifield) for lip-reading. In both experiments tachistoscopic presentation was used (200 ms stimulus duration in the first experiment and 100 ms in the second). The right hemisphere bias found in this experiment, could, however, have been due to other factors. Sergent has claimed that the use of fast presentations with visually complex stimuli that are hard to discriminate favours right hemisphere visual processing strategies [22]. The relationship between presentation time and hemispheric bias is, however, complicated and other researchers have suggested the opposite [see NICHOLLS 16].

Neuropsychological evidence suggests a critical role for the left hemisphere in the perceptual aspects of lip-reading. CAMPBELL *et al.* [4] investigated two individuals with lateralized posterior brain lesions. Mrs D had right occipito-temporal lesions and severe face recognition problems (prosopagnosia). The other individual, Mrs T, had left occipito-temporal lesions and severe reading deficits (alexia). CAMPBELL *et al.* found that the right hemisphere lesioned patient was able to lip-read normally but that the left hemisphere lesioned patient was unable to lip-read. This evidence, combined with the finding that fast presentation of stimuli may itself cause right hemisphere bias in normal viewers [22], raises the possibility that the use of chimaeric stimuli under free vision (i.e. prolonged exposure) to examine lip-reading could lead to a left hemisphere advantage and a right hemistimulus perceptual bias (Figure 2*d*).

This paper sets out to investigate the relative importance of the left and right sides of face stimuli in the processing of a variety of facial dimensions. The experiment looks at facial expression and gender, and three additional facial dimensions: age, attractiveness and lip-reading. We expected that the bias in attending to information present on the left side of facial stimuli, found previously for expression and gender, would be replicated and would also be manifest in judgements about attractiveness and age.

We included lip-reading stimuli which required observers to match speech sounds to the shape of the mouth in single video frames taken mid-utterance. Since such judgements are more linguistic or verbal in nature, these judgements may depend on aspects of processing for which the left hemisphere is dominant. It was predicted, therefore, that the left hemiface perceptual bias present for other facial judgements would disappear or would be reversed for lip-reading stimuli.

METHOD

Subjects

The stimuli were tested on 132 subjects of which 73 were female and 59 male with an average age of 20.7 years.

Manufacture of stimuli

Two face images were used to manufacture each pair of test stimuli. These face images (Figure 3a, b) were first made symmetrical (Figure 3c, d). This preliminary procedure removed all structural asymmetries present in the face. Then, using information contained in the 'mask image' (Figure 4), the two symmetrical face images were merged together with a gradual change in shape and colour from one face image to the other across the vertical mid-line, producing the first stimulus of a pair (Figure 3e). The second stimulus of the pair was then made by reflection of the first stimulus across the y-axis (Figure 3f). The stimuli thus produced were pairs of chimaeric faces where the left and right halves differed in a particular dimension.

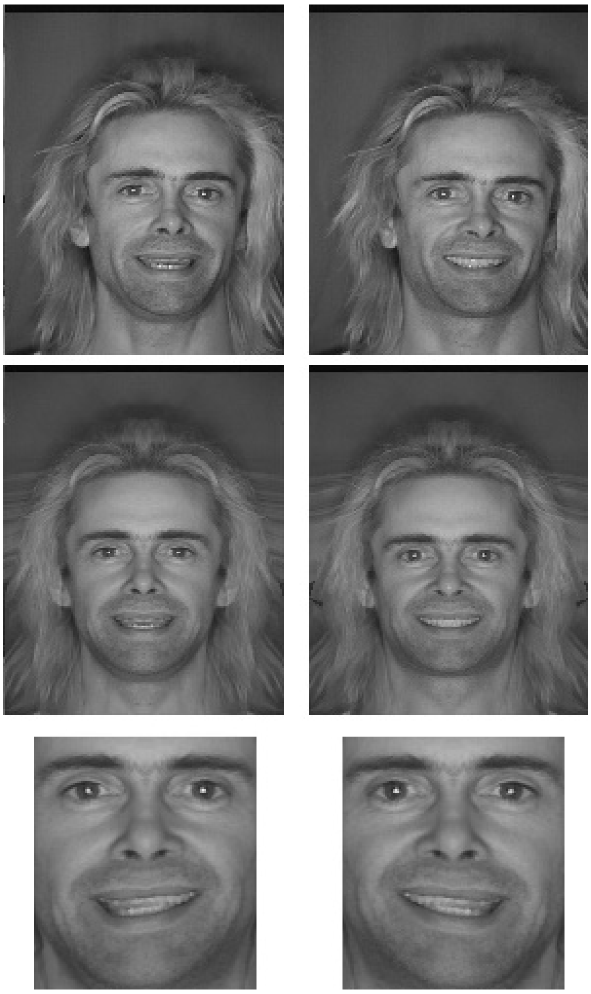

Fig. 3 - The manufacture of stimuli. Each stimulus was made from two face images. In the case of the first lip-reading these were (a) an individual saying 'ee' and (b) the same individual saying 'i'. These face images were first made symmetrical (c and d) before being merged together and cropped to form the final composite images. The first of these images (e) has on the left a symmetrical face saying 'ee' and on the right the symmetrical face saying 'i'. The second (f) is the mirror image of the first.

Description of stimuli

Stimuli were manufactured for 5 facial dimensions: ageing (2 stimuli: Male Ageing and Female Ageing), attractiveness (4 stimuli: Male Employee, Female Employee, Male Model and Female Model), gender (2 stimuli: Gender Employee and Gender Model), expression (2 stimuli: Smile-Neutral and Sad-Neutral) and lip-reading (2 stimuli: ee-i and ee-ss). In total, this gave 12 stimulus types. Examples of some these stimuli are presented in Figure 5.

The first ageing stimulus (Male Ageing) was made from two male face blends; one was composed of 21 faces, average age 22 years, and the other of 18 faces, average age 51 years (for further details of these blends see BURT and PERRETT [3]). The second ageing stimulus (Female Ageing) was made from two female blends. The first was composed of 34 faces, average age 22 years, and the second of 17 faces, average age 52 years.

Fig. 5 - Test stimuli. Four examples of these are presented. Top row of stimuli: (a) age (Female Ageing), the left half is a blend of old female faces and the right is a blend of young female faces; (b) attractiveness (Male Employee), the left half is a blend of faces rated high in attractiveness and right is a blend faces rated low in attractiveness; (c) gender (Gender Employee), the left half is a blend of male faces and the right a blend of female faces (d) emotion (Smile-Neutral), the left half is a blend of smiling faces and the right is a blend of the same faces with neutral expression. The bottom row of stimuli are mirror images of the top row stimuli. Testing involved pairs of corresponding stimuli from top and bottom rows.

The first of the attractiveness stimuli (Male Employee) was made from two male face blends, a High attractiveness blend and a Low attractiveness blend. The High was composed of the 15 most attractive faces from a population of 59 males aged 20-30 and the Low from the 15 least attractive faces. The original faces were presented in random order and rated for attractiveness on a 7 point Likert scale (1 very unattractive, 7 very attractive) by Caucasian subjects (15 male, 15 female, aged 18-30) [17]. So that all of the features of the two blends coincided across the midline, the Low face blend was stretched in height enabling the distance between the mouth and the midpoint between the eyes to match those of the High blend. The second attractiveness stimulus (Female Employee) was made from two female face blends, a High blend (15 most attractive female faces from a population of 60, aged 20-30) and a Low blend (15 least attractive faces from the same population) matched in height to the High. The original Likert ratings of female faces were obtained from Caucasian subjects (26 female, aged 18-45 and 10 male, aged 19-24) [17]. The shape [17] and the colour (BURT and PERRETT, unpublished work) of the High male and female blends were perceived by most subjects as more attractive than the Low blends. The third and fourth attractiveness stimuli (Male and Female Model) were made from different collection of faces (see ROWLAND and PERRETT [20]). The Male Model was made from two male face blends, a High blend (11 faces rated to be most attractive from a population of 43 faces taken from fashion magazines) and a Low blend (11 least attractive from the same population), matched in height to the High. The Female Model was composed of two blends of female faces, a High blend (20 faces rated as most attractive from a population of 61 taken from fashion magazines) and a Low blend (20 faces rated least attractive from the same population), matched in height to the High. Likert ratings of the original male and female fashion model faces were made by 40 Caucasian subjects (35 female 5 male aged 19-30).

The first gender stimulus (Gender Employee) was made from the High attractive male face blend used to make the Male Employee and the High attractive female face blend used to make the Female Employee. The female face blend was stretched so that the vertical distance from the centre of the mouth to between the eyes was the same as the male blend. The second gender stimulus (Gender Model) was made from the High attractive male face blend used to make Male Model and the high attractive female blend used in Female Model. Again the female face blend was stretched so that the vertical distance from the centre of the mouth to the midpoint between the eyes was the same as the male blend.

The first expression stimulus (Smile-Neutral) was made from a blend of 6 smiling faces and the same 6 faces with neutral expressions. The second expression stimulus, the Sad-Neutral, was made from two grey-scale blends, one of 8 sad faces and the other the same 8 faces with neutral expressions (original sad and neutral faces were taken from EKMAN and FRIESEN [9]).

The first lip-reading stimulus ('ee-i') was made from two single frames of a face. One frame was taken while the subject was pronouncing the word 'bee', captured mid utterance during the 'ee' sound. The second frame came from the same face pronouncing the word 'side' captured during the 'i' sound. The second lip-reading stimulus ('ee-ss') was made from single frames from sequences of the face saying 'bee' and 'hiss' captured during the sounds 'ee' and 'ss'. Other experiments have shown that the faces from which the lip-reading stimuli were made are easily understood by subjects, who recognise around 90% of them.

Manufacture of symmetrical face images

The co-ordinate positions of 208 'feature points' [1], each representing a specific feature of the face (e.g. nose, right of lip), were logged. This spatial description of the face was then transformed so that the eyes were in standard positions, equidistant from the vertical midline. The symmetrical face shape was then calculated by averaging the co-ordinate position of each 'feature point' with the co-ordinate position of the related feature point on the opposite side of the face reflected across the y-axis. The starting face image was then warped into the new symmetrical shape. The image was then blended with its mirror image to produce a face symmetrical in shape and texture.

Manufacture of left-right chimaeric face images

After being made symmetrical, the two faces were merged together across the mid-line in shape and in RGB colour. The mask (Figure 4) encodes which areas of the face are to be taken from the face image ‘a’ (dark areas on the mask) and which from the face image ‘b’ (light areas). The two faces were blended together (colour and shape) in varying proportions across the midline according to the intensity of the mask.

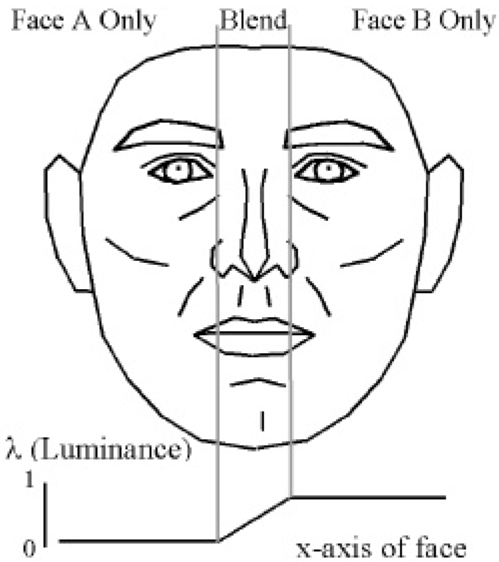

Fig. 4 - The mask used to manufacture chimaeric faces. The luminance (l) of the mask varied from black (0) on the left to white (1) on the right with a ramp across the midline. This is illustrated as a graph at the base of the figure. The position of the mask is defined relative to the average face shape. As can be seen the ramp was matched in width to the average nose. Chimaeric stimuli were made by taking shape and colour information from 2 faces in proportion to the value of l (see text).

Calculation of the final face shape proceeded in a stepwise fashion from the first to the last feature point. From the mask, the intensity of the pixel at the each feature point was looked up (using the feature point data for the average face). This defined the fraction of fade (λ) for the feature point (i.e. how much of the information for that point was taken from the first vs. the second face). This provided the spatial data for a new chimaeric face shape with the features on the left side defined by one face (e.g. old) and the right side defined by a second face (e.g. young). The two face images were warped into this chimaeric shape and then integrated in a pixelwise fashion. Starting with the first pixel the fraction of fade (λ) was again looked up from the mask and used to calculate how much of the RGB colour information for that pixel in the final image would come from the first (old) vs. the second (young) warped face images.

Alternatively the method can be looked at as an equation where λ is the luminance (0-1 in 256 steps) derived from the mask image using the associated shape data, *new* is the new (x,y) co-ordinate or RGB triple (for calculation of shape and colour respectively) and *a* and *b* are the (x,y) co-ordinate or RGB triple for the first and second face images respectively:

$$new_{(x,y\ /\ RGB)} = a_{(x,y\ /\ RGB)} - \lambda\ (b_{(x,y\ /\ RGB)} - a_{(x,y\ /\ RGB)})$$

The final stimulus was made by cropping the output image to a size of 268 by 308 pixels. The second stimulus of the pair was made by reflection of the first. Then each facial stimulus was printed (size: 4.6 cm by 5.2 cm, 150 dpi 24 bit colour, Printer: Mitsubishi Sublimation S3410-30, CMYK 4 colour print roll).

Procedure

During testing the pair of stimuli were placed one above the other. Subjects were asked to choose whether the lower or higher stimulus was older, happier, more feminine, more attractive, or more like it was saying 'ee', 'i' or 'ss', depending upon the dimension that the stimulus tested. Each subject was tested with all of the stimuli in a self paced manner. The vertical position of each stimulus within each pair was counterbalanced between subjects. For all facial dimensions, the adjective used to test subjects was also counterbalanced (i.e. for age judgements, half the subjects were asked which is older and half were asked which is younger).

RESULTS

For most dimensions tested, the subjects' perceptual judgements were biased by the left hand side of the faces. That is, information on the left of the stimuli had a dominant influence on responses. This bias was significant for perception of age (Male Ageing, 77% of subjects' judgements were based on the left of stimulus faces, Binomial test, $P<0.05$; Female Ageing, 73%, $P<0.05$). The bias to the left side of stimuli was significant for attractiveness judgements for the first two facial stimuli (Male Employee, 67%, $P<0.05$; Female Employee, 60%, $P<0.05$) but did not reach significance for the second two attractiveness stimuli (Male model, 57%, $P=0.07$; Female Model, 55%, $P=0.13$). Significant biases to the left of stimuli were found for judgements about gender (Gender Employee, 66%, $P<0.05$; Gender Model, 69%, $P<0.05$) and expression (Smile-Neutral 58%, $P<0.05$; Sad-Neutral 59%, $P<0.05$).

The perceptual bias was reversed for the choice of lip-reading stimuli. Subjects showed a significant tendency to make choices dominated by information present on the right hand side of the face stimulus (ee-i 42%, $P<0.05$; ee-ss 42%, $P<0.05$) rather than the left side.

DISCUSSION

Forced choice, free vision testing of 132 subjects confirmed and extended the view that, for many aspects of face processing (perception of age, attractiveness, gender and expression), subjects preferentially attend to information on the left side of the facial stimulus. In the case of lip-reading the opposite bias was found; most subjects' perception of what sound was being spoken was influenced by the information on the right side of the face.

Expression, gender and age

As predicted, the experiment replicated the findings of perceptual bias to the left half of the chimaeric face stimuli under free vision for processing of both expression [6,18,21] and gender [14]. We interpret these perceptual biases as reflecting the predominance of the right hemisphere in the processing of facial information.

Of more interest was the finding of a perceptual bias to the left half of the face stimulus during judgements of age. A right hemisphere predominance in perception of facial age might be anticipated from the neurological evidence of DE RENZI *et al.* [8] who found that patients with right posterior brain injury performed worse at face age tests than patients with other brain injury.

Attractiveness

Since attractiveness is strongly influenced by age and the degree of femininity or masculinity of a face, it may not be surprising that judgements of attractiveness were also biased to the left side of stimulus faces. It should be noted, however, that though a significant bias was obtained for two stimuli (Male Employee and Female Employee) the bias did not reach significance for two other stimuli (Male Model and Female Model). This may have been due to the difference in attractiveness between High and Low attractive groups being smaller for the Models than the Employees. Alternatively it could be due to subjects making preference judgements on the basis of the entire hemistimulus picture colour rather than on the basis of hemiface. Colour was tightly controlled in the Employee stimuli and left right colour differences were therefore minimal.

ZAIDEL *et al.* [27] found that chimaeric faces made by combining the right side of the owner's face and mirror right (Figure 1, Left composite from the viewer's perspective) were found more attractive than chimaeric face composites made from the left side of the owner's face and mirror left (Figure 1, Right composite from the viewer's perspective). Chimaeric composites made from the owner's left (viewer's right) were judged to have more pronounced "smiling expressions" than composites made from the owner's right (viewer's left). This led ZAIDEL *et al.* [27] to speculate that "attractiveness and smiling may be asymmetrically and oppositely organised on the face".

Our results also indicate that perception of attractiveness is lateralized and, in accordance with the interpretation of ZAIDEL *et al.*, we found a perceptual bias favouring the left side of the face stimuli (right side from the owner's perspective). From our results, the perception of expressions, including smiling, also showed a bias to information on the left side of face images. This finding would appear to contradict the interpretation by ZAIDEL *et al.* but replicates previous findings of a left sided bias (right hemisphere advantage) in the perceptual processing of expressions under free fixation [6,18,21].

Symmetric smiles can be perceived as less genuine when compared with asymmetric expressions [23] and look less attractive [13]. Thus chimaeric stimuli may have unnatural looking symmetric expressions even when constructed from natural faces. The greater attractiveness of left face chimaeric stimuli in the experiment of ZAIDEL *et al.* may therefore be due to the fact that these stimuli were perceived as having less pronounced symmetrical smiles [12].

Whatever the interpretation of the findings of ZAIDEL *et al.*, our experiment indicates that for judgements about attractiveness there is a perceptual bias with greater attention paid to information on the left side of both male and female face stimuli. Aesthetic judgements about faces appear to exhibit the same lateral bias as judgements about face gender, expression and age.

Lip-reading

Neurological evidence [4] suggests that subjects use their left hemisphere during the recognition of speech sounds from facial images (Figure 2*d*). In our experiment, normal subjects were allowed free fixation of stimuli. Thus, we cannot make strong inferences that information from one side of the facial stimuli projected primarily to the contralateral cerebral hemisphere. Nevertheless the bias to attend to information on the right side of stimuli may be interpreted as reflecting a predominance of the left hemisphere's abilities during processing. In this sense the current findings are consistent with the neurological evidence of a predominant role of the left hemisphere in processing facial cues to speech sounds. Our use of long presentation times (unlimited exposures) may have uncovered a left hemisphere bias which had been overshadowed in previous work with normal subjects [5] by fast presentation times which SERGENT [22] has argued favours the right hemisphere (though see NICHOLLS [17]).

Since the right side of the face (left of stimulus, Figure 2*b*) shows a greater amplitude of movement when talking [11] and is more informative for interpreting speech [24], we can conclude that learning to pay attention to the most informative side does not have a large (if any) effect on the perceptual processes underlying lip-reading. If lip-reading used the most informative side of face then we would expect a left side of face advantage which is opposite to the result we obtained.

Hemispheric asymmetries in processing

MILNER and DUNNE [15] presented chimaeric faces briefly (100 ms) and found that normal subjects behaved somewhat like commisurotomised (‘split-brain’) patients when the junction of the two half faces at the vertical mid-line was obscured from view with a black strip. With such stimuli many subjects were unaware that the two sides of the chimaeras were different in identity. They experienced perceptual completion of a single intact face. When subjects were required to match the identity of the chimaeric faces by pointing with their left hand, identity matching was significantly biased to the left half faces. When a verbal response was required in a different block of trials, the subjects showed a non-significant bias to name the right half faces (i.e. projecting to the left hemisphere). Thus hemispheric biases in face processing were influenced by the mode of response (verbal label or pointing with the left hand).

A critical aspect of MILNER and DUNNE’s [15] experiment was the presence of the vertical strip at the mid-line to prevent subjects seeing the join between the two half faces. In our experiment, the employment of blended stimuli and graphics processing allowed the two half faces to be gradually merged in the chimaeras. This again meant that the mid-line junction was not obvious. Indeed subjects were unaware that the two sides of the face were different in the dimension being tested (i.e. they did not realise one side was young and the other was old). Furthermore most subjects did not realise that the two stimuli presented as a pair were mirror images. If subjects realise that each chimaera is a composite of two separate faces, then they may not engage the same type of processing as that employed if the stimulus is seen as one image. This difference in processing of face identity was also noticed with chimaeric stimuli made of two half faces of famous individuals joined at a horizontal mid-line [26].

The left sided perceptual bias with chimaeric faces is normally attributed to a right hemisphere processing superiority. It is not clear, however, why the right hemisphere bias arises. It is commonly attributed to a right hemisphere specialization in face processing. It could be, however, that all visual stimuli requiring complex configurational judgements produce right hemisphere bias. Alternatively, right parietal mechanisms involved in control of spatial attention may be selectively engaged during visual processing; these could cause a bias to scan the left side of all visual stimuli. From both of these latter explanations the perceptual bias to the left side of faces need not reflect a right hemisphere specialization for face processing. Indeed, LUH *et al.* [14] reported a right hemisphere advantage in perceptual judgements for both chimaeric face stimuli and chimaeric non-face patterns.

The lip-reading condition demonstrates that it is possible to obtain a perceptual bias to the right as well as the left side of face stimuli. To our knowledge such a right sided bias has not been observed before in studies using free fixation. If these perceptual biases reflect hemispheric biases then evidence for specialization of the left and right cerebral hemispheres can be obtained with simple testing methods. The hemisphere predominantly engaged in processing is determined by the facial dimension to be judged. For normal subjects the left hemisphere seems to predominate during processing of facial information about speech (lip-reading) and the right hemisphere seems to predominate during processing of other facial dimensions (age, gender, expression and attractiveness). Both of these findings are concordant with the neuropsychological studies of brain damaged subjects.

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