Perception, 2009, volume 38, pages 1821 – 1830

doi:10.1068/p6424

Perception of 'best likeness' to highly familiar faces of self and friend

Hannah Allen, Nuala Brady¶
School of Psychology, University College Dublin, Belfield, Dublin 4, Ireland; e-mail: nuala.brady@ucd.ie
Colin Tredoux
Department of Psychology, University of Cape Town, Rondebosch 7701, Cape Town, South Africa
Received 28 March 2009, in revised form 8 June 2009; published online 26 November 2009

Abstract. We investigated the idea that our memory for familiar faces involves an accurate representation of their unique spatial configuration and, further, whether this configuration may be caricatured in memory. In separate experimental blocks, thirty-five Irish participants were presented with a series of photographic images of their own face and of the face of a close friend, and were asked to choose the image which looked most like themselves or their friend. Both sets of images included an original full-face colour photograph, and photographic distortions ranging from a highly caricatured (+100%) to a highly anti-caricatured (−100%) version of the original, generated with reference to newly created average male and female Irish faces. Contrary to suggestions that we hold a slightly caricatured version of a familiar face in memory, the mean 'best-likeness' image, calculated across both self and friend trials, was an anti-caricature of −13.88% which was significantly different from 0 ($t_{69} = -5.34$, $p < 0.0001$). The difference in the mean 'best-likeness' image chosen for self (−12.06%) and friend (−15.7%) was not significant ($t_{34} = 0.715$, $p = 0.48$). These results are discussed with reference to our ability to discriminate facial shape, together with the possibility that we idealise the attractiveness of faces of those close to us.

1 Introduction

We each hold a very large number of faces in memory and can readily tell apart familiar faces that share a high degree of physical similarity. What underlies this impressive ability? While facial features and the arrangement of these features within the face are both important to recognition, it is generally accepted that expertise with faces involves an accurate representation of facial shape or configuration (LeGrand et al 2003). Here 'configuration' refers to second-order spatial relations—the precise geometric arrangement of the features within a face—rather than to first-order relations that describe the generic arrangement of the eyes, nose, and mouth (Diamond and Carey 1986). The notion of a multidimensional face-space, in which individual faces are represented by vectors describing their position relative to a prototypical or average face, provides a useful framework for thinking about the neural representation of face shape (Valentine 1991). In particular, it suggests norm-based coding in which individual neurons are tuned to different spatial characteristics of the average face and signal deviations from this average (Leopold et al 2001, 2006).

Caricatures provide a powerful way to study the perception of facial configuration and are increasingly used to test models of how faces are represented in memory (Rhodes et al 1987, 1998; Benson and Perrett 1991, 1994; Lewis and Johnson 1998; Leopold et al 2001). Artists have long exaggerated distinctive characteristics of a face to create line drawings and two-tone sketches that are easily recognised (Gombrich 1969). The more recent use of mathematical algorithms allows for precise control of the degree of spatial caricaturing both in line drawings (Rhodes et al 1987) and continuous-tone images (Benson and Perrett 1991; Tredoux et al 2007). Caricatures exaggerate the idiosyncratic shape of an individual face by first comparing it to an average face and then enhancing any differences in shape between the two.

¶ Author to whom all correspondence should be addressed.

In the opposite direction, anti-caricatures reduce the differences between the target face and the average face.

In this study we used caricatures to study memory for faces that are both highly familiar and personally known to us. In two separate tasks, participants were asked to select from a series of images, ranging from extreme anti-caricatures to extreme caricatures, an image that was most like their memory for their own face or for the face of a close friend. The results of this best-likeness task suggests that personally familiar faces, which are assumed to have a particularly robust representation, may be encoded with a bias toward the simpler, generic, or average form.

Research on caricature effects in face recognition has generated mixed results that vary with the stimulus medium (line drawings, photographs), the task (timed recognition, best-likeness judgments), the range and degree of caricaturing employed in making the stimuli, and whether the faces are more or less familiar.

In general, line drawings which capture the outline of a face and faithfully specify the location of its features provide a poor representation of the subject. Rhodes et al (1987) found that line drawings of familiar faces caricatured to 50% (ie where the difference between the original face and an average face was exaggerated by 50%) were recognised more quickly than veridical line drawings and anti-caricatures. Similarly, in a study in which line drawings were generated in real-time, participants consistently chose caricatures to match their memory of various celebrities and they were faster at naming the caricatured than the veridical drawings (Benson and Perrett 1994). There was considerable variability in the caricature level chosen as best likeness in this study (7% to 85%) with less typical or more distinctive faces requiring less caricaturing. These findings support the notion that caricatures act as 'super-portraits' by increasing facial distinctiveness, and are consistent with research showing a memory advantage for distinctive over typical faces (Bartlett et al 1984).

However, caricatured drawings are less effective probes to memory than are photographs, as shown both for recently learned faces (Hagen and Perkins 1983) and for familiar faces (Tversky and Baratz 1985). Consistent with this are a variety of findings that show less dramatic caricature effects with photographs than with line drawings. Using seven celebrity faces caricatured between $\pm 32\%$, Benson and Perrett (1991) found a modest mean best likeness of 4.4%; again, there was considerable variation in the caricature level chosen for different faces, with the original image chosen as best likeness for four of the seven. In an associated recognition task, caricatured images led to faster naming, with an interpolated fastest time occurring for caricatures of 19%. A developmental study by Chang et al (2002) showed that both children and adults identified photographs of both familiar and recently learned faces caricatured by 36% more quickly than the original photographs. But, whereas the children showed evidence of caricature effects in a best-likeness task, the adults rated the veridical images as most like the person portrayed. More recent research with high-quality photographic stimuli suggests that caricature effects may occur only when viewing conditions are poor. Lee et al (2000) reported faster reaction times to name caricatures than original images for faces displayed for very short durations (33 ms and 100 ms). Lee and Perrett (2000) showed improved accuracy in identifying caricatures over veridical image faces for exposures of 33 ms, but not when exposure was increased to between 67 ms and 133 ms.

Best-likeness tasks and recognition tasks ostensibly tap into similar processing and ultimately require a comparison of an image with some internal representation or memory of the face. Yet these tasks often yield different findings. In general, caricature effects are stronger for recognition than for perceptual judgments as described above for Benson and Perrett (1991) and Chang et al (2002). In Lee and Perrett (2000) the mean caricature level for best likeness was an anti-caricature of -8.2%. These findings question the suggestion that we store a caricatured rather than a veridical representation of a face in memory (Rhodes et al 1987), a proposal that is quite distinct from the idea that the shape of an individual face is represented in terms of how it deviates from the average. It is more likely that caricatures operate as an aid to memory; by exaggerating distinctive features of a face they may constrain the search for a match to regions of face-space that contain the target (Benson and Perrett 1991; Lee and Perrett 2000).

A final research issue concerns face familiarity and the choice of the average face or norm used to generate caricatures. As noted by Benson and Perrett (1991), the norm should match the target images with respect to race, sex, and age. Much research on caricatures has used famous faces with the norm created from an average of the target faces. This is convenient in that all participants rate the same set of faces and some baseline level of familiarity is ensured. But, while a particular politician or actor may be highly familiar from his/her appearances on TV, in cinema, and in the press, a recent study by Carbon (2008) suggests that our expertise with such faces may be illusory. He measured recognition accuracy both of famous faces and of personally familiar faces (classmates, lecturers) in highly familiar photographs, in photographs which were realistically modified (by changes to hairstyle, headgear, etc), and in uncommon photographs of the subjects. Whereas recognition accuracy was fairly robust across these three conditions for the personally familiar faces, performance declined very dramatically for famous faces with even minor modifications to the original images, leading to a significant decline in recognition accuracy. Famous faces may be processed as 'icons' with expertise tied to common, pictorial representations.

In contrast, we appear to have a particularly 'robust representation' for personally familiar faces. Tong and Nakayama (1999) introduced this idea to explain difference in performance in visual search for one's own face and more recently learned faces. Despite hundreds of trials of exposure to a new target face, participants could find their own faster and more efficiently. Balas et al (2007) have shown that personal familiarity with faces leads to superior performance in matching the gender and orientation of faces, tasks that are ostensibly independent of knowing the face identity. And research by Bredart and Devue (2006) shows that observers are highly sensitive to distortion in photographs of their own faces and the faces of friends.

In the current study we examined caricature effects for highly familiar faces which are personally known to the observers, their own face, and the face of a close friend. As a pilot study showed a ceiling effect in recognition accuracy for these highly familiar faces, we present the results of a best-likeness study below. Caricatures and anti-caricatures of continuous-tone colour photographs were generated between +100% and −100% in steps of 2.5% relative to a male or female average face matched in age and race to the target faces.

2 Methods

2.1 *Participants*

Thirty-five participants (seventeen female) aged between 20 and 28 years (mean = 22.93 years, SD = 2.31 years) volunteered to take part. All had normal or corrected-to-normal visual acuity. Each participant was paired with a close friend of the same sex whom he/she had known for at least one year and whom he/she saw on a regular daily basis. The majority of participants were postgraduate or undergraduate students from University College Dublin who had known their friend for more than one year. All were Irish. In accordance with University ethical guidelines participants were assured that their photographs would be stored securely and would not be published or publicly displayed without their written permission.

2.2 *Materials*

Each participant was photographed with a digital camera (Fujifilm FinePix 4900Zoom) in frontal view while standing against a blank wall under overhead, symmetrically placed lighting. The participants were asked to remove glasses if necessary. As the process of caricaturing is reported to increase emotional intensity of expression and to decrease plausibility (Calder et al 2000), participants were asked to close their lips and maintain a neutral expression.

The digital images were processed on a Dell Precision 360 personal computer with the image-processing software GIMP 2. Following guidelines for successful caricature generation (Benson and Perrett 1991), each image was first checked to ensure that the pupils of the eyes lay on a horizontal plane and the image was rotated to achieve this if necessary. After that, head size was scaled with the Shortcut Scaling Calculator software (courtesy of Brian Donaghy, 071 Computing, Sligo, Ireland) to ensure that the criterion of matching interpupillary distance to the norm was met (Benson and Perrett 1991). The images were then set on a canvas size of 559×812 pixels and customised 'Landmark' software (Tredoux et al 2007) was used to select and predefine features by a set number of vertices. Each eye was defined by 9 vertices, each eyebrow by 8, and each ear by 7. The nose was defined by 6 vertices, the mouth by 9 vertices, the outline of the face by 16 vertices, and the outline of the hair by 15 vertices. In total, 94 vertices were used to define each face and vertices were placed at points of inflexion when present, or evenly spaced otherwise (following Rhodes et al 1987).

The Facewarp program (Tredoux et al 2007) was then used to create caricatures and anti-caricatures for each face with the average Irish male or female face used as the comparison norm. These composites, shown in figure 1, were made by morphing digital images from a bank of 140 faces, 70 each of young males and females. All people who contributed their images to this project were Irish and were either students at University College Dublin or their friends, and were in a similar age range to that reported above for the participants of the current study. Caricatures and anti-caricatures of each of the thirty-five participants' faces were generated at intervals of 2.5% on a scale of +100% to −100%, giving a total of 81 images for each face. A caricature level of +100% refers to a face in which the difference between the face and the average face has been doubled and a 50% caricature is one in which

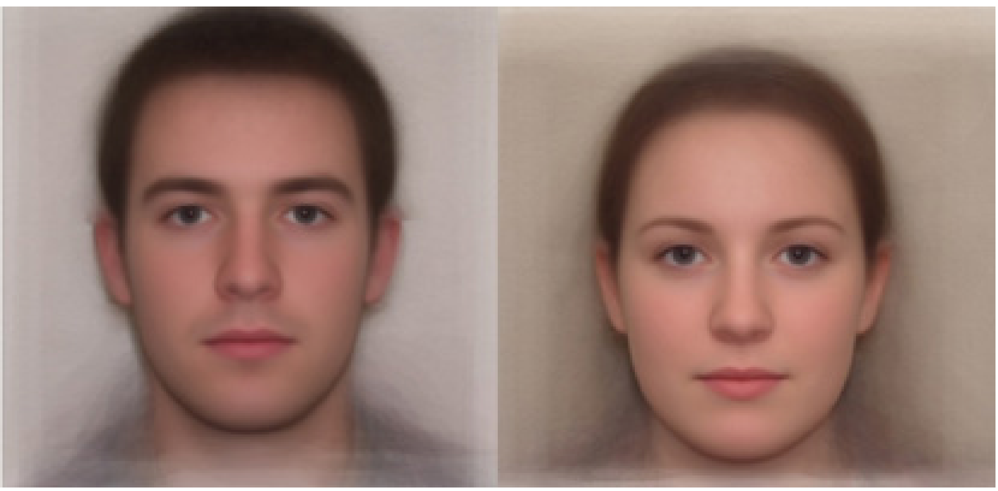

Figure 1. [In colour online, see http://dx.doi.org/10.1068/p6424] Average or composite faces made by morphing digital images of 70 young Irish male faces (left) and 70 young Irish female faces (right).

this difference has been increased by half. A −50% anti-caricature is one in which the difference between the face and the average face has been halved and a −100% anti-caricature has been normalised to the shape of the average face (see figure 2 for examples from one participant). Note that the images are caricatured for shape only and not for colour; both shape and colour caricaturing have been studied by Lee and Perrett (2000). Finally, each image was further processed with Adobe Photoshop® to crop the image to show only the face and to remove extraneous background. The selected region, which included the inner hairline and the full outline of the face, was then centred on a neutral background and the image was saved in 8-bit colour format.

Figure 2. [In colour online.] An original image (centre) and two caricatures (+100% and +50%) and anti-caricatures (−100% and −50%) are shown for one participant. These images are reproduced here with the written permission of the participant.

2.3 *Procedure*

The experiment was run with the software Presentation® on a Dell Precision 360 personal computer. The display was run at 75 Hz and a resolution of 1024 × 768 pixels and the images were viewed at a distance of approximately 50 cm. The images were centred on the screen which was set to the same colour as the background of the image.

Each participant completed two sessions separated by a short break, both comprising an initial practice trial and 10 experimental trials. They judged images of themselves (presented in the familiar mirror-reversed orientation) and their friends (presented in the familiar photographed orientation) in the first and second sessions, respectively. At the start of each trial an image was chosen at random from between −100% (extreme anti-caricature) and +100% (extreme caricature). Participants then used the keyboard to scroll through the series of images; two keys were programmed to move in opposite directions either increasing or decreasing the caricaturing in steps of 2.5%. When participants were satisfied with their choices of best likeness they pressed the return key and the next trial began automatically. The trials were not timed and participants reported that the task was easy to understand and complete.

3 Results

The data were analysed with Splus 2000®. For each participant the 10 caricature levels chosen across trials as best likeness to self and to friend were averaged to give a single mean caricature choice for self and for friend. The distribution of the means across participants is shown separately for self and friend images in figure 3a. These box-plots show the median by the horizontal line, the inter-quartile distance by the height of the box, and extreme values by the whiskers. For both stimulus types the distributions of the mean choice are centred about an anti-caricature, a median of −11% for self and −12% for friend. A paired t-test comparing the mean caricature choice for self and

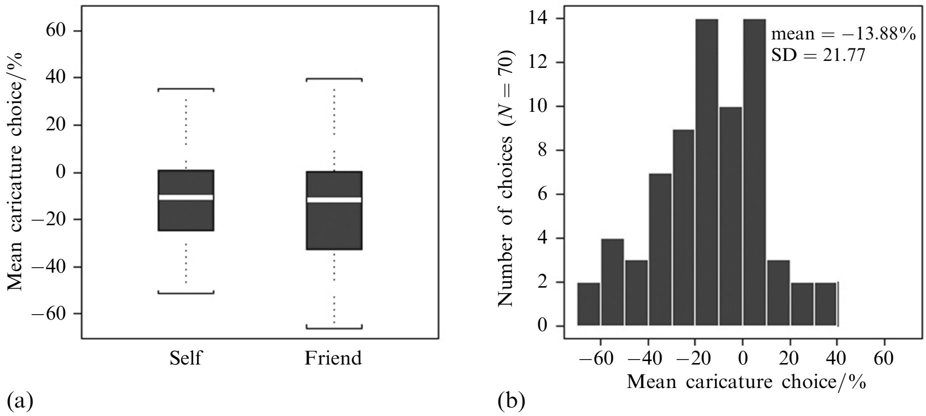

Figure 3. Box-plots of mean caricature choice for self and friend images (a), and distribution of mean caricature choices collapsed across self and friend images (b).

friend images showed no significant difference ($t_{34} = 0.715$, $p = 0.48$; 95% CI: −6.7%, 13.97%). The distribution of mean caricature choices, collapsed across self and friend images, is shown in figure 3b; the overall mean for best likeness of a highly familiar face was an anti-caricature of −13.88%. A one-sample two-sided t-test of the hypothesis that the population mean is different from zero was highly significant ($t_{69} = -5.34$, $p = 0.000001$; 95% CI: −8.69%, −19.07%).

As the mean caricature choices shown in figure 3 could reflect either a preference for veridical and anti-caricatured images or a preference for veridical images coupled with a bias in preference for anti-caricatures over caricatures, it is important to also look at the distribution of best-likeness choices prior to averaging (Chang et al 2002). The distribution of choices is plotted in figure 4 for images of self on the left and images of friend on the right. There is a clear bias toward choosing anti-caricatures in

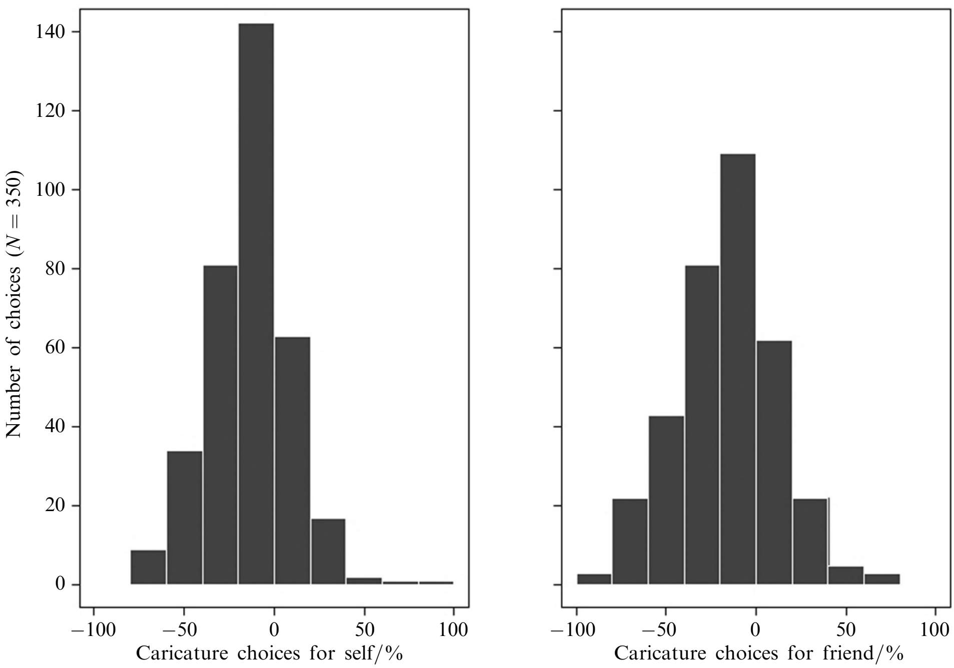

Figure 4. The distribution of 350 caricature level choices (thirty-five participants by 10 choices) for best likeness to self (left) and to friend (right).

both cases with the distributions peaking to the left of zero. Table 1 shows the number of anti-caricatures, veridical images, and caricatures chosen as best likeness to self and friend. The binomial test indicated that anti-caricatures were chosen significantly more often than caricatures as a best likeness image for self (252/336, $p \sim 0$) and for friend (243/335, $p \sim 0$).

Finally, there were no differences in mean ratings between male and female participants, whether collapsing across self and friend judgments ($t_{68} = -0.47$, $p = 0.64$) or whether looking at self ($t_{33} = -0.37$, $p = 0.71$) and friend ($t_{33} = -0.30$, $p = 0.77$) judgments separately.

Table 1. Number of anti-caricatures, veridical images, and caricatures chosen as the best likeness of self and friend.

	Anti-caricatures	Veridical	Caricatures
Self	252	14	84
Friend	243	15	92

4 Discussion

In this study we used a best-likeness task to investigate sensitivity to facial configuration in memory for highly familiar faces—one's own face and the face of a close friend. Guided by previous research on caricature effects in face recognition, we used photorealistic caricatures generated at fine intervals and allowed participants to scroll through the images to find that which best matched their memory for the face. Each participant made this judgment 10 times starting from a randomly chosen image in the sequence. The caricatures and anti-caricatures were generated relative to age- and sex-matched average faces, composites of young Irish faces created specifically for this study. The mean best-likeness image was an anti-caricature of -13.88% which was significantly different from 0 (the original photograph) and the difference in the mean best likeness chosen for self and friend was not significant. The distribution of best-likeness choices clearly confirms this bias with anti-caricatures chosen considerably more often than caricatures.

Although clearly at odds with suggestions that we hold a caricatured rather than a veridical representation of a familiar face in memory (Rhodes et al 1987), these findings join others in showing that for photographic stimuli and best-likeness tasks, caricature effects are at best modest (Benson and Perrett 1991) or absent (Lee and Perrett 2000; Chang et al 2002; Kaufmann and Schweinberger 2008). Using 6 faces of actors, Lee and Perrett (2000) report a mean best likeness of -8.2% with 3 images best matched to veridical images and 3 best matched to anti-caricatures. While they describe this finding as 'unexpected', the current study on a larger sample of 70 faces also shows a significant bias toward choosing anti-caricatures to match one's memory for a highly familiar face. We now consider what may underlie this bias.

As outlined by Rhodes et al (1998) there are two different accounts of how caricatures operate to make effective portraits of the faces they depict. The first proposes that faces are stored as caricatures in memory so that their distinctive characteristics are somehow exaggerated in the neural code. By this account, a caricatured image of a face better matches the neural template; it is therefore recognised more readily than the veridical image and serves as a better likeness. The alternative proposal is that the stored representation is veridical so that the distinctive characteristics of a face are accurately encoded. By this account, the veridical image is the better likeness, although caricatures may enhance performance in timed recognition tasks by constraining the memory search (Benson and Perrett 1991). Recent research with high-quality photographic stimuli agrees with this second account in showing an absence of caricature effects in best-likeness tasks and caricature advantages in recognition tasks only when viewing conditions are suboptimal.

The current results also argue strongly against the idea of a caricatured representation, in that, on average, participants do not select a caricature as being most like the remembered face. But what accounts for the bias toward choosing an anti-caricature? One possibility is that this bias reflects differences in our ability to discriminate facial shape in different regions of face-space. In choosing an anti-caricature as best likeness to their memory for a specific face, participants are choosing an image that is more like the average face than is the veridical image. In terms of facial configuration, they are shifting away from an accurate representation of second-order spatial relations and toward a more generic representation. A recent study of portraits and perception by Balas and Sinha (2007) is relevant to thinking about this bias. They gave participants the task of reconstructing familiar faces by placing features within a face outline and found consistent errors in reproducing facial configuration accurately. They suggest that production of portraits may be particularly difficult in that participants may start by arranging the features according to a 'generic template' which observes first-order relations and are then unable to see what exactly is wrong with what they have created.

While the task we used in the current study requires discrimination and not production of images, the issues raised by Balas and Sinha (2007) are relevant; images which look *both* like the target face and like the average face may better match our memory for the target face than images which look like the target face but which deviate away from, rather than toward, the average face. In terms of the multidimensional face-space model (Valentine 1991), discriminating caricatures from original photographs may be easier than discriminating anti-caricatures from original photographs because caricatures are further away from the norm and anti-caricatures are closer to the norm. An explicit test of discrimination could further our knowledge of how personally familiar faces are encoded in memory.

A very different interpretation of the results is suggested by the recent work of Penton-Voak et al (2007). They investigated the idea that idealisation of one's romantic partner—specifically, idealisation of facial attractiveness—may serve to maintain long-term relationships. They asked participants to select from five images of their partner's face—the original photograph and two pairs of images which had been manipulated to different degrees to appear more or less attractive than the original—the image that looked most like their partner. On average, participants chose as the best likeness an image that was more attractive than the veridical image of their partner's face, a result not found when the task was repeated with celebrity faces. Interestingly, the degree of idealisation shown by participants correlated with prior ratings of their satisfaction with their partner. Finally, while these effects were shown for all participants and for female participants alone, the effects did not reach significance for male participants alone. Interpreted within a framework of evolutionary psychology, idealisation of a partner's facial appearance may serve to maintain long-term relationships, and females, for whom relationship maintenance is particularly important, may have a stronger tendency to hold positive illusions of their partner's attractiveness.

While Penton-Voak et al (2007) stress that their results do not demonstrate an anti-caricature effect for familiar-face recognition (as they manipulated the images relative to the difference between an average face and a highly attractive average), the results of the current study could be interpreted as extending their findings in that anti-caricatures, being closer to the average face, are typically judged to be attractive (eg Langlois and Roggman 1990). This raises the intriguing possibility that idealisation of facial attractiveness may characterise other close relationships such as those we hold with friends and kin (assuming that self faces are representative of kin). Our data show no differences between the sexes in average ratings of best likeness, and it should be noted that each participant in our study was paired with a same-sex friend. Because we do not have data on our participants' satisfaction with their friendships, it is difficult to speculate beyond this.

To conclude, we have shown that peoples' memory for personally familiar faces appears biased toward the generic or average form rather than toward a caricatured form in which differences in facial shape are exaggerated. Whether this bias reflects limitations in perceptual discrimination or a tendency to represent the faces of others held in high regard as more attractive requires further study.

Acknowledgments. We thank Áine Ni Choisdealbha for help with data processing and two anonymous reviewers for comments on an early draft.

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

PERCEPTION

VOLUME 38 2009

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