Perception, 2005, volume 34, pages 319 – 340

DOI:10.1068/p5191

Attractiveness of own-race, other-race, and mixed-race faces

Gillian Rhodes¶§, Kieran Lee¶§, Romina Palermo¶, Mahi Weiss¶, Sakiko Yoshikawa§#, Peter Clissa¶, Tamsyn Williams¶, Marianne Peters¶, Chris Winkler¶, Linda Jeffery¶

¶ Department of Psychology, University of Western Australia, 35 Stirling Highway, Crawley, WA 6009, Australia; e-mail: gill@psy.uwa.edu.au; § ATR Human Information Processing Research Laboratories, 2-2 Hikari-dai, Soraku-gun, Kyoto 619-02, Japan; # Department of Cognitive Psychology in Education, Kyoto University, Sakyo, Kyoto 606-8501, Japan

Received 10 December 2003, in revised form 8 June 2004; published online 9 March 2004

Abstract. Averaged face composites, which represent the central tendency of a familiar population of faces, are attractive. If this prototypicality contributes to their appeal, then averaged composites should be more attractive when their component faces come from a familiar, own-race population than when they come from a less familiar, other-race population. We compared the attractiveness of own-race composites, other-race composites, and mixed-race composites (where the component faces were from both races). In experiment 1, Caucasian participants rated own-race composites as more attractive than other-race composites, but only for male faces. However, mixed-race (Caucasian/Japanese) composites were significantly more attractive than own-race composites, particularly for the opposite sex. In experiment 2, Caucasian and Japanese participants living in Australia and Japan, respectively, selected the most attractive face from a continuum with exaggerated Caucasian characteristics at one end and exaggerated Japanese characteristics at the other, with intervening images including a Caucasian averaged composite, a mixed-race averaged composite, and a Japanese averaged composite. The most attractive face was, again, a mixed-race composite, for both Caucasian and Japanese participants. In experiment 3, Caucasian participants rated individual Eurasian faces as significantly more attractive than either Caucasian or Asian faces. Similar results were obtained with composites. Eurasian faces and composites were also rated as healthier than Caucasian or Asian faces and composites, respectively. These results suggest that signs of health may be more important than prototypicality in making average faces attractive.

1 Introduction

What makes a face attractive? To many people's surprise, average faces are attractive (Langlois and Roggman 1990; Langlois et al 1994; Rhodes et al 1999; Rhodes and Tremewan 1996; Rhodes and Zebrowitz 2002). Computer-generated averaged composite faces are generally more attractive than the component faces used to make them (Langlois and Roggman 1990; Rhodes et al 1999; Rhodes and Tremewan 1996). Distorting an individual face towards an average configuration for its sex increases its attractiveness (Rhodes et al 1999, 2001b) and natural variations in averageness correlate positively with attractiveness (Jones and Hill 1993; Light et al 1981; Rhodes et al 1999; Rhodes and Tremewan 1996). The appeal of average faces cannot be attributed to blending artifacts, symmetry, or pleasant expressions (for a review see Rhodes et al 2001a) and, although some extremes can be more attractive than average traits (eg feminised traits—Perrett et al 1998; Rhodes et al 2000; neotenous traits—Zebrowitz 1997), the fact remains that average faces are more attractive than most.

Experience with a population of faces determines what is average and a person's mental representation of the prototypical or average face appears to be rapidly updated in response to consistent changes in experience (Rhodes et al 2003). For instance, after subjects have viewed consistently distorted faces, faces with a low level of this distortion appear to them more normal and more attractive than undistorted faces (Rhodes et al 2003). These findings suggest that average faces are attractive because of their central location in a distribution of faces (ie because of their prototypicality, and not because of any intrinsic appeal of particular physical traits) and that what is central is determined by experience.

If average faces are attractive because they match mental prototypes derived from experience, then averaged composite faces should be more attractive when their component faces come from a familiar, own-race population, than when they come from a less familiar, other-race population. We use the term race to refer to visually distinct social groups. Furthermore, adding other-race faces to an own-race composite should reduce its attractiveness because it moves the composite away from the familiar prototype. To our knowledge, only one study has compared the attractiveness of own-race, other-race, and mixed-race composites (Rhodes et al 2001b). There was no significant difference in attractiveness ratings given by Caucasian participants to Caucasian, Chinese, and mixed composites. Here, we adopted more sensitive tests of preferences and included both Caucasian and Japanese participants (experiment 2).

In experiment 1, Caucasian participants were shown sets of same-sex composites of Caucasian faces, Japanese faces, and various weighted combinations of the two, and were asked to select the most attractive face and rate its attractiveness. This procedure was repeated until all the composites had been rated. In experiment 2, Caucasian participants living in Australia and Japanese participants living in Japan used an interactive slider to select the most attractive image from a continuum of composites, ranging from a composite with exaggerated Caucasian features at one end to one with exaggerated Japanese features at the other end, and a mixed-race composite in the middle.

To foreshadow our findings, the most attractive composites were generally mixed-race (close to 50/50) composites for both participant groups. This result is difficult to explain as a preference for prototypicality. Prototypes display typical traits for a class of stimuli and, even if minority faces contribute disproportionately to our face prototypes (perhaps because of greater attention to less common faces), it seems unlikely that equal weight would be given to majority and minority group faces. Furthermore, given the salience of race as a visual and social category, it seems likely that people would maintain distinct prototypes for different races (Cosmides et al 2003). Direct support for distinct prototypes for different races comes from findings that caricatures of Caucasian and Chinese faces are recognised best when caricatured against their own-race norms (Byatt and Rhodes 1998).

What, then, might explain the appeal of mixed-race composites? Evolutionary psychologists propose that attractive traits signal aspects of mate quality, such as health (for discussions see Rhodes and Zebrowitz 2002; Symons 1979; Thornhill and Gangestad 1999). Two meta-analyses have found a relationship, albeit weak, between attractiveness and health (Feingold 1992; Langlois et al 2000). Furthermore, facial averageness, which is attractive, not only looks healthy but is associated with health during development in real faces (Rhodes et al 2001c), although overall attractiveness was not associated with health in this sample (Kalick et al 1998).

We hypothesised that the appeal of mixed-race traits might be due to a healthy appearance. This hypothesis follows from three premises. The first is that there is an association between average traits and heterozygosity (when the two forms of a gene are not identical). Gangestad and his colleagues first proposed this association, based on the idea that protein heterozygosity is typically highest in individuals with average traits (Gangestad and Buss 1993; Thornhill and Gangestad 1993). We know of no direct evidence that individuals with average faces are more heterozygous than their peers, but evidence that individuals with higher levels of heterozygosity at loci involved in immune responses (major histocompatibility complex loci) have more attractive faces than their peers (Roberts et al 2004, but see Thornhill et al 2002) suggests that heterozygous individuals could well have more average faces (given that average faces are attractive).

The second premise is that mixed-race individuals are more heterozygous (on average) than single-race individuals. If parents from different races are less similar genetically (on average) than ones from the same race (Penn 2002), then their (mixed-race) offspring would be more likely to inherit different alleles from each parent and have higher levels of heterozygosity. Note that the assumption here is not that races form genetically distinct groups, only that geographically distinct populations have different locally adapted gene complexes (Endler 1977).

The third premise is that heterozygosity is associated with good health, for which there is some support. Heterozygosity at the major histocompatibility complex loci, which control immune responses, is associated with enhanced resistance to infectious diseases (Carrington et al 1999; Penn 2002; Penn et al 2002). Multilocus heterozygosity is associated with fitness at both individual and population levels (Britten 1996; Hansson and Westerberg 2002; Mitton 1993; Reed and Frankham 2003) and is also associated with fitness of offspring in a fluctuating environment (Charlesworth 1988). Low levels of heterozygosity, due to inbreeding, are associated with increased childhood mortality and morbidity (Bittles and Neel 1994; Grant and Bittles 1997; Hussain et al 2001; Reddy et al 2001; Sudhakaran and Vijayavalli 1997). Therefore, individuals with high levels of heterozygosity may be healthier than their peers.

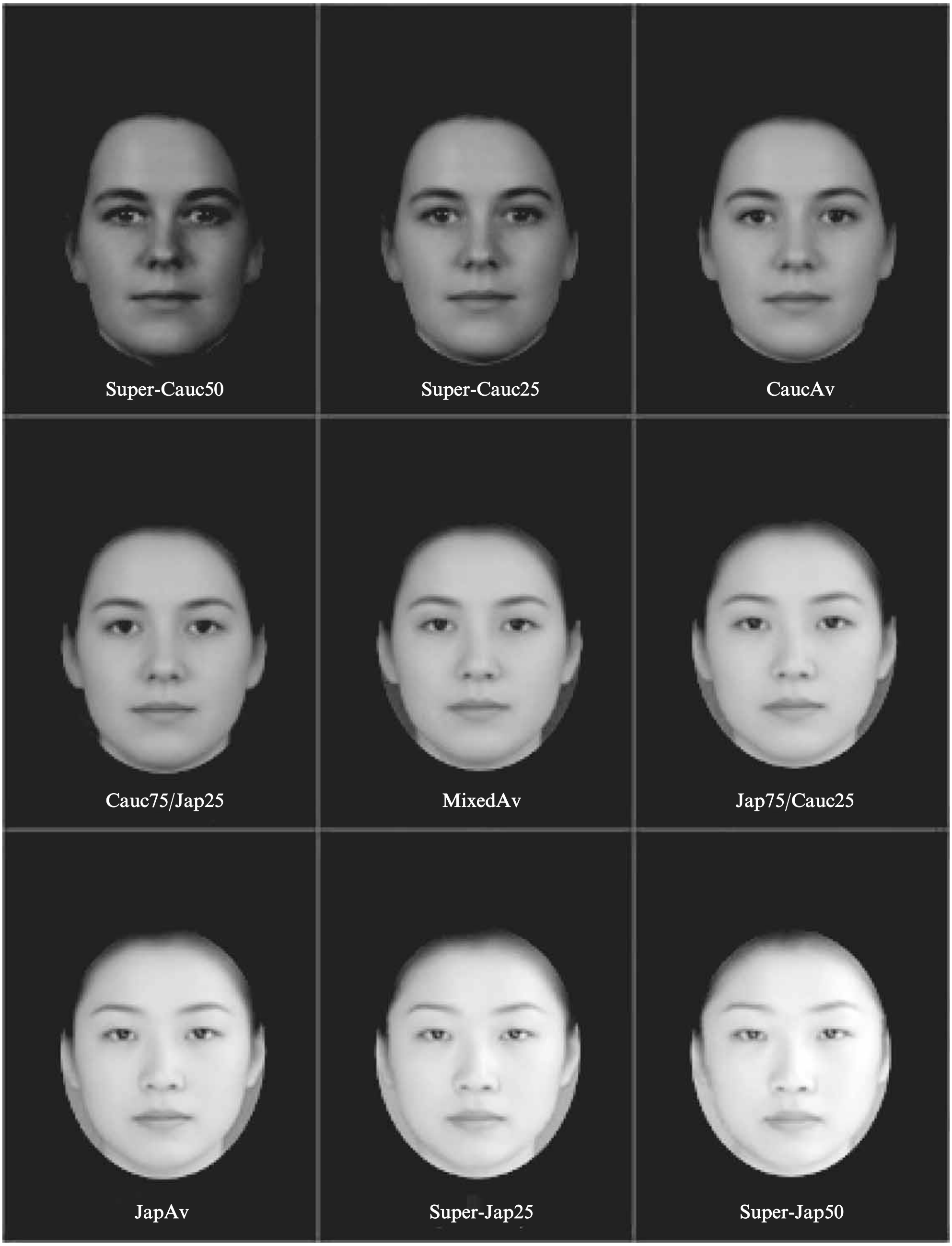
In experiment 3 we tested whether mixed-race averaged composite faces look healthier than single-race composites, and whether individual mixed-race (Eurasian) faces look healthier than Caucasian and Asian faces. We could not directly assess the health of these individuals but perceptions of health do have some accuracy (Kalick et al 1998; Rhodes et al 2001c).

2 Experiment 1

Experiment 1 was designed to determine whether averaged composites of own-race faces are more attractive than other-race composites or mixed-race composites. Caucasian participants were asked to select the most attractive face from a set of nine composite faces of the same sex and rate its attractiveness. They then selected the next most attractive face and rated its attractiveness, and so on, until all nine faces had been rated. The nine faces were taken from a continuum of images that ranged from a composite with exaggerated Caucasian features to one with exaggerated Japanese features (see figure 1). Intermediate images included an own-race (Caucasian) average (CaucAv), a mixed-race average (MixedAv), and an other-race (Japanese) average (JapAv). We created own-race and other-race averages by averaging twenty-four same-sex Caucasian faces, and twenty-four same-sex Japanese faces, respectively, using computer morphing software. Mixed-race averages were created by morphing the Caucasian and Japanese averages together.[(1)] Separate sets were generated for male and female faces.

There were two sets of faces for each sex. In one, both face shape and skin colour were allowed to vary, representing natural differences between Caucasian and Japanese faces. The primary data of interest come from choices in these *shape + colour* sets. We also included *shape-only* sets, where all the faces had the skin colour of the mixed-race average and only face shape was allowed to vary, to see whether a mixed-race preference would be found independently of variation in skin colour. However, the faces in the shape-only sets were all very similar and all had mixed-race (colour) characteristics, so they may not provide as sensitive a test of our hypotheses as the shape + colour sets.

[(1)] Mixed-race composites had forty-eight component faces, whereas single-race composites had twenty-four component faces. This difference should not affect the attractiveness of the composites because any increase in attractiveness with increasing number of component faces asymptotes below twenty-four faces (Rhodes et al 2001a, 2001b).

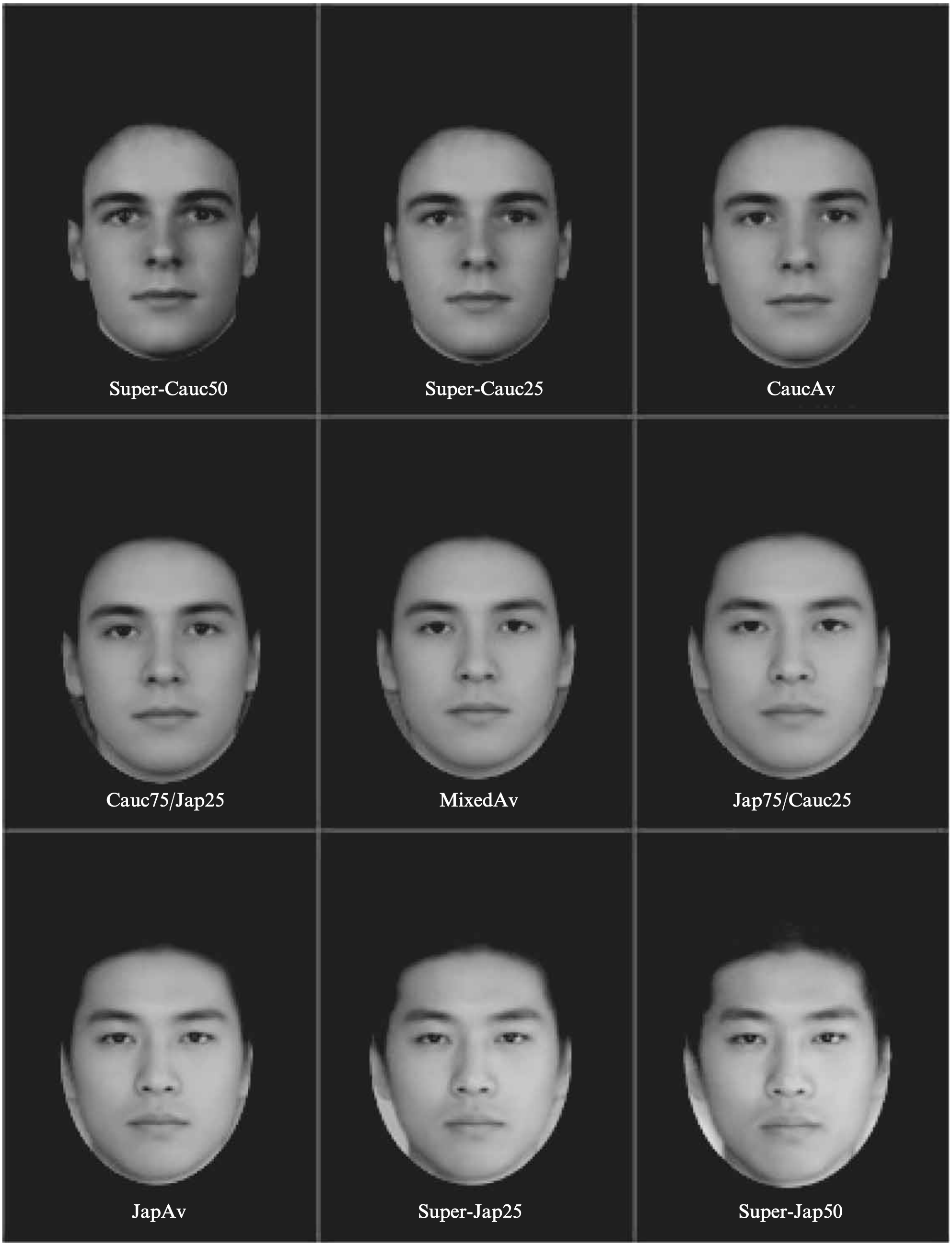


(a)

Figure 1. The four face sets used in experiment 1. (a) Female shape + colour set; (b) male shape + colour set; (c) female shape-set; (d) male shape-set. A colour version of this figure can be viewed on the *Perception* website at http://www.perceptionweb.com/misc/p5191/.

2.1 *Method*

2.1.1 *Participants.* Thirty-two Caucasian participants (nineteen female and thirteen male) aged between 16 and 34 years ($M = 21$ years) participated. On average, the participants knew fewer than four Japanese individuals personally ($M = 3.9$, SD = 9.1) and only two had ever visited Japan. Thirteen had studied Japanese, for a mean duration of 2.0 years (SD = 1.3 years).

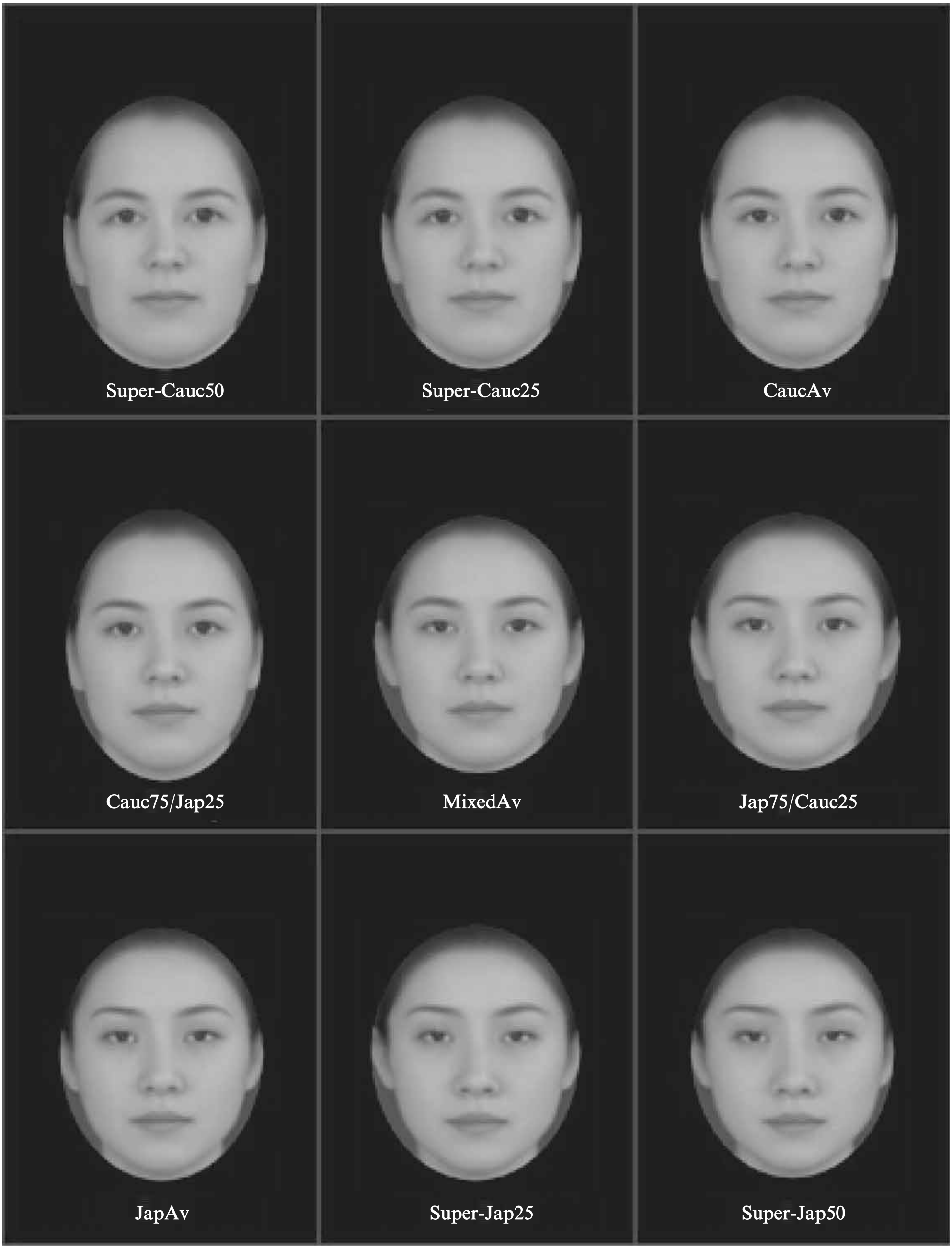


(b)

Figure 1 (continued)

2.1.2 *Stimuli.* Four average faces were constructed—Caucasian female, Caucasian male, Japanese female, and Japanese male. Each average face was constructed from a set of twenty-four high-quality, digitised colour photographs of young adults[(2)] displaying neutral expressions, taken with symmetric lighting under studio conditions. The faces were taken from databases of Japanese and Caucasian faces held in Japan and Australia, respectively. A fixed set of 179 landmark points indicating the shape and position of

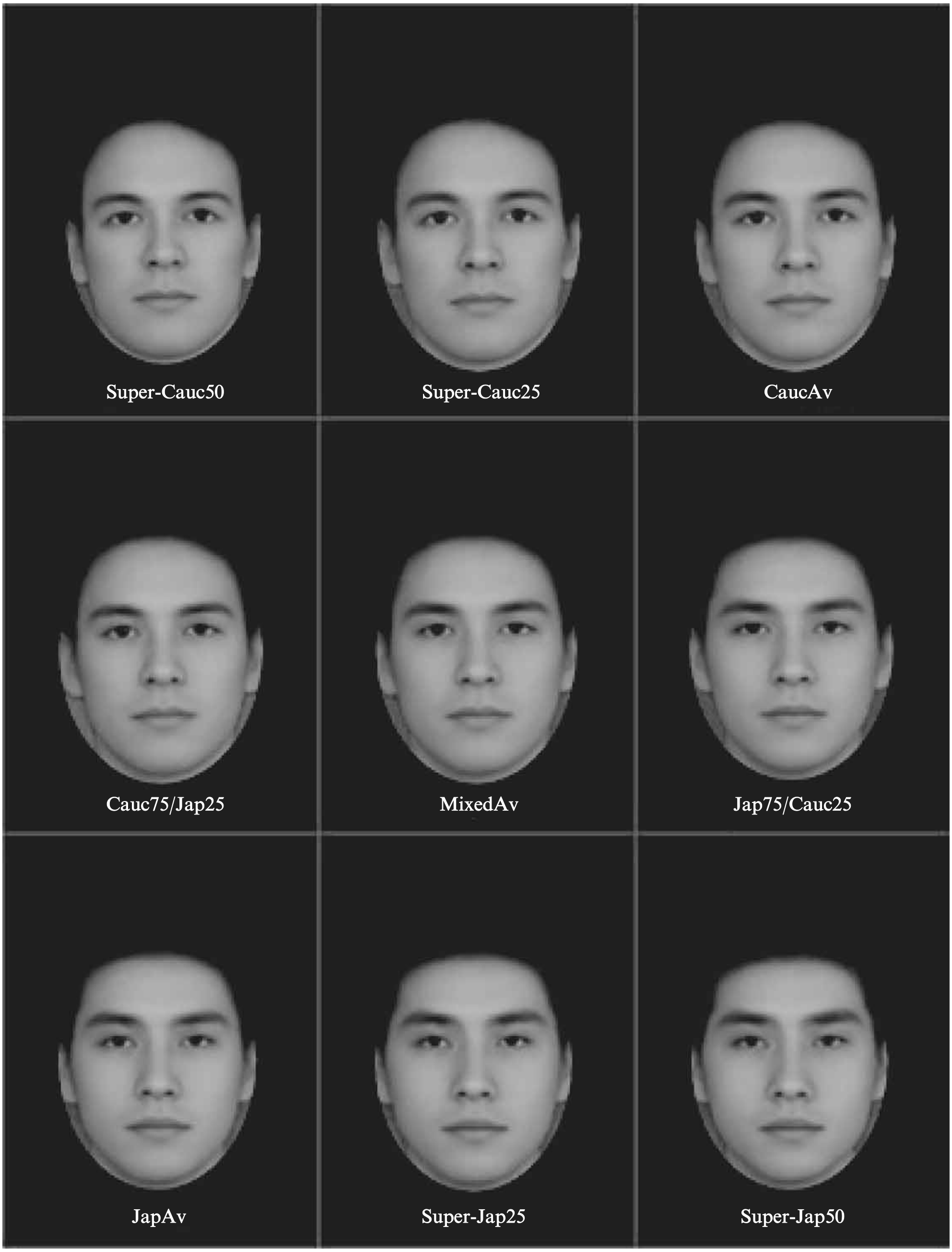
[(2)] Exact ages were not available.



(c)

Figure 1 (continued)

internal features and the face outline were placed on each face. For each set of twenty-four faces, the program calculated the average location of each landmark point for each face and then each original face was warped (morphed) onto the shape of the average face. The reshaped face images were then blended together by averaging the colour and intensity values of pixels at corresponding image locations. The procedure is described in more detail in Rowland and Perrett (1995).



(d)

Figure 1 (continued)

Using these average faces, a set of nine faces was created for each sex (figure 1). These included four images with exaggerated differences between Caucasian and Japanese faces: Super-Cauc25 and Super-Cauc50 ('Super-Caucasian' images where the differences of the Caucasian average from the Japanese average were exaggerated by 25% and 50%, respectively), and Super-Jap25 and Super-Jap50 ('Super-Japanese' images where the differences of the Japanese average from the Caucasian average were exaggerated by 25% and 50%, respectively) (see Rowland and Perrett 1995 for details).

The set also contained images that blended the Japanese and Caucasian averages: a mixed-race average, formed by blending equally the Caucasian and Japanese averages, a Cauc75/Jap25 image that was made by blending the Caucasian average with the mixed-race average, and a Jap75/Cauc25 image that was made by blending the Japanese average with the mixed-race average. The nine images can be thought of as forming a continuum, from Caucasian features exaggerated by 50% at one end to Japanese features exaggerated by 50% at the other. In between are images with average Caucasian features, mixed-race features, and average Japanese features. Both face shape and skin colour (texture) vary in these sets (shape + colour). A second set of images was created for each sex in which only face shape varied (shape-only), and all had the colour of the mixed-race average. These shape continua were created by applying the mixed-race skin colour to the nine faces in the shape + colour continua for each sex.

The resulting images were adjusted for artifacts produced by the blending algorithm. The 'blur' and 'smudge' tools in Adobe Photoshop were used to remove hard lines. The 'blur' filter in Adobe Photoshop was then applied to all the faces. The images were scaled so that the pupils were a standard 80 pixels apart on a template of 320×420 pixels. A black opaque mask was placed over each face from just above the hairline to just below the chin. The faces, which measured 6.5 cm $\times$ 8.0 cm, were printed in colour at 360 dpi onto 9 cm $\times$ 12 cm cards. The pictures were then laminated and each picture was coded with a number on the back (1 – 9).

2.1.3 *Procedure.* For each set, participants were asked to select the most attractive face and rate its attractiveness on a scale from 1 (not at all attractive) to 10 (very attractive). The participant was then asked to pick the next most attractive face and rate its attractiveness, and so on, until all nine faces were rated. The sets were presented in random order and the faces in each set were shuffled by the experimenter prior to presentation. Finally, participants completed a questionnaire assessing their contact with Japanese people and their fluency, if any, in Japanese.

2.2 *Results and discussion*

Attractiveness ratings were highly reliable, with Cronbach coefficient alphas above 0.94 for all four sets. Ratings were averaged across same-sex participants to get mean male and mean female ratings for each face in each set (figure 2). Inspection of figure 2 shows that for the shape + colour sets, which best capture the variations in appearance between Caucasian, Japanese, and mixed-race faces, both male and female raters found the mixed-race average most attractive for the opposite sex (rated equal-top with an image halfway between the mixed-race and own-race averages for female raters). For same-sex ratings the most attractive image varied between the mixed-race average, the own-race average, and their intermediate image. The mixed-race average was the most attractive of the female, but not male, faces in the shape-only sets. Therefore, for female faces a preference for mixed-race characteristics was found even when skin colour was held constant and only the shape of facial features varied. In no case were other-race averages considered more attractive than own-race averages.

These observations were confirmed by two-way ANOVAs on attractiveness ratings carried out for each set of faces, with type of average (own-race, mixed-race, other-race) as a repeated-measures factor and sex of rater as a between-participants factor. We used planned pairwise comparisons to test whether own-race averages were significantly more attractive than other-race averages and mixed-race averages, with Bonferroni correction for multiple comparisons ($N = 4$, Bonferroni corrected $p = 0.0125$, if sex of rater interacted with type of average; $N = 2$, Bonferroni corrected $p = 0.025$, otherwise). By focusing on these three comparisons, we could test our hypotheses without making the Bonferroni corrections unnecessarily conservative. However, the complete data set

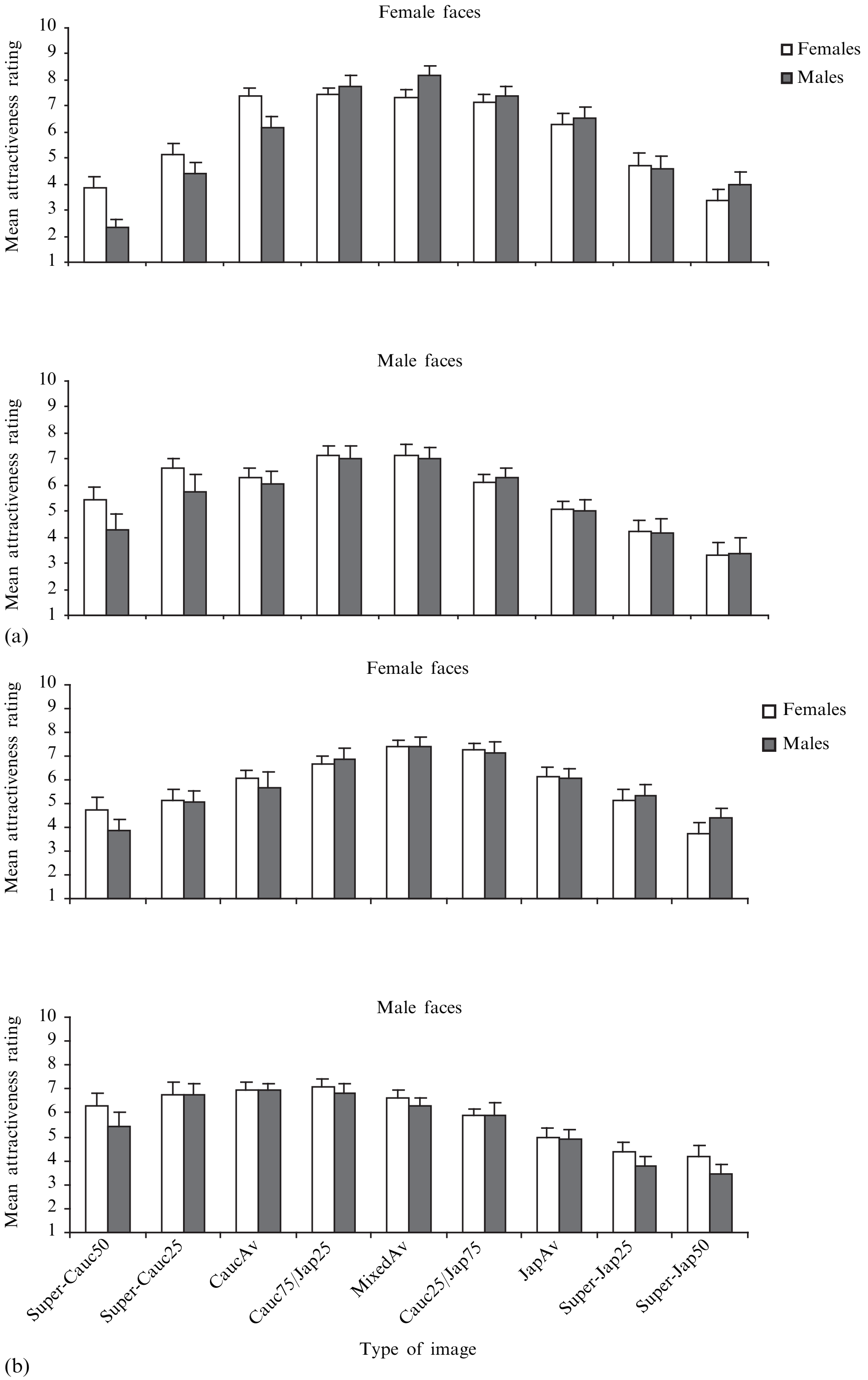


Figure 2. Mean attractiveness ratings for female (top) and male (bottom) faces in (a) the shape + colour sets and (b) shape-only sets in experiment 1.

for all nine image types is shown in figure 2 so that the reader can confirm that this targeted analysis does not misrepresent the overall pattern of results.

For the female shape + colour set there was a significant main effect of type of average ($F_{2,60} = 6.14$, $p < 0.006$) which interacted with sex of rater ($F_{2,60} = 3.69$, $p < 0.04$). Therefore, the planned comparisons between own-race averages and both other-race and mixed-race averages were carried out separately for each sex of rater. The own-race and other-race female averages did not differ significantly for either sex of rater (both ts < 2.12, ns). Males rated the mixed-race female average as significantly more attractive than the own-race female average ($t_{60} = 3.35$, $p < 0.0014$) but females did not ($t < 1$). There was no main effect of sex of rater ($F < 1$).

For the male shape + colour set there was a significant main effect of type of average ($F_{2,60} = 14.05$, $p < 0.0001$) but no effect of sex of rater or any interaction (both Fs < 1). The own-race male average was rated as significantly more attractive than the other-race male average ($t_{60} = 2.95$, $p < 0.005$). However, the mixed-race male average was significantly more attractive than the own-race male average ($t_{60} = 2.34$, $p < 0.023$).

For the female shape set there was a significant main effect of type of average ($F_{2,60} = 7.92$, $p < 0.0009$) but no effect of sex of rater or any interaction (both Fs < 1). The own-race female average did not differ significantly from the other-race female average ($t < 1$). However, the mixed-race average was significantly more attractive than the own-race average, as was also found for male faces in the shape + colour set ($t_{60} = 3.68$, $p < 0.0005$).

For the male shape set there was a significant main effect of type of average ($F_{2,60} = 25.99$, $p < 0.0001$), but no effect of sex of rater or any interaction (both Fs < 1). The own-race male average was significantly more attractive than the other-race male average ($t_{60} = 6.90$, $p < 0.0001$). There was no significant difference in attractiveness between the own-race and mixed-race male averages ($t_{60} = 1.63$, ns).

These results show that both sexes preferred own-race averages to other-race averages for male faces, and rated own-race and other-race averages equally attractive for female faces. For male faces, then, we have some support for the hypothesis that composites of faces drawn from a familiar population are more attractive than those drawn from a less familiar population. However, the most salient result was that mixed-race composites were more attractive than own-race composites, particularly in the opposite sex.

3 Experiment 2

Here we tested Japanese participants living in Japan and Caucasian participants living in Australia. We used an interactive paradigm in which participants could alter the appearance of a face on a computer screen, using the mouse, until they found the most attractive version. The displayed face could vary continuously from an image with exaggerated Caucasian features (Super-Caucasian) to one with exaggerated Japanese features (Super-Japanese), passing through all intermediate points including a Caucasian average, a mixed-race average, and a Japanese average. The Caucasian and Japanese averages from experiment 1 were used to make these images. The continua were constructed online by pairwise interpolation between the Super-Caucasian, Caucasian average, Japanese average, and Super-Japanese images. By using this interactive procedure, we can determine whether the optimally attractive face lies on a continuum from own-race to other-race composites (passing through mixed-race composites of varying proportions).

3.1 *Method*

3.1.1 *Participants.* Thirty-nine (twenty-one female and eighteen male) Caucasian adults (19 – 32 years), resident in Australia, and thirty-two (sixteen female and sixteen male) Japanese adults (18 – 24 years), resident in Japan, participated. All were recruited from local universities.

3.1.2 *Stimuli.* The Caucasian and Japanese averages were those used in experiment 1. The Super-Caucasian and Super-Japanese images were created by exaggerating the differences between the Caucasian and Japanese averages by 75%. These four images were used to create a continuum for each sex in which the face changed continuously in response to mouse movements from the Super-Caucasian to the Super-Japanese image (or vice versa), passing through all intermediate points. The midpoint of each continuum was a mixed-race average generated online by interpolating between the Caucasian and Japanese averages. Both shape and colour information varied in these continua (shape + colour continua). Two additional continua were created, one male and one female, in which face shape varied and all the images had the colour of the mixed-race average (shape-only continua). All images were displayed surrounded by black oval masks, as in experiment 1. To facilitate data analysis and display, the Super-Caucasian, Caucasian average, mixed-race average, Japanese average, and Super-Japanese images were assigned values of 0, 0.25, 0.50, 0.75, and 1.00, respectively, with intermediate images assigned intermediate numbers.

3.1.3 *Procedure.* Participants used an interactive slider displayed on the computer screen, controlled by the mouse, to view images from each of the four continua. They altered the image until they found the most attractive one, which was selected by a mouse click. Each continuum was seen twice, once beginning with the Super-Caucasian image and once with the Super-Japanese image, and the two responses were averaged to give a preference for that continuum. Half the participants saw the eight continua in one random order and half saw them in the reverse order.

3.2 *Results and discussion*

Neither Japanese nor Caucasian participants selected an image close to their own-race average as the most attractive face. Instead, participants generally chose a face with mixed-race characteristics (figure 3). Planned t-tests were carried out separately for each race of participant, sex of face, and type of face (shape-only, shape + colour) to determine whether the preferred face differed significantly from the own-race average (the 0.25 image for Caucasian participants, or the 0.75 image for Japanese participants). The preferred face was always significantly biased away from the own-race average, towards the mixed-race average (all ts > 4.10, ps < 0.001).

There was some variation in the optimal balance of own-race and other-race characteristics across face sets. The greatest deviation from a 50/50 balance occurred for male faces in the shape + colour continuum, where the optimum was midway between the mixed-race average and the Caucasian average. For Japanese participants this represents a preference for mixed-race composites weighted more towards other-race than own-race characteristics, whereas for Caucasian participants it represents a preference for mixed-race composites weighted more towards own-race characteristics. This asymmetry could reflect cultural differences in ethnocentrism, generated by a more positive portrayal of Westerners in Japanese media than of Japanese people in Western media. Such an account does not, however, explain why the asymmetry occurs only for male faces. A possible account for the sex difference may be that Western male faces look more masculine (squarer jaws, thicker brows) than Japanese male faces (see figure 1) and that this appeals to both Japanese and Caucasian participants. We note, however, that there is some controversy about whether masculine traits are attractive (for recent reviews see Rhodes and Zebrowitz 2002). Another possibility is that these particular Western male faces had more positive expressions. Notwithstanding these speculations, the important point is that, despite some variation in the balance considered optimal, the most attractive face always displayed mixed-race characteristics.

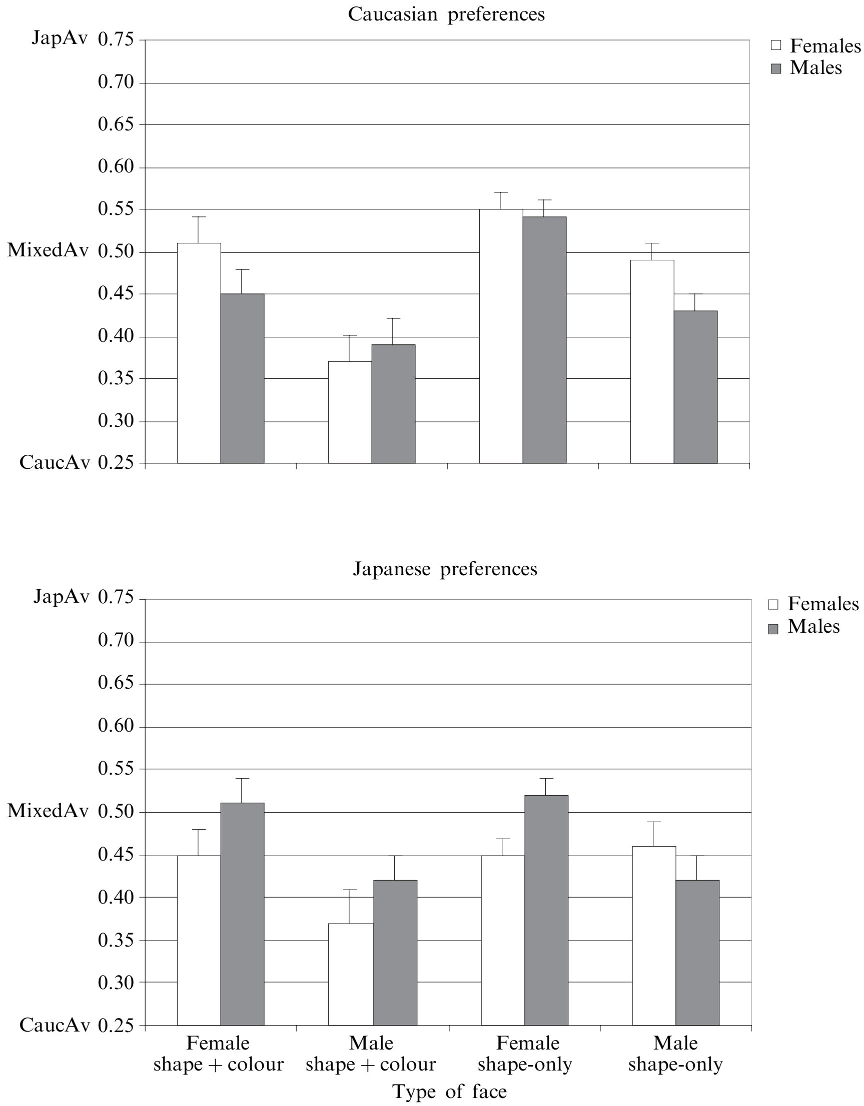


Figure 3. Male and female faces preferred by Caucasian (top) and Japanese (bottom) participants for continua in which only the shape varied (shape-only) and continua in which both the shape and colour varied (shape + colour). Note that own-race averages appear at the bottom of the y-axis for Caucasian participants and at the top of the y-axis for Japanese participants.

4 Experiment 3

In experiments 1 and 2 we found that mixed-race composites were more attractive than own-race composites. This result cannot be readily explained by a preference for prototypicality per se because mixed-race composites are not prototypical of the populations of faces experienced by our participants. Japanese people living in Japan see few Caucasian faces, and Caucasian participants living in Australia see far fewer Japanese (and other Asian faces, which they may not discriminate from Japanese faces) than Caucasian faces, as confirmed by the responses on our contact questionnaire.

In section 1, we proposed that mixed-race faces might be more attractive than single-race faces because they contain stronger cues to health. In experiment 3 we tested this hypothesis. To do so, we photographed individual Eurasian faces and also selected a set of age-matched Caucasian and Asian faces from a database containing faces of students photographed in Perth, Australia, over several years. Different groups of participants rated these faces on attractiveness and health. Finally, we made a range of composites from these faces, with different weightings of Caucasian and Asian faces, together with a composite of the individual Eurasian faces. These composites were also rated on attractiveness and health. We expected the Eurasian individuals and composites would be rated as more attractive, and healthier, than the Caucasian and Asian individuals and composites.

4.1 *Method*

4.1.1 *Participants.* Seventy-two (thirty-six female and thirty-six male) Caucasian undergraduates from the University of Western Australia participated.

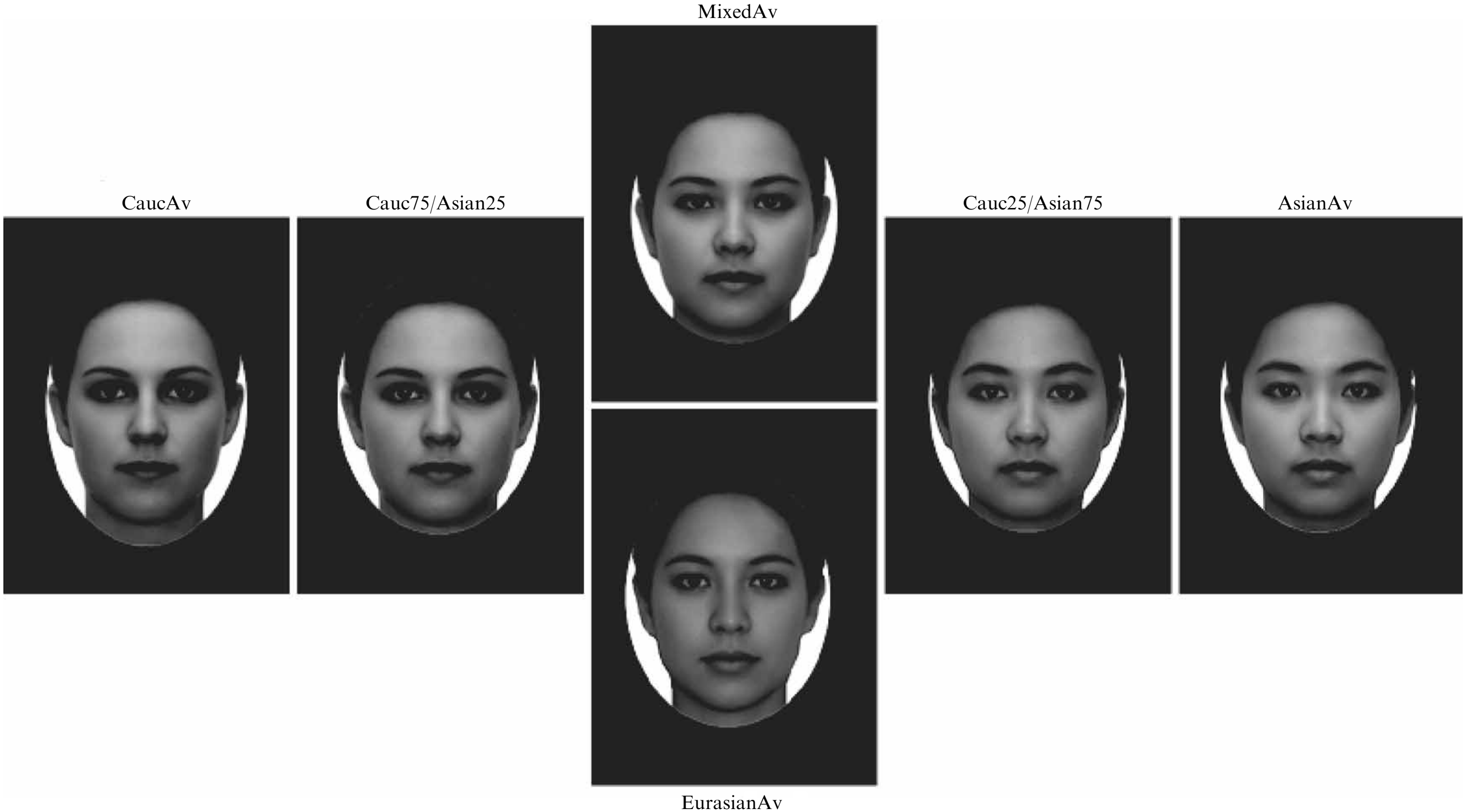
4.1.2 *Stimuli.* A total of thirty-two Caucasian (sixteen female and sixteen male), thirty-two Eurasian (sixteen female and sixteen male), and thirty-two Asian (sixteen female and sixteen male) colour photographs (front-views, neutral expressions) were used to generate two sets of six averaged composites, one set for each sex (figure 4). The Eurasian individuals were recruited from the Universities of Western Australia and Western Sydney, and Macquarie University (Australia). Caucasian and Asian faces were selected from a large Facelab database, so that their ages matched those of the Eurasian faces ($F_{2,45} = 1.23$, ns, male faces; $F < 1$, female faces). As in experiments 1 and 2, the pupils of all faces were horizontally aligned and the interpupil distance was standardised to 80 pixels on a 320×420 pixel template.

The Eurasian females consisted of sixteen individuals: eight Chinese/Caucasian, four Malaysian/Caucasian, one Japanese/Caucasian, one Filipino/Caucasian, one Vietnamese/Caucasian, and one South Korean/Caucasian. Asian faces were chosen so their ethnicity matched that of the Asian parent of the Eurasian individuals. The Eurasian males consisted of sixteen individuals: five Chinese/Caucasian, three Malaysian/Caucasian, two Filipino/Caucasian, three Japanese/Caucasian, two Vietnamese/Caucasian, and one Thai/Caucasian. The ethnicity of all but two of the Asian faces was matched with the ethnicity of the Asian parent of the Eurasian individuals. The two unmatched Asian faces were Chinese and Japanese rather than Filipino and Thai, because the latter were not available.

The average faces were made in the same way as the composites for the shape + colour continuum in experiment 1. We did not include shape-only continua. The Caucasian average (CaucAv), the Eurasian average (EurasianAv), and the Asian average (AsianAv) were each constructed from sixteen Caucasian, sixteen Eurasian, and sixteen Asian faces of the same sex, respectively. A Cauc75/Asian25 composite was constructed from twelve Caucasian and four Asian faces, and a Cauc25/Asian75 was constructed from four Caucasian and twelve Asian faces. A mixed-race average (MixedAv) was generated from eight Caucasian and eight Asian photographs (randomly selected). Unlike the mixed-race composite used in experiment 1, this mixed composite has the same number of component faces as the single-race composites. These images were sharpened or blurred as needed to ensure similar image quality for all the composites. All faces were displayed in oval masks as in experiments 1 and 2.

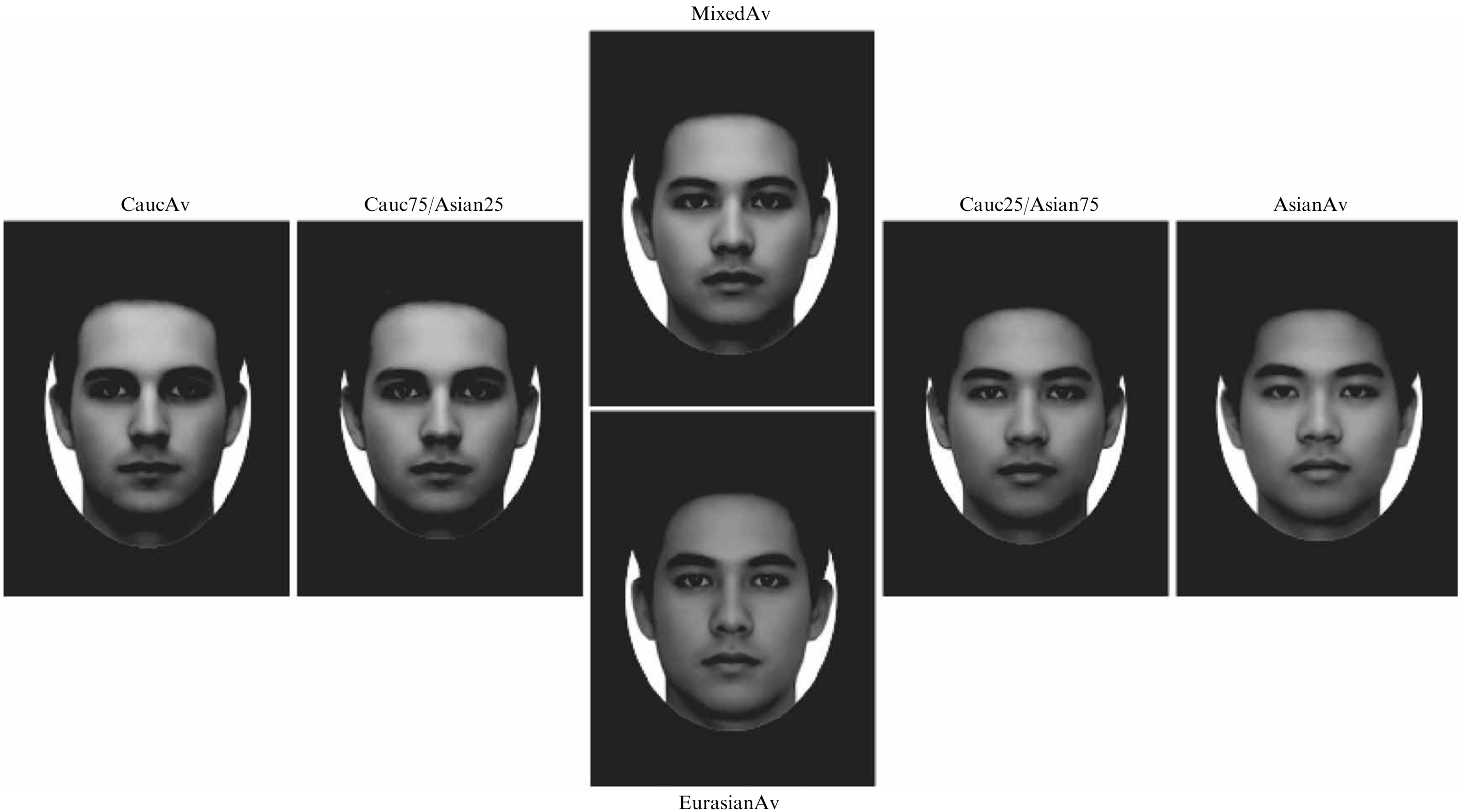
4.1.3 *Procedure*

Individual faces. Only eighty-eight of the ninety-six faces were rated, because eight people (five Eurasian females, two Eurasian males, and one Asian male) gave permission for their faces to be used only in composites. Twenty-four participants (twelve female and twelve male) rated the attractiveness of the individual faces on a 10 point scale. An additional twenty-four participants (twelve female and twelve male) rated the individual faces on health. The participants were tested in small groups with the



(a)

Figure 4. The face composites used for (a) female faces and (b) male faces in experiment 3. A colour version of this figure can be viewed on the *Perception* website at http://www.perceptionweb.com/misc/p5191/.



(b)

Figure 4 (continued)

images displayed on a large screen, in random order, for 4.5 s each. The photographs were displayed for a fixed exposure time so that we could test in groups. However, the exposure duration was chosen to give ample time for responding. Each face was approximately 42.5 cm $\times$ 55.0 cm when projected and participants sat between 2.5 m and 6.0 m from the screen and wrote their ratings on answer sheets.

Averaged composites. A different group of twenty-four raters (twelve female and twelve male) rated the twelve composites on attractiveness and health. The procedure was similar to that of experiment 1. Colour images of the faces were printed (inside an oval window of dimensions 8.3 cm $\times$ 10.1 cm) and the participants had to rank these in order of attractiveness, and rate each on attractiveness using a 10 point scale ($1 = $ low, $10 = $ high). The participants then had to rank and rate the faces on health in the same way. Attractiveness was always rated first, because it was the most important measure and we wanted to avoid any possible contamination from rating health first. Composites were blocked by sex, with order counterbalanced across female and male participants. Presentation of the composites within each block was random.

4.2 *Results and discussion*

4.2.1 *Individual faces.* Three-way repeated-measures ANOVAs were carried out on the mean attractiveness and mean health ratings, with sex of rater as a between-participants variable and sex of face and type of face (Caucasian, Eurasian, Asian) as within-participants variables. Planned t-tests were carried out to compare Eurasian, Caucasian, and Asian faces, with Bonferroni correction for multiple comparisons ($N = 12$, corrected $p = 0.004$, if separate comparisons were needed for male and female faces and raters; $N = 6$, corrected $p = 0.008$, if separate comparisons were needed for male and female faces and raters; $N = 3$, corrected $p = 0.017$, otherwise).

Attractiveness ratings. There was a significant main effect of type of face ($F_{2,44} = 55.22$, $p < 0.0001$) with higher attractiveness for Eurasian faces ($M = 5.4$, $\mathrm{SD} = 0.9$) than for Caucasian ($M = 4.7$, $\mathrm{SD} = 1.0$) or Asian faces ($M = 4.3$, $\mathrm{SD} = 1.0$). Type of face also interacted with sex of face ($F_{2,44} = 7.74$, $p < 0.002$) and with both sex of face and sex of rater ($F_{2,44} = 4.63$, $p < 0.02$) (see figure 5). Planned t-tests to compare the face types were carried out separately for male and female raters and male and female faces. In all cases, Eurasian faces were significantly more attractive than either Caucasian or Asian faces (all ts > 3.96, ps < 0.0007). In addition, Caucasian female faces were significantly more attractive than Asian female faces, for both male and female raters (both ts > 4.53, ps < 0.0002). However, Caucasian male faces were not significantly more attractive than Asian male faces for either male or female raters [both ts < 2.51, ps < 0.03 (ns with Bonferroni correction)].

Health ratings. There was a main effect of type of face ($F_{2,44} = 27.06$, $p < 0.0001$), with significantly higher health ratings for Eurasian faces ($M = 6.0$, $\mathrm{SD} = 1.0$) than for Caucasian ($M = 5.2$, $\mathrm{SD} = 0.9$) or Asian faces ($M = 5.1$, $\mathrm{SD} = 1.0$) (both ts > 6.26, ps < 0.0001), which did not differ ($t < 1$). The only other significant effect was a main effect of sex of face ($F_{1,22} = 9.57$, $p < 0.006$), with male faces ($M = 5.7$, $\mathrm{SD} = 1.0$) rated as healthier than female faces ($M = 5.2$, $\mathrm{SD} = 1.0$).

4.2.2 *Averaged composites.* Three-way repeated-measures ANOVAs were conducted on the mean attractiveness and health ratings, with sex of rater as a between-participants variable and sex of face and type of composite (CaucAv, Cauc75/Asian25, MixedAv, EurasianAv, Cauc25/Asian75, AsianAv) as within-participants variables. We used planned t-tests to test whether the Eurasian average and mixed-race average faces were more attractive and healthy than Caucasian averages and whether Caucasian averages were more attractive and healthy than Asian averages, using Bonferroni correction for multiple comparisons ($N = 6$, corrected $p = 0.008$ if separate comparisons were needed for male and female faces; $N = 3$, corrected $p = 0.017$, otherwise).

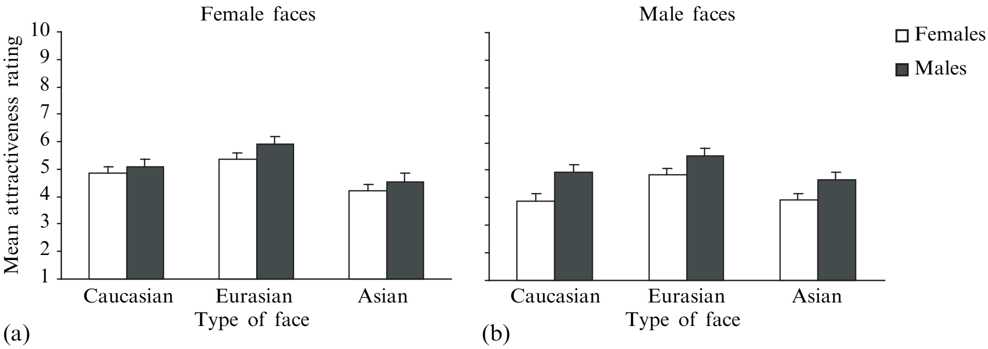


Figure 5. Mean attractiveness ratings for (a) individual female faces and (b) individual male faces in experiment 3.

Attractiveness ratings. The Eurasian average received the highest attractiveness rating for both male and female faces (see figure 6). The ANOVA confirmed that there was a main effect of type of composite ($F_{5,110} = 17.54$, $p < 0.0001$). Type of composite also interacted with sex of face ($F_{5,110} = 3.77$, $p < 0.004$) (see figure 6). The Eurasian average was significantly more attractive than the Caucasian average for both female faces ($t_{110} = 7.26$, $p < 0.0001$) and male faces ($t_{110} = 4.13$, $p < 0.0001$). In contrast to experiment 1, the mixed-race averages were not significantly more attractive than the Caucasian averages (both ts < 1). The Caucasian average was significantly more attractive than the Asian average for male faces ($t_{110} = 3.63$, $p < 0.0004$), but not female faces ($t < 1$). This preference for own-race (Caucasian) male composites was also found in experiment 1, with a different sample of faces.

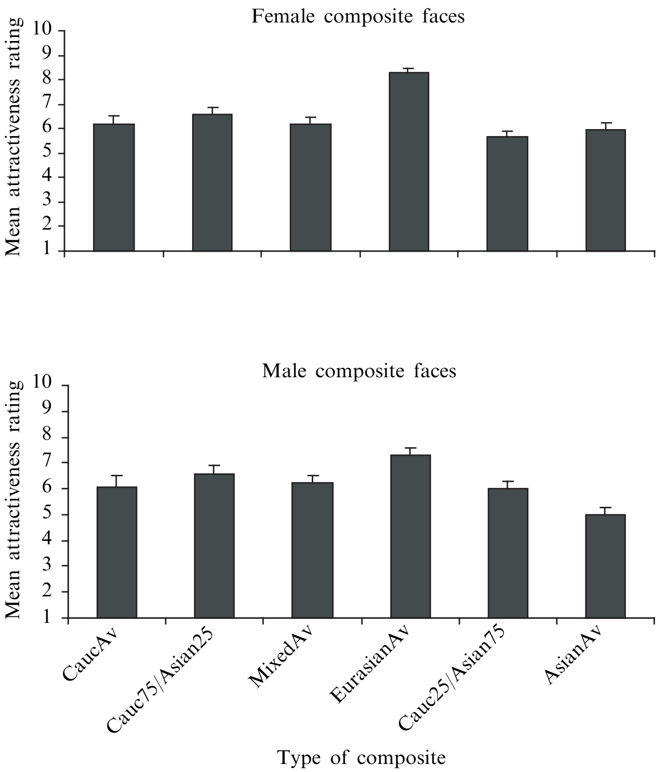


Figure 6. Mean attractiveness ratings for female (top) and male (bottom) composite faces in experiment 3.

Health ratings. There was a significant main effect of type of composite ($F_{5,110} = 21.97$, $p < 0.0001$). The Eurasian averages had the highest health ratings (see figure 7) and these were significantly higher than the ratings for Caucasian averages ($t_{110} = 10.02$, $p < 0.0001$). Mixed-race averages were also rated more highly than the Caucasian averages ($t_{110} = 2.71$, $p < 0.008$). However, the Asian average was rated as healthier than the Caucasian average ($t_{110} = 4.40$, $p < 0.0001$).

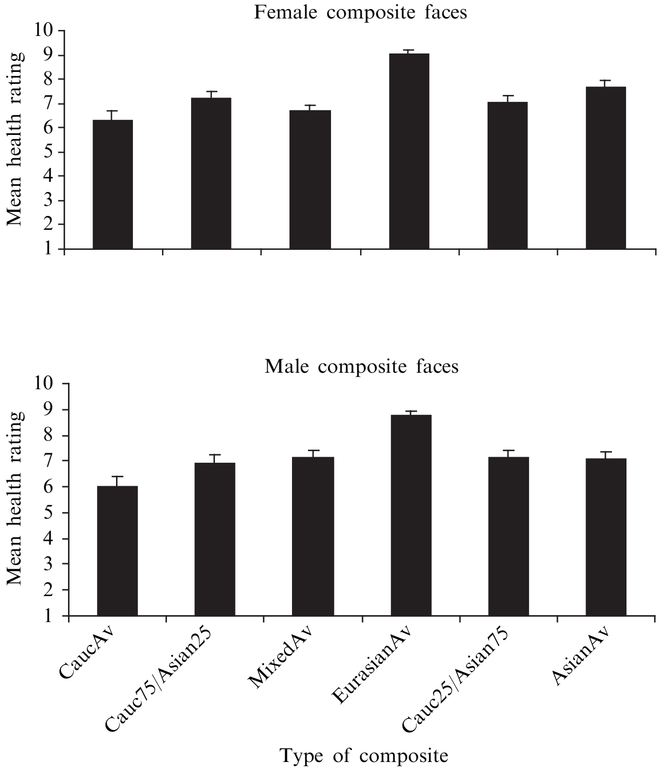


Figure 7. Mean health ratings for female (top) and male (bottom) composite faces in experiment 3.

4.2.3 *Summary.* Eurasian faces were rated as more attractive and healthier than Caucasian faces and Asian faces, for both individual faces and composites. These results confirm the appeal of mixed-race faces and support the hypothesis that a healthy appearance contributes to that appeal. One caveat is that, unlike in experiment 1, mixed-race composites, made by blending Caucasian and Asian faces, were not significantly more attractive than Caucasian composites. This could be because the mixed-race composites in this experiment contained fewer component faces than those in experiment 1. Also, in this experiment the mixed-race composites and the single-race composites contained the same number of component faces, whereas the mixed-race composites contained twice the number of component faces as the single-race composites in experiment 1. These differences may have contributed to the different results. Nevertheless, the results for individual Eurasian faces and composites clearly demonstrated the attractiveness, and the healthy appearance, of mixed-race traits. However, there was not a perfect match in the ordering of attractiveness and health ratings across the full set of images, suggesting that health is not the only determinant of attractiveness.

5 General discussion

In all three experiments faces with mixed-race characteristics were particularly attractive. Mixed-race averaged composites, created by combining faces from two races, were rated as more attractive than either Caucasian or Asian averaged composites by both Caucasian and Asian raters (in experiments 1 and 2, but not experiment 3), and individual mixed-race faces (Eurasian) were rated as more attractive than either Caucasian or Asian faces (experiment 3). Eurasian composites, made from Eurasian faces, were also more attractive than Caucasian and Asian composites (experiment 3). These results clearly demonstrate the appeal of mixed-race traits.

Computer-generated composites and individual faces each have disadvantages as stimuli. The disadvantage of computer-generated mixed-race composites is that they may not precisely capture the appearance of mixed-race individuals. After all, genetic mixing is not a blending process. This concern was met by comparing the attractiveness of individuals from different groups (Eurasian, Caucasian, and Asian). However, the use of individual faces has its own problems. The groups may differ on factors that affect attractiveness (eg socio-economic status), not all of which can be controlled or even identified. The use of computer-generated composites, which can be made from arbitrarily selected sets of faces from each race, may reduce this problem, at least when these factors do not have consistent facial correlates that survive the averaging process. Our results from the two approaches converge, with mixed-race faces rated as more attractive than single-race faces for both composites and individual faces.

A more general problem is whether the faces were representative of their groups. In experiment 3, most of the Eurasian sample came from a large Introductory Psychology class, from which we recruited every Eurasian individual (making the sample reasonably representative of a Eurasian student population), and the Caucasian and Asian faces were selected from larger face databases to match the ethnicity of each Eurasian person's parents and the age of the Eurasian individuals. However, we cannot be sure that these faces were representative of these groups, and, ideally, future studies should randomly select faces from large databases of each group.

Initially, our results appear to be at odds with the popular view that people are attracted to individuals who resemble themselves. However, this view is based on studies showing assortative mating on physical traits (for a recent review, see Little et al 2003), which can occur without any preference for self-similar individuals. For example, perfect assortative mating on attractiveness can arise even when people have identical preferences, simply because everyone can't have the same partner. Penton-Voak et al (1999) are the only researchers who have directly tested whether self-similar faces are attractive and found little evidence that they were, concluding that a preference for average faces was stronger than any preference for self-similarity.

We found some evidence that own-race composites were more attractive than other-race composites (experiments 1 and 3), consistent with our initial proposal that averaged composites are attractive because they are prototypical of the population of faces that a person sees. However, own-race composites were only more attractive than other-race composites for male faces, and the most attractive faces had mixed-race characteristics, which are not prototypical of the faces people see. Therefore, we suggest that prototypicality cannot be the only factor contributing to the attractiveness of averaged composites.

An advocate of a prototypicality account might argue that mixed-race faces are prototypical of the faces seen in these experiments. On this view, their attractiveness would still derive from prototypicality, but it would be prototypicality of the experimental stimuli rather than of the population(s) of faces the subject has experienced in the world. We know that people do indeed abstract prototypes of experimental stimuli, including faces (eg Posner and Keele 1968; Solso and McCarthy 1979, 1981).

However, we do not favour this account for two reasons. First, as noted in section 1, people abstract and use distinct prototypes for faces of different races (Byatt and Rhodes 1998), in which case they would not abstract a single prototype for the racially diverse sets used here. Second, an experimental-prototype account predicts that an averaged composite should be more attractive when its component faces have been seen in an experiment than when they have not. However, this does not appear to be the case (Halberstadt et al 2003; Rhodes et al 2004).

What factors other than prototypicality might contribute to the appeal of averaged composites and facial attractiveness generally? We suggest that cues to health are also important. Previous research has shown that average (Caucasian) faces look healthy and are attractive (Rhodes et al 2001c). In the present research we found that Eurasian faces (both composite and individual) look healthier, and are rated as more attractive, than Caucasian or Asian faces. Therefore, health cues may be more important than prototypicality per se in making faces attractive. Of course, when a population exists in a stable environment over many generations, prototypicality (averageness) and health are likely to be correlated (due to stabilising selection, which ensures that average values of traits are optimal for their functions).

A sceptic might question whether the perception of health in average faces is accurate or whether this is simply an attractiveness halo effect, whereby positive traits are erroneously attributed to attractive faces (for a review see Zebrowitz and Rhodes 2002). However, we know that people can judge health with (modest) accuracy from faces (Kalick et al 1998) and we know that facial averageness is an honest signal of health during development (Rhodes et al 2001c). Therefore, we suggest that the perception of attractive faces as healthy is not simply an attractiveness halo effect.

Selection pressures are unlikely to have shaped perceptions of attractiveness to favour mixed-race traits per se, given that our ancestors probably encountered few such individuals. They could, however, have shaped perceptions of attractiveness to favour cues to health. If, as conjectured here, such cues were stronger in mixed-race faces than single-race faces, then a preference for healthy individuals could result in a preference for mixed-race individuals. Therefore, human perceptions of attractiveness could facilitate outbreeding. Many species show some level of outbreeding, which may reflect a trade-off between benefits (eg increased heterozygosity of offspring) and costs (eg the disruption of locally adapted gene complexes) of outbreeding (Bateson 1978, 1983; Partridge 1983).

Important issues for future research are whether the appeal of mixed-race faces is universal and whether it requires some familiarity with the component races. If the appeal of mixed-race faces is due to their healthy appearance, as we propose, then familiarity with the component races should not be required.

Acknowledgments. This work was supported by the Australian Research Council and the Advanced Telecommunications Research Laboratories. We thank Alison Clark and Linda Jeffery for assistance with stimulus preparation, Colin Clifford and Guy Curtis for assistance recruiting and photographing Eurasian models, Katiuska Molina-Luna, Elizabeth Pellicano, and Hannah Stevenson for assistance in testing Caucasian participants, Yoshie Nagao for testing the Japanese participants, and Shigeru Akamatsu and the Human Information Processing Laboratory of the Advanced Telecommunications Research Laboratories for providing testing facilities in Japan. We also thank Leigh Simmons for helpful comments on an earlier draft of the manuscript.

References

Bateson P, 1978 "Sexual imprinting and optimal outbreeding" *Nature* **273** 659 – 660

Bateson P, 1983 "Optimal outbreeding", in *Mate Choice* Ed. P Bateson (Cambridge: Cambridge University Press) pp 257 – 277

Bittles A H, Neel J V, 1994 "The costs of human inbreeding and their implications for variations at the DNA level" *Nature Genetics* **8** 117 – 121

Britten H B, 1996 "Meta-analysis of the association between multi-locus heterozygosity and fitness" *Evolution* **50** 2158 – 2164

Byatt G, Rhodes G, 1998 "Recognition of own-race and other-race caricatures: Implications for models of face recognition" *Vision Research* **38** 2455 – 2468
Carrington M, Nelson G W, Martin M P, Kissner T, Vlahov D, Goedert J J, Kaslow R, Buchbinder S, Hoots K, O'Brien S J, 1999 "HLA and HIV—1: Heterozygote advantage and B*35-Cw*04 disadvantage" *Science* **283** 1748 – 1752
Charlesworth B, 1988 "The evolution of mate choice in a fluctuating environment" *Journal of Theoretical Biology* **130** 191 – 204
Cosmides L, Tooby J, Kurzban R, 2003 "Perceptions of race" *Trends in Cognitive Sciences* **7** 173 – 179
Endler J A, 1977 *Geographic Variation, Speciation, and Clines* (Princeton, NJ: Princeton University Press)
Feingold A, 1992 "Good-looking people are not what we think" *Psychological Bulletin* **111** 304 – 341
Gangestad S, Buss D M, 1993 "Pathogen prevalence and human mate preferences" *Ethology and Sociobiology* **14** 89 – 96
Grant J C, Bittles A H, 1997 "The comparative role of consanguinity in infant and childhood mortality in Pakistan" *Annals of Human Genetics* **61** 143 – 149
Halberstadt J, Rhodes G, Catty S R, 2003 "Subjective and objective familiarity as explanations for the attraction to average faces", in *Advances in Psychology Research* volume 22 Ed. S P Shohov (New York: Nova Science) pp 111 – 126
Hansson B, Westerberg L, 2002 "On the correlation between heterozygosity and fitness in natural populations" *Molecular Ecology* **11** 2467 – 2474
Hussain R, Bittles A H, Sullivan S, 2001 "Consanguinity and early mortality in the Muslim populations of India and Pakistan" *American Journal of Human Biology* **13** 777 – 787
Jones D, Hill K, 1993 "Criteria of facial attractiveness in five populations" *Human Nature* **4** 271 – 296
Kalick S M, Zebrowitz L A, Langlois J H, Johnson R M, 1998 "Does human facial attractiveness honestly advertise heath? Longitudinal data on an evolutionary question" *Psychological Science* **9** 8 – 13
Langlois J H, Kalakanis L E, Rubenstein A J, Larson A D, Hallam M J, Smoot M T, 2000 "Maxims and myths of beauty: A meta-analytic and theoretical review" *Psychological Bulletin* **126** 390 – 423
Langlois J H, Roggman L A, 1990 "Attractive faces are only average" *Psychological Science* **1** 115 – 121
Langlois J H, Roggman L A, Musselman L, 1994 "What is average and what is not average about attractive faces?" *Psychological Science* **5** 214 – 220
Light L L, Hollander S, Kayra-Stuart F, 1981 "Why attractive people are harder to remember" *Personality and Social Psychology Bulletin* **7** 269 – 276
Little A C, Penton-Voak I S, Burt D M, Perrett D I, 2003 "Investigating an imprinting-like phenomenon in humans. Partners and opposite-sex parents have similar hair and eye color" *Evolution and Human Behavior* **24** 43 – 51
Mitton J B, 1993 "Theory and data pertinent to the relationship between heterozygosity and fitness", in *The Natural History of Inbreeding and Outbreeding* Ed. N Thornhill (Chicago, IL and London: University of Chicago Press) pp 17 – 41
Partridge L, 1983 "Non-random mating and offspring fitness", in *Mate Choice* Ed. P Bateson (Cambridge: Cambridge University Press) pp 227 – 253
Penn D J, 2002 "The scent of genetic compatibility: Sexual selection and the major histocompatibility complex" *Ethology* **108** 1 – 21
Penn D J, Damjanovich K, Potts W K, 2002 "MHC heterozygosity confers a selective advantage against multiple-strain infections" *Proceedings of the National Academy of Sciences* **99** 11260 – 11264
Penton-Voak I S, Perrett D I, Pierce J W, 1999 "Computer graphic studies of the role of facial similarity in judgements of attractiveness" *Current Psychology: Developmental, Learning, Personality, Social* **18** 104 – 117
Perrett D I, Lee K J, Penton-Voak I, Rowland D, Yoshikawa S, Burt D M, Henzi S P, Castles D, Akamatsu S, 1998 "Effects of sexual dimorphism on facial attractiveness" *Nature* **394** 884 – 887
Posner M I, Keele S W, 1968 "On the genesis of abstract ideas" *Journal of Experimental Psychology* **77** 353 – 363
Reddy K K, Rao A P, Reddy T P K, 2001 "Consanguinity and reproductive health among Kurichias: A tribal population of Kerala" *Journal of Human Ecology* **12** 57 – 61
Reed D H, Frankham R, 2003 "Correlation between fitness and genetic diversity" *Conservation Biology* **17** 230 – 237

Rhodes G, Halberstadt J, Jeffery L, Palermo R, 2004 "The attractiveness of average faces is not a generalized mere exposure effect" *Social Cognition* in press
Rhodes G, Harwood K, Yoshikawa S, Nishitani M, McLean I G, 2001a "The attractiveness of average facial configurations: Cross-cultural evidence and the biology of beauty", in *Facial Attractiveness: Evolutionary, Cognitive and Social Perspectives* Eds G Rhodes, L A Zebrowitz (Westport, CT: Ablex) pp 35 – 58
Rhodes G, Hickford C, Jeffery L, 2000 "Sex-typicality and attractiveness: Are supermale and superfemale faces super-attractive?" *British Journal of Psychology* **91** 125 – 140
Rhodes G, Jeffery L, Watson T L, Clifford C W G, Nakayama K, 2003 "Fitting the mind to the world: Face adaptation and attractiveness aftereffects" *Psychological Science* **14** 558 – 566
Rhodes G, Sumich A, Byatt G, 1999 "Are average facial configurations only attractive because of their symmetry?" *Psychological Science* **10** 52 – 58
Rhodes G, Tremewan T, 1996 "Averageness, exaggeration and facial attractiveness" *Psychological Science* **7** 105 – 110
Rhodes G, Yoshikawa S, Clark A, Lee K, McKay R, Akamatsu S, 2001b "Attractiveness of facial averageness and symmetry in non-Western cultures: In search of biologically based standards of beauty" *Perception* **30** 611 – 625
Rhodes G, Zebrowitz L A (Eds), 2002 *Facial Attractiveness: Evolutionary, Cognitive and Social Perspectives* (Westport, CT: Ablex)
Rhodes G, Zebrowitz L A, Clark A, Kalick S M, Hightower A, McKay R, 2001c "Do facial averageness and symmetry signal health?" *Evolution and Human Behavior* **22** 31 – 46
Roberts S C, Little A C, Gosling L M, Perrett D I, Carter V, Jones B C, Penton-Voak I, Petrie M, 2004 "MHC-heterozygosity and human facial attractiveness" *Evolution and Human Behavior* in press
Rowland D A, Perrett D I, 1995 "Manipulating facial appearance through shape and colour" *IEEE Computer Graphics and Applications* **15** 70 – 76
Solso R L, McCarthy J E, 1981 "Prototype formation: Central tendency model vs. attribute frequency model" *Bulletin of the Psychonomic Society* **17** 10 – 11
Solso R L, Raynis S A, 1979 "Prototype formation from imaged, kinesthetically, and visually presented geometric figures" *Journal of Experimental Psychology: Human Perception and Performance* **5** 701 – 712
Sudhakaran M V, Vijayavalli B, 1997 "The genetic effects of consanguinity on morbidity: A population study" *Journal of Human Ecology* **8** 287 – 291
Symons D, 1979 *The Evolution of Human Sexuality* (Oxford: Oxford University Press)
Thornhill R, Gangestad S W, 1993 "Human facial beauty" *Human Nature* **4** 237 – 269
Thornhill R, Gangestad S W, 1999 "Facial attractiveness" *Trends in Cognitive Sciences* **3** 452 – 460
Thornhill R, Gangestad S W, Miller R, Scheyd G, McCullough J K, Franklin M, 2002 "Major histocompatibility complex genes, symmetry, and body scent attractiveness in men and women" *Behavioral Ecology* **14** 668 – 678
Zebrowitz L A, 1997 *Reading Faces* (Boulder, CO: Westview Press)

ISSN 0301-0066 (print) ISSN 1468-4233 (electronic)

PERCEPTION

VOLUME 34 2005

www.perceptionweb.com