Pergamon

PII: S0028–3932(96)00065–6

Neuropsychologia, Vol. 35, No. 4, pp. 471–476, 1997

Printed in Great Britain
0028–3932/97 $17.00+0.00

Brain asymmetry and facial attractiveness: Facial beauty is not simply in the eye of the beholder

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(*Received* 31 *July* 1995; *accepted* 11 *June* 1996)

Abstract—We recently reported finding asymmetry in the appearance of beauty on the face [Zaidel *et al*., *Neuropsychologia*, Vol. 33, pp. 649–655, 1995]. Here, we investigated whether facial beauty is a stable characteristic (on the owner's very face) or is in the perceptual space of the observer. We call the question 'the owner vs observer hypothesis'. We compared identity judgements and attractiveness ratings of observers. Subjects viewed left–left and right–right composites of faces and decided which most resembled the normal face (Experiment 1). Identity judgements (resemblance) are known to be associated with perceptual factors in the observer. Another group viewed the same normal faces and rated them on attractiveness (Experiment 2). In each experiment, there were two separate viewing conditions, original and reversed (mirror-image). Lateral reversal did affect the results of Experiment 1 (confirming previous findings [Bennett *et al*., *Neuropsychologia*, Vol. 25, pp. 681–687, 1987; Gilbert and Bakan, *Journal of Anatomy*, Vol. 183, pp. 593–600, 1993]) but did not affect the results of Experiment 2. The fact that lateral reversal did not affect the results of Experiment 2 suggests that facial attractiveness is more dependent on physiognomy (of the owner) and less dependent on an asymmetrical perceptual process (in the observer) than is facial identity. The results are discussed in the context of beauty's biological significance and facial processing in the brain. © 1997 Elsevier Science Ltd. All rights reserved.

Key Words: face; beauty; face asymmetry; hemispheric specialization; aesthetics; evolution; facial physiognomy; brain asymmetry.

Introduction

Facial asymmetry is not easily noticed in ordinary social context, but can be observed under special experimental manipulations. Neuropsychological research has emphasized facial asymmetry in expression [1, 4, 5, 8, 21, 23, 39] and, to a lesser extent, in identity (resemblance judgements) [3, 18, 36]. Asymmetric aspects of facial beauty have largely been neglected. Yet, physical facial attractiveness has some biological significance [6, 7, 25, 26, 31, 32, 33], and its assessment must be anchored in neuroanatomy. We recently reported finding functional asymmetry in facial beauty and a difference in its manisfestation on women's and men's faces, in head-on photographs [39] and in painted fine-art portraits [38]. However, there has always been a question regarding facial asymmetry: 'Is the asymmetry perceptual or is it in the physiognomy of the face of the observed (the owner)?'. We shall refer to this question as the 'observer vs owner hypothesis'. (Hereafter, left or right of the owner's face refers to the owner's body, e.g. the left side of the owner's face is ipsilateral to the owner's left hand, the right side is ipsilateral to the owner's right hand. The owner's facial half ipsilateral to the owner's left hand will be called LF and the owner's facial half ipsilateral to the right hand, RF.) In other words, empirical results regarding facial asymmetry (typically assessed under free-viewing conditions) could reflect (1) the facial halves of the owner perceived in the left or right visual spaces (projecting via anatomical pathways to the right and left hemispheres, respectively) of the observer, or (2) features inherent in the physiognomy of the owner's face. In our previous study [39], in women's faces, there was a significant difference between LF and RF, with the RF judged more attractive than the LF (by both female and male observers). In men's faces, there was no left–right difference. The stimuli were left–left and right–right composites of normal faces prepared from a facial half and its mirror reflection. On the whole, the bulk of neuropsychological studies associate expressions with LF, while identity is associated with RF. In the present study, our goal was to compare the observer vs owner hypothesis in facial attractiveness and identity.

Evidence for facial asymmetry in the size of soft-tissue [16] would imply asymmetry in neuroanatomical control as well as in the organization of beauty on the sides of the face. Indeed, craniofacial research generally describes asymmetries in the middle and lower third of the face [15,

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16, 27, 34]. In large sets of faces, Ferrario and colleagues found that (1) in general, the lower third of RF is larger than LF, in both men and women; but (2) the lower RF itself is slightly larger in men than in women [15, 17], while (3) the LF is essentially the same size in both sexes. They did not find any significant differences in facial shape between men and women. The sexual-dimorphism finding is in agreement with another report [29]. Taken together, the morphological evidence implies that aspects of beauty could be in the physiognomy of the owner's face.

We commonly think that aesthetic judgement of facial beauty is based on subjective impressions which lack an anchor in the brain's functional neuroanatomy. However, several lines of evidence suggest otherwise. (1) There is cross-cultural agreement on facial attractiveness. Faces judged very attractive in their own society are judged to be equally attractive in other societies [10, 28]. (2) People with attractive faces receive more positive reactions than those with unattractive faces [30, 33]. People with attractive faces are given a variety of positive attributes purely on the basis of the appearance of facial beauty [13]. (3) In evolutionary biology, the significance of the display of beauty on the face lies in its potential to reveal features that are critical for successful reproduction and survival of the offspring. Mate attraction habits by diverse non-human species rely on external features (e.g. feathers, antlers, fur) to reveal clues related to health, quality of genes, state of immune system, and similar factors [9, 25, 26, 32]. (4) Buss [6, 7] found that, in 37 cultures, attractiveness was a primary consideration in mate selection by men. In humans, it is reasonable to assume that biologically-relevant characteristics, revealed in facial attractiveness, are interpreted in the observer's brain, a functionally asymmetric brain, even without his or her conscious awareness of their parameters or knowledge of their specific features.

When testing the observer vs owner hypothesis, a good tool for determining invariance in facial physiognomy is lateral reversal (mirror-image) of faces. This strategy has been applied profitably in several studies using facial or pictorial stimuli [18, 23, 24, 38]. In reversal, content is constant, but lateral layout is changed. If reversal does not affect subjects' responses, then the responses must reflect features inherent in the physiognomy. Similarly, when assessing facial asymmetries, a good experimental tool is faces created from combining one half of the face with its reflection [36]. Since left–left and right–right composites appear like regular faces, they accentuate the asymmetrical features of each side. In the two experiments described below, we used the same faces but asked different questions.

Experiment 1: facial identity

In this experiment, we followed Gilbert and Bakan [18] in asking subjects to compare left–left and right–right composites and decide which of the two more resembles the normal face. Here, however, the composites were counterbalanced in their lateral position on the viewing screen; counterbalancing permits assessment of the dominant factors in subjects' reactions, the composites or the normal face itself. A separate group of subjects was assigned to each viewing condition, original and lateral reversal.

Method

Subjects

The subjects in this experiment were recruited from introductory psychology courses at UCLA. They volunteered to participate in the experiment in partial fulfilment of course requirements. They were randomly assigned to the 'original orientation' viewing condition ($N=18$; 9 females, 9 males) or to the 'lateral reversal' viewing condition ($N=16$; 8 females, 8 males).

Materials

We used the identical stimuli described in an earlier study [39]. There were 38 head-on Caucasian faces (21 women, 17 men) which were photographed under symmetrical lighting conditions. When photographed, the subjects (ranging in age from 18 to 26 years) were instructed to look straight ahead and to 'look natural'. Smiling or 'posing' was discouraged. The photographs were digitized on a Macintosh computer, and Macintosh software (Adobe PhotoShop®) was used to create a left–left and a right–right composite for each individual. Each photographed face was divided down the midline in the midsagittal axis and a mirror image of each half was created. Then, the original half and its reflection were joined to produce a normal-looking full-face. This procedure produced the left–left and right–right composites.

Procedure

Subjects looked at 38 different facial triads. A triad consisted of the normal face, and its left–left and right–right composites. The normal face was positioned centrally and above the two composites, which were positioned side-by-side on a Macintosh screen. Exposure duration of each triad was 10 sec. Men's and women's faces were intermixed within the series of 38 trials. Importantly, the lateral position on the viewing screen of the left–left and right–right composites of women and men was counterbalanced (e.g. on some of the trials, left–left composites appeared on the screen's left half, while on other trials, the left–left composites appeared on the screen's right half; a similar counterbalancing applied to the right–right composites). The task for the subjects was to decide which one of the two composites most resembled the normal face. There were two viewing conditions, with a separate group of subjects assigned to each condition. One group viewed original orientation of the normal face and a second group viewed a lateral reversal (mirror-image) of this face.

Results and discussion

Figure 1 illustrates a summary of the results for the two groups of subjects. The two viewing conditions, original and lateral reversal, yielded opposite results. Whichever half of the owner's normal face was perceived in the left visual space of the viewer appeared to 'dominate' the decision and to determine the choice of which composite most-resembled the face. We calculated the proportion of 'left' most-resembles and 'right' most-resembles responses for each subject. A repeated measures ANOVA with a between-subjects factor of Orientation (original, reversed) and within-subjects factors for Side (left–left, right–right) and Sex of Face (females, males) was applied to the proportion of 'more resembles' in each of the viewing conditions. The results of the ANOVA revealed a significant interaction of Orientation × Side [$F(1,31) = 28.40$, $P = 0.000008$)] but not for for Side × Sex of Face ($P = 0.166$). In view of the significant two-way interaction, further analyses were applied to the data. In the first viewing condition (original orientation), the only significant effect was a main effect for Side [$F(1,17) = 19.49$, $P = 0.0004$)] with a higher mean of right–right composites judged to most-resemble the normal face (Fig. 1). Similarly, the results for 'most-resembles' in the lateral reversal condition revealed only a main effect for Side [($F(1,15) = 8.18$, $P = 0.01$)], reflecting a higher mean of left–left composites judged to most resemble the normal face. In neither viewing condition was there an interaction between Sex of Face and Side. Resemblance decisions, then, appear largely independent of the sex of the viewed face.

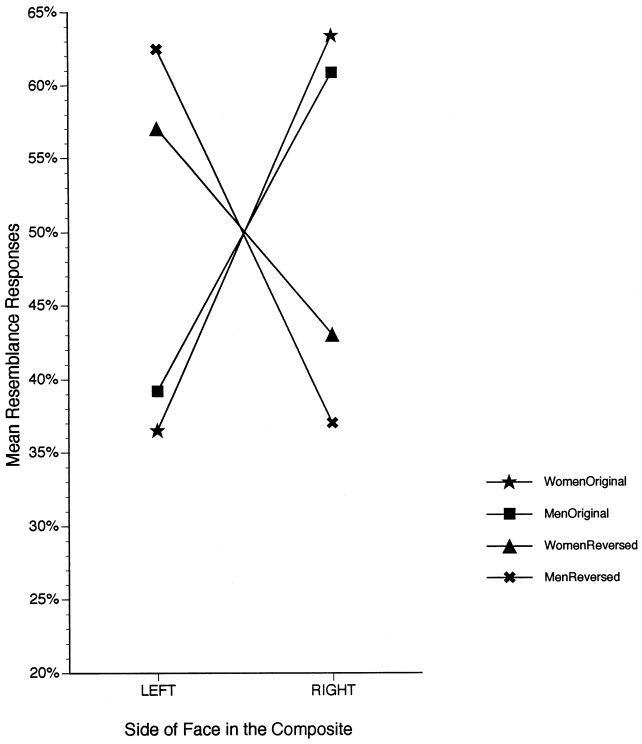

Fig. 1. Summary of mean proportion of responses for 'left' most-resembles or 'right' most-resembles the normal (target) face under two separate viewing conditions. Mean proportion of responses in the original orientation. Mean proportion of responses in the lateral reversal condition.

The results on the present set of faces confirm and extend the findings of Gilbert and Bakan [18] and Bennett *et al.* [3] that perceptual factors in the left visual space of the observer dominate resemblance decisions. We extended the question of sex of the viewed face, but found that the sex of the viewed face was unimportant in making resemblance decisions. In counterbalancing the lateral position of the composites on the viewing screen, we showed further that facial physiognomy is not critical. Regardless of which face side was represented in the composite, the decision appeared to be determined by the normal face itself. This was true for both women's and men's faces. Generalizing to normal face-to-face-interactions, what the observer sees in the owner's right facial side (the side ipsilateral to the right hand) is seen in the observer's left visual space, and processed initially in the right, face-specialized hemisphere.

Experiment 2: facial beauty

In this experiment, we studied the observer vs owner hypothesis in beauty ratings of normal faces. Again, we applied the logic of lateral reversal of pictures on the assumption that content is held constant while lateral layout changes. Our previous study [39] indicated that, in women's faces, right–right facial composites are more attractive than left–left composites. Since the composites were bilaterally symmetrical, it was important to see if the findings extended to normal faces which are naturally bilaterally asymmetrical. If subjects relied on clues perceived in the facial physiognomy of the normal face, lateral reversal should not alter the results of Experiment 1.

Method

Subjects

A different set of right-handed subjects was tested. They were drawn from the same subject pool described in Experiment 1. Again, there were two different viewing conditions: 'original' ($N = 25$; 12 females, 13 males) and 'lateral reversal' ($N = 26$; 13 females, 13 males) with a different group of subjects assigned to each condition.

Materials

Only normal faces were used; they were from the identical stimulus set used in Experiment 1.

Procedure

Subjects saw a single normal face in the center of a Macintosh screen for a duration of 10 sec. The task was to rate the beauty of the face on a five-point Likert scale, with 1 for 'very unattractive' and 5 for 'very attractive'. This procedure was the same in the 'original orientation' viewing group and in the 'lateral reversal' group.

Results and discussion

The ratings for women's and men's faces by each subject were entered into the data analysis. Figure 2 shows a graphic summary of the results. A repeated-measures ANOVA with a between-subjects factor of Orientation (original, reversed) and a within-subjects factor of Sex of Face (women, men) was applied to the ratings. It revealed only one significant result, a main effect for Sex of Face [(F (1,49) = 53.86, $P = 0.0001$)]. The significant effect reflected a higher mean rating for women's faces (2.71) than for men's faces (2.34), in each of the viewing conditions. The factor of Orientation was not significant ($P = 0.32$), reflecting a similar mean rating by the original and reversed viewing conditions, nor was the Orientation by Sex of Face interaction significant ($P = 0.54$). The mean overall rating by female and male subjects did not differ substantially from each other (mean of females rating men's faces = 2.29 and of women's faces = 2.89; mean of male subjects rating men's faces = 2.45 and women's faces = 2.64). These results show that, if asymmetric perceptual factors alone were critical, subjects' reactions to the faces would change dramatically (and significantly) as a function of the two viewing conditions. Since this was not the case, it is reasonable to conclude that the owner's facial physiognomy was predominant in the ratings.

General discussion

We relied on the lateral layout in bilaterally asymmetrical faces to test the observer vs owner hypothesis in the appearance of beauty on the face and in resemblance

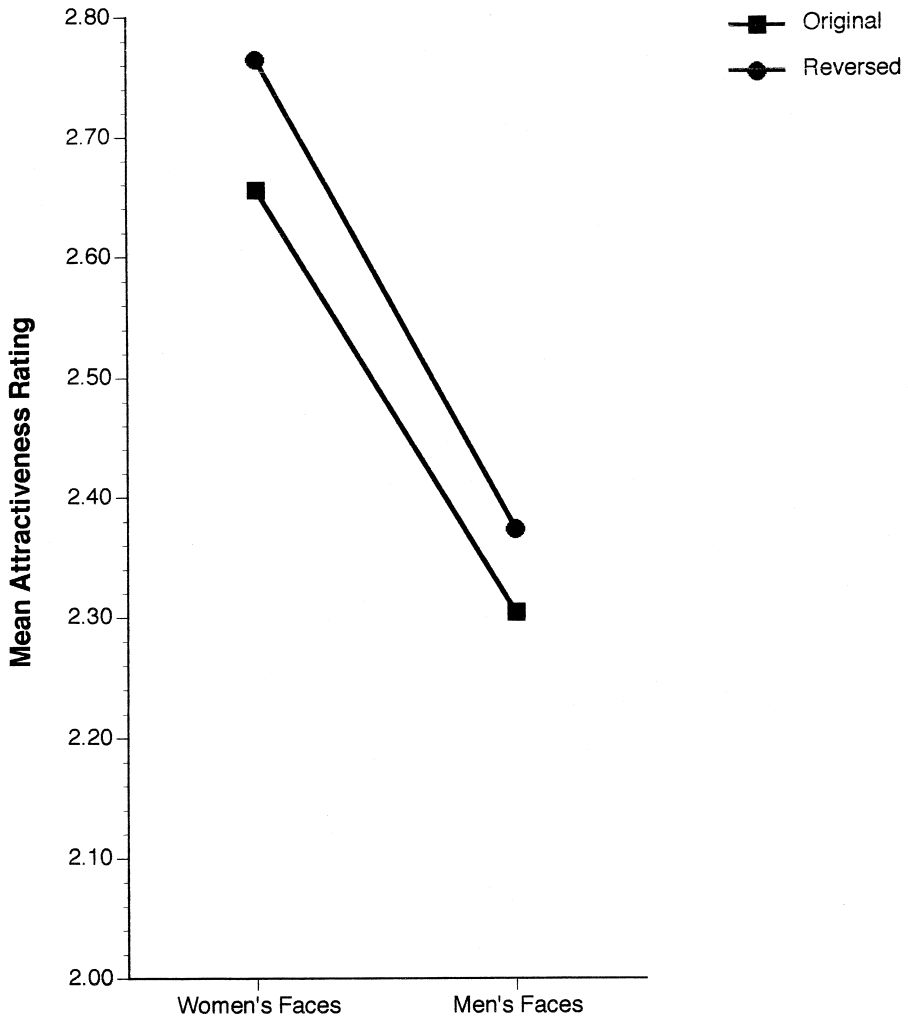

Fig. 2. Summary of mean ratings for attractiveness of normal faces (women's and men's) on a five-point Likert scale in original orientation and lateral reversal. '1' = very unattractive; '5' = very attractive.

judgments. The absence of a difference in attractiveness ratings between the viewing conditions is consistent with a previous study of sitters in painted fine-art portraits [38]. The assumption was that content remains the same, even when the face is mirror-reversed. If important information regarding attractiveness is in the facial physiognomy, subjects' ratings should not differ significantly between the viewing conditions. Indeed, this is what we found. In resemblance judgements, facial morphology does not appear to be as important as in beauty judgements.

Normally, the sides of the owner's face are fixed (mirror reversal is a laboratory condition). Thus, we should think of the original orientation in these experiments as best representing normal biological arrangement, one that is encountered in ordinary social interaction. In this study, all faces were observed in free-vision; no attempt was made to lateralize the information tachistoscopically to one or the other visual half fields. We may, nevertheless, speculate on the relationship between face and brain, especially with regards to the left and right hemispheres. There may be a biological advantage to lateral asymmetry in the face, namely division of labor for the brain of the observer looking at an asymmetrical face: The LF (the owner's facial side ipsilateral to the left hand) falls in the observer's right visual space (which is transmitted initially to the left hemisphere), and the RF falls in the observer's left visual space (transmitted initially to the right hemisphere). Specialization in facial recognition is consistently attributed to the right hemisphere [2, 14, 19, 20, 35, 37]. If identity judgements are dominated by visual information in the observer's left perceptual space, it is most likely in order to optimize facial processing in the observer's right hemisphere.

What the present results show is that the difference between facial identity and beauty lies in the physiognomy of the observed rather than in perceptual asymmetries of the observer, and, importantly may be entirely independent of sex. The owner's RF does not have special features that represent the whole face, whether the face of a woman or a man, or else the results would not have altered with lateral reversal. Under normal conditions, the observer's right hemisphere interprets visual information regarding the owner's RF to identify the face. However, in women's faces, since attractiveness is relatively more pronounced in RF [39], beauty might be incorporated into the identity decision. Such an arrangement may be advantageous from an adaptive perspective, although we are in no position to speculate on its origin.

While not enough is known to determine what specific features related to beauty are extracted from the face, nor what would be advantageous about a right hemisphere's selective role in the extraction, it may be fruitful to suggest that 'beauty is not simply in the eye of the beholder'. That is, that beauty is not merely a subjective decision independent of functional neuroanatomical arrangements in the brain. Facial beauty is anchored in biology and survival of the species because it relays signals about reproduction and internal health [32] more so than facial identity. Fixed neuroanatomical arrangements in the human brain must be in place to extract the biological relevance of beauty. The individual, subjective assessment of facial beauty is also processed and computed in the brain. Obviously, the same biological relevance argument could apply to both the observer's and the owner's brain asymmetries.

The influence of facial beauty in ordinary human interactions is more important than has been acknowledged in the neuropsychological literature. A recent study of fine-art portraits found a positive significant correlation ($r = 0.59$) between subjects' reactions to the portrait as a whole and the attractiveness rating of the sitter. The more attractive the sitter, the more the painting was liked [38]. Preference for attractiveness begins early on; 6- to 8-month-old babies prefer to look at beautiful faces [22]. Right hemisphere specialization for facial processing similarly begins early on, in infants 4–9 months old [11, 12, 14]. What remains to be determined is the onset of the relationship between attractiveness preference and right hemisphere specialization for faces. A critical test of our hypothesis (the relationship between a woman's identity and her attractiveness) is the age at which facial asymmetries in attractiveness emerges in girls, and the age in boys when this relationship is processed in the brain. Associating the onset of this asymmetry with the onset of puberty, for example, would give us a useful handle on the relationship between attractiveness, biology, and identity.

The role of esthetics in mate selection was debated long ago by Darwin and continues to be discussed by biological evolutionists and anthropologists even now [9, 25, 26, 32]; "... there loomed over Darwin's theory of sexual selection the unanswered question of why it is adaptive for females to choose the best-ornamented males. Could mere aesthetic choice be selectively advantageous? Or was the choice perhaps not aesthetic? And if not, how could it be explained? ([9], p. 181)". In the field of neuropsychology, we might arrive at an explanation if we begin to consider specific lateralized brain mechanisms wired up to react selectively to facial beauty.

Acknowledgements—This study was supported by NIH grant NS 20183. We thank Hiep Dim for assistance in testing some of the subjects, Hadyn Ellis, and two anonymous reviewers for useful comments on the manuscript.

References

1. Alford, R. and Alford, K. F. Sex differences in asymmetry in the facial expression of emotion. *Neuropsychologia* **19,** 605–608, 1981.
2. Beardsworth, E. D. and Zaidel, D. W. Memory for faces in epileptic children before and after brain surgery. *Journal of Clinical and Experimental Neuropsychology* **16,** 589–596, 1994.

3. Bennett, H. L., Delmonico, R. L. and Bond, C. F. Expressive and perceptual asymmetries of the resting face. *Neuropsychologia* **25,** 681–687, 1987.
4. Borod, J. C., Caron, H. S. and Koff, E. Asymmetry in positive and negative facial expressions: Sex differences. *Neuropsychologia* **19,** 819–824, 1981.
5. Borod, J. C., Koff, E. and White, B. Facial asymmetry in spontaneous and posed expressions of emotion. *Brain and Cognition* **2,** 165–175, 1983.
6. Buss, D. The evolution of human intrasexual competition: Tactics of mate attraction. *Journal of Personality and Social Psychology* **54,** 616–628, 1988.
7. Buss, D. M. Sex differences in human mate preferences: Evolutionary hypotheses tested in 37 cultures. *Behavioral and Brain Sciences* **12,** 1–49, 1989.
8. Campbell, R. Asymmetries in moving faces. *British Journal of Psychology* **73,** 95–103, 1982.
9. Cronin, H. *The Ant and the Peacock*: *Altruism and Sexual Selection from Darwin to Today*. Cambridge University Press, New York, 1991.
10. Cunningham, M. R. Measuring the physical in physical attractiveness: Quasi-Experiments on the sociobiology of female facial beauty. *Journal of Personality and Social Psychology* **50,** 925–935, 1986.
11. de Schonen, S. and Mathivet, E. First come, first served: A scenario about the development of hemispheric specialization. *European Bulletin of Cognitive Psychology* **9,** 33–44, 1989.
12. de Schonen, S. and Mathivet, E. Hemispheric asymmetry in a face discrimination task in infants. *Child Development* **61,** 1192–1205, 1990.
13. Dion, K., Berscheid, E. and Walster, E. What is beautiful is good. *Journal of Personality and Social Psychology* **24,** 285–290, 1972.
14. Ellis, H. D. The role of the right hemisphere in face perception. In *Functions of the Right Hemisphere*, A. W. Young (Editor). Academic Press, London, 1983.
15. Ferrario, V. F., Sforza, C., Miani, A. J. and Tartaglia, G. Craniofacial morphometry by photographic evaluations. *American Journal of Orthodontics and Dentofacial Orthopedics* **101,** 327–337, 1993.
16. Ferrario, V. F., Sforza, C., Pogio, C. E. and Tartaglia, G. Distance from symmetry: A three-dimensional evaluation of facial asymmetry. *Journal of Oral Maxillofacial Surgery* **52,** 1126–1132, 1994.
17. Ferrario, V. G., Sforza, C., Pizzini, G., Vogel, G. and Miani, A. Sexual dimorphism in the human face assessed by euclidean distance matrix analysis. *Journal of Anatomy* **183,** 593–600, 1993.
18. Gilbert, C. and Bakan, P. Visual asymmetry in perception of faces. *Neuropsychologia* **11,** 355–362, 1973.
19. Hauser, M. D. Right hemisphere dominance for the production of facial expression in monkeys. *Science* **261,** 475–477, 1993.
20. Hecaen, H. The neuropsychology of face recognition. In *Perceiving and Remembering Faces*, G. Davies, H. Ellis and J. Shepard (Editors), pp. 52–65. Academic Press, London, 1981.
21. Hoptman, M. and Levy, J. Perceptual asymmetries in left- and right- handers for cartoon and real faces. *Brain and Cognition* **8,** 178–188, 1988.
22. Langlois, J. H. Infant preferences for attractive faces: Rudiments of a stereotype? *Developmental Psychology* **23,** 363–369, 1987.
23. Levy, J., Heller, W., Banich, M. and Burton, L. Asymmetry of perception in free viewing of chimeric faces. *Brain and Cognition* **2,** 404–419, 1983.
24. Lindauer, M. S. Perceived and preferred orientations of abstract art. *Empirical Studies of the Arts* **5,** 47–58, 1987.
25. Moller, A. P. Fluctuatuing asymmetry in male sexual ornaments may reliably reveal male quality. *Animal Behavior* **40,** 1185–1187, 1990.
26. Moller, A. P. Females prefer large and symmetrical ornaments. *Nature* **357,** 238–240, 1992.
27. Peck, S., Peck, L. and Kataia, M. Skeletal asymmetry in esthetically pleasing faces. *The Angle Orthodontist* **61,** 43–48, 1991.
28. Perrett, D. I., May, K. A. and Yoshikawa, S. Facial shape and judgements of female attractiveness. *Nature* **368,** 239–242, 1994.
29. Scheideman, G. B., Bell, W. H., Legan, H. L., Finn, R. A. and Reisch, J. S. Cephalometric analysis of dentofacial normals. *American Journal of Orthodontics and Dentofacial Orthopedics* **78,** 404–420, 1980.
30. Sigall, H. and Landy, D. Radiating beauty: The effects of having a physically attractive partner on person perception. *Journal of Personality and Social Psychology* **28,** 218–224, 1973.
31. Symons, D. The psychology of human mate preferences. *Behavioral and Brain Sciences* **12,** 34–35, 1989.
32. Symons, D. Beauty is in the adaptations of the beholder: The evolutionary psychology of human female sexual attractiveness. In *Sexual Nature*, *Sexual Culture*, P. R. Abramson and S. D. Pinkerton (Editors), pp. 80–118, University of Chicago Press, Chicago, 1995.
33. Thornhill, R. and Gangestad, S. W. Human facial beauty. *Human Nature* **4,** 237–269, 1993.
34. Vig, P. S., Hewitt, A. B. Asymmetry of the human facial skeleton. *The Angle Orthodontist* **45,** 125–129, 1975.
35. Warrington, E. and James, M. An experimental investigation of facial recognition in patients with unilateral cerebral disease. *Cortex* **3,** 317–326, 1967.
36. Wolff, W. *Expression of Personality*. Harper and Brothers, New York, 1943.
37. Yin, R. Face recognition by brain injured patients: A dissociable ability. *Neuropsychologia* **8,** 395–402, 1970.
38. Zaidel, D. W. and FitzGerald, P. Sex of the face in Western art: Left and right in portraits. *Empirical Studies of the Arts* **12,** 9–18, 1994.
39. Zaidel, D. W., Chen, A. C. and German, C. She is not a beauty even when she smiles: Possible evolutionary basis for a relationship between facial attractiveness and hemispheric specialization. *Neuropsychologia* **33,** 649–655, 1995.