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FlashReport

Generalizing from human facial sexual dimorphism to sex-differentiate macaques: Accuracy and cultural variation

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HIGHLIGHTS

► We find humans can accurately sex-differentiate macaques based on the face alone.
► Humans use cues that are sexually dimorphic in human faces to accomplish this task.
► Asian observers perform better than Caucasian observers, due to their increased use of eye height.
► These findings suggest cultural differences in how sexually-dimorphic cues affect person perception.

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ABSTRACT

Anthropomorphism in impressions of animals is commonplace, and this generalization from humans to animals is one example of a broader tendency to generalize from adaptively significant categories when judging specific exemplars. Although anthropomorphism may lead to unlikely or incorrect judgments, it fostered accurate sex-differentiation of macaque faces due to an appropriate generalization from the sexually dimorphic cues that distinguish human male and female faces to macaques. As predicted, Koreans performed better than Caucasians in sex-differentiating macaque faces, a difference mediated by Koreans' greater use of sexually dimorphic eye height cues. These results extend and disambiguate evidence of East Asian superiority in sex-differentiating human faces. Whereas an own-race advantage might explain the previous but not the present findings, both can be explained by East Asians' keener sensitivity to sexually dimorphic cues, perhaps owing to the greater subtlety of such cues in East Asian faces. Implications of this sensitivity for other cultural differences in person perception are discussed.

Introduction

Humans frequently anthropomorphize non-human entities, giving them human-like characteristics and interpreting their behavior in human-like ways (Epley, Waytz, & Cacioppo, 2007). As recently argued in a path-breaking special issue on anthropomorphism, this tendency is a unique example of social perception in which the target is a non-human entity (Kwan, Gosling, & John, 2008). The tendency to generalize from humans to other entities may be viewed as one example of a broader tendency to generalize from adaptively significant categories when judging specific exemplars. In particular, considerable research indicates that first impressions of human faces reflect the generalization of adaptive responses to other faces that they resemble, including baby faces, familiar faces, anomalous faces, emotion faces, and even faces of other species (Zebrowitz, Bronstad, & Montepare, 2011; Zebrowitz, Wadlinger, et al., 2011). Whereas these generalization effects, like anthropomorphism, often lead to incorrect judgments, the present study investigated a situation in which anthropomorphic generalization can foster accuracy. Specifically, we investigated whether generalizing from the facial qualities that distinguish male and female human faces (human sexual dimorphism) fosters accurate recognition of the sex of rhesus macaque faces (*Macaca mulatta*). We also investigated whether accuracy is greater among people whose ethnicity may require greater sensitivity to sexually dimorphic cues in human faces, a question that not only is interesting in its own right, but also can inform previous evidence for cultural differences in human face sex recognition.

Anthropomorphism in face perception

Many processes used when forming first impressions of people's traits extend to perceptions of non-human animals. For example, people show high consensus and consistency when rating how well the 'Big 5' personality traits apply to pictures of dogs, suggesting the use of appearance stereotypes in first impressions (Gosling, Kwan, & John, 2003; Kwan et al., 2008). This also applies to face perception, as well-documented facial appearance stereotypes influence first

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impressions of animal faces. Specifically, Zebrowitz, Wadlinger, et al. (2011) found an attractiveness halo effect in impressions of animal faces, with more positive traits attributed to lions, foxes, and dogs whose faces were judged more attractive than other animals from the same species. The babyface stereotype also affected judgments of animal faces, with more childlike traits attributed to animals judged more babyfaced than others from the same species. Although anthropomorphic impressions of animals may seem fanciful, commonalities in facial structure across different primates (e.g., Waller, Parr, Gothard, Burrows, & Fuglevand, 2008), including sexual dimorphism, suggests that using knowledge of human faces may yield accurate impressions of primates' sex.

Sexual dimorphism and sex-differentiation

We are highly sensitive to the facial qualities that distinguish between female and male human faces, as shown in high accuracy in sex-recognition, an ability established during the first year of life (Quinn, Yahr, Kuhn, Slater, & Pascalis, 2002). The sexual dimorphism in facial appearance derives from additional facial growth in males and the masculinizing effects of male hormones that yield larger jaws, larger noses, and more protrusive brow ridges, with the latter yielding more prominent eyes in females (Enlow, 1990). Consistent with this account, measurements of adult faces revealed that, compared with women, men have wider cheekbones, wider mouths, larger noses, longer faces, lower eyebrows, and smaller eye width and height (Fellous, 1997; Gangestad & Thornhill, 2003; Penton-Voak et al., 2001).

In macaques, as in humans, additional growth in males during adolescence leads to wider faces and larger jaw structures (Wang, Dechow, & Hens, 2007). These sex differences are sufficient for macaques to recognize female and male macaques based on the face alone (Koba, Izumi, & Nakamura, 2009). Since human and macaque faces show some of the same sexually dimorphic qualities and since humans use these qualities to recognize the sex of other humans, they also may be able to recognize the sex of macaque faces by generalizing their expertise with human faces. Such an achievement would stand in contrast to evidence that training is required for people to accurately sex-differentiate other species for which generalizing from human sexual dimorphism is not useful, including day-old chicks (Biederman & Shiffrar, 1987) and facial images of cats (Quinn, Palmer, & Slater, 1999). Establishing human accuracy in sex-differentiating macaque faces is significant for the field of social perception because it would underscore the power of generalization effects. Specifically, it would demonstrate that the previously established tendency for people to generalize from known face categories to non-category members who resemble them (Zebrowitz, Bronstad, et al., 2011) is sufficiently strong that it even influences perceptions of other species. Showing that people generalize their knowledge of human faces when judging macaque faces also has implications for understanding conditions conducive to anthropomorphism, suggesting that it may be facilitated when perceivers can detect physical similarities between humans and non-human entities.

Cultural differences in sex-differentiation

There also may be individual differences in the ability of humans to sex-differentiate macaque faces. Although accurate face recognition develops early in life, developmental processes can affect what information is extracted from faces. For example, six-month old infants were equally able to discriminate differences in the identity of macaque and human faces, while nine-month infants and adults were better at discriminating human than macaque face identity (Pascalis, de Haan, & Nelson, 2002), indicating that early childhood exposure to human faces increases the specialization for processing human faces above other facial examples. Supporting this, exposure to macaque faces between 6 and 9 months helps prevent this loss of the ability to discriminate macaque faces (Pascalis et al., 2005).

The effects of perceptual experience suggest that cultural variations may exist in the ability to sex-differentiate faces. In particular, those whose perceptual experiences would foster greater expertise recognizing sexually dimorphic cues in human faces may show superior sex-differentiation of macaque faces. Since there is less sexual dimorphism in East Asian versus Caucasian faces (Brown, 1999; Kunjur, Sabesan, & Ilankovan, 2006; Zebrowitz, Kikuchi, & Fellous, 2010), East Asians may have developed greater expertise recognizing sexual dimorphism in human faces. Consistent with this possibility, not only is it is more difficult to sex-differentiate Japanese than Caucasian faces, but this greater difficulty was less marked for Asian-American judges (O'Toole, Peterson, & Deffenbacher, 1996; Zhao & Bentin, 2008). Although the better performance of Asian-American judges could reflect an own-race bias rather than greater sensitivity to sexual dimorphism, the former explanation can be ruled out if Asian-Americans also show better performance sex-differentiating macaque faces. Moreover, clear evidence that Asian-Americans are more sensitive to sexual dimorphism is pertinent to possible cultural differences in person perception, since the use of sexually dimorphic cues is implicated in stereotyping and emotion recognition (Becker, Kenrick, Neuberg, Blackwell, & Smith, 2007; Sczesny, Spreemann, & Stahlberg, 2007).

Hypotheses

We tested four hypotheses. First, we predicted that humans would be able to sex-differentiate macaques from facial cues alone. Second, we predicted that sex-differentiation accuracy would be stronger for East Asian than Caucasian participants. Third, we predicted that face width, jaw size, nose size, and eye size would predict macaque face sex. Fourth, we predicted that these characteristics would be used by human observers.

Method

Participants

Thirty-six Korean office workers (16 female, 20 male) from Seoul, Korea volunteered for this study in exchange for a brief break from work. Thirty Caucasian students (20 female, 10 male) at an American university participated in this study for $10 compensation.

Stimuli

Thirty grayscale images of rhesus macaques (*M. mulatta*) (15 female and 15 male) were selected from the Gothard Primate Lab at the University of Arizona (Gothard, Erickson, & Amaral, 2004). Images consisted of macaques with a closed-mouth neutral expression and no head tilt. Images were resized to 7.5×7.5 cm and cropped to only show the head and neck region. Female and male images were matched on the brightness of the fur as rated by 3 raters ($t(29) = .01$, $p = .99$). We use macaque faces as stimuli both for the theoretical reason that they share sexually dimorphic features with humans, and also for the practical reason that these primate faces were available to us.

Facial metrics

Macaque images were measured by using computer software to digitize 72 points on the face. Two judges marked all the faces in order to establish interrater reliability for the distances calculated from the points. We calculated 11 distances from these digitized points that captured previously documented sex differences in human and macaque faces (see Fig. 1). These were face width (W4), jaw width (W1), nose width (N2), eye width (E4), mouth width

(M0), face length (C1), chin length (C3), nose length (N3), and eye height (E5). To adjust for head size variations, the metrics in the horizontal dimension were normalized by pupil distance (E2) while the metrics in the vertical dimension were normalized by head length (L0).

Design and procedure

An interactive slideshow was created using the program DirectRT, in which participants were asked to sex differentiate the macaque faces as quickly and as accurately as possible. Participants viewed the 30 images of macaques in random order and each image remained on the screen until the participant pressed a keyboard key to indicate the sex of the macaque.

Results

Accuracy sex-differentiating macaque faces

Participants' sex-differentiation showed 60.9% accuracy, ($M = 18.3$ out of 30), which was significantly greater than chance (50%), $t(65) = 8.25$, $p < .001$, $d = 2.05$. Further, each combination of participant sex by participant culture performed significantly better than chance, all $ts > 2.81$, all $ps < .02$. As predicted, Korean participants' accuracy (63.2%) was higher than that of the Caucasian participants (58.1%), $t(58) = 1.95$, $p = .056$, $d = .51$. There was no difference between the accuracy of female (59.9%) and male (62.1%) participants, $t(63) = .83$.

Facial metric predictors of macaque sex

The 9 facial metrics assessed to test our hypotheses achieved acceptable inter-rater agreement between two raters (correlations ranged from $r = .70$ to .98, $M = .86$), and mean values across raters were computed to examine correlations with macaque sex (coded 0 for female, 1 for male). Consistent with previous research on sexual dimorphism in human and/or macaque faces, measures of face length and width, jaw size, nose size, and eye size, were significant predictors of macaque sex, paralleling the sexual dimorphism of these features in human faces (see Table 1).

Facial metric predictors of perceived macaque sex

We used sensitivity correlations to examine which cues were significantly used by Korean and Caucasian raters and which cues were differentially used by the two groups. We correlated each rater's judgment of the sex of the faces (coded 0 for female, 1 for male) with each facial metric. This yielded a set of correlations for each participant reflecting the extent to which each metric was correlated with their judgments of face sex. These correlations were Fisher-Z transformed to normalize them (see Franklin & Adams, 2009), and the mean of the normalized correlations across Caucasian or Korean raters was compared to zero by using a t-test to determine which metrics significantly predicted rated sex (see Table 2).

As reported in Table 2, judgments of face sex by both Korean and Caucasian raters were predicted by all of the metrics that significantly differentiated macaque sex. The only significant cultural difference in cue utilization was eye height (E5), which predicted sex judgments

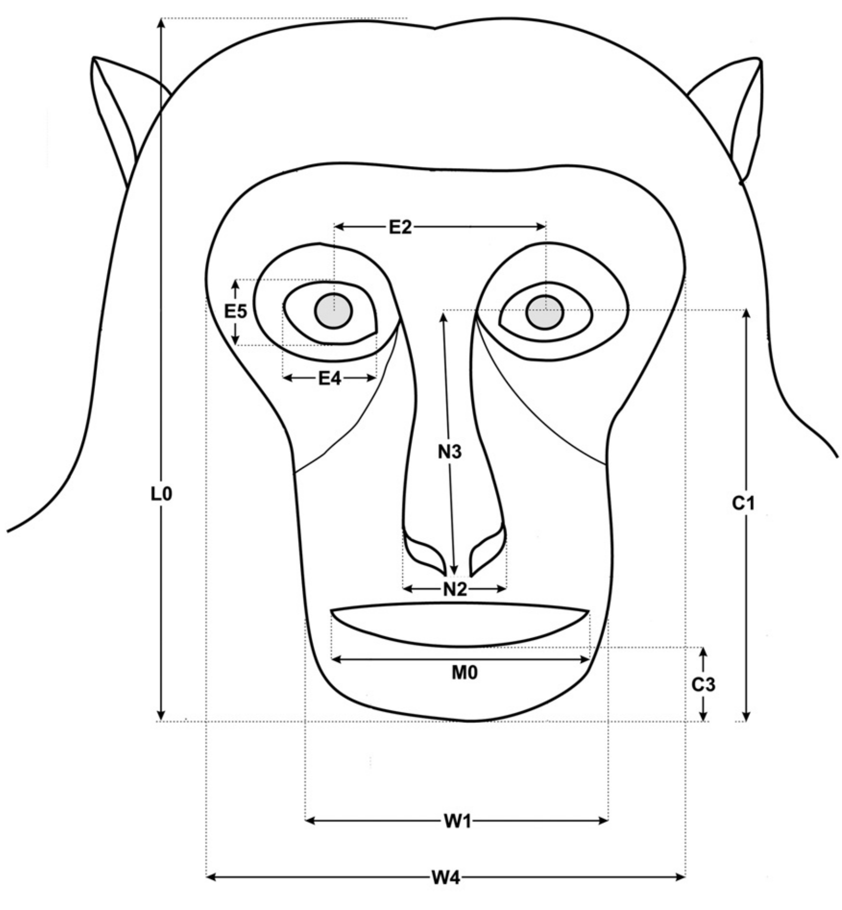

Fig. 1. Facial metrics used to examine sexual dimorphism in macaque faces.

Table 1
Facial metrics reliability and its correlation with macaque sex.

Metric	Males	Females	Reliability	Correlation with face sex	t-Value	p-Value
C1 – eye to chin length	2.14	1.94	0.95	0.52	3.52	0.002
C3 – chin length	0.46	0.39	0.70	0.31	2.78	0.01
E2 – interpupil distance	0.23	0.23	0.98	0.15	0.81	0.42
E4 – eye width	0.97	0.97	0.80	−0.01	0.06	0.95
E5 – Eye Length	0.26	0.28	0.82	−0.68	2.81	<.001
L0 – head length	0.79	0.75	0.93	0.38	2.18	0.038
M0 – mouth width	1.12	0.85	0.88	0.69	4.99	<.001
N2 – nose width	0.47	0.44	0.93	0.51	3.12	0.004
N3 – nose length	1.18	1.07	0.91	0.32	2.12	0.043
W1 – jaw width	1.49	1.25	0.74	0.67	4.83	<.001
W4 – face width	2.25	2.16	0.88	0.36	2.03	0.052

Sex was scored as 0 = female; 1 = male.

Table 2
Mean sensitivity correlations between facial metrics and rated sex.

Measure	Mean	t-Value	p-Value
C1 – eye to chin distance	0.20	7.90	0.00
C3 – chin length	0.01	0.29	0.90
E2 – interpupil distance	−0.03	−1.45	0.45
E4 – eye width	−0.02	−0.76	0.90
E5 – eye height	−0.27	−9.17	0.00
L0 – head length	0.14	5.11	0.00
M0 – mouth width	0.12	5.17	0.00
N2 – nose width	0.10	3.84	0.00
N3 – nose length	0.29	8.92	0.00
W1 – jaw width	0.17	7.57	0.00
W4 – face width	0.14	6.67	0.00

Correlations are between an individual's rating of sex scored as 0 = female and 1 = male; thus positive correlations indicate that the metric is larger in macaques labeled as male.

more for Asians than Caucasians, $t(53) = 2.13$, $p = .038$. For all other metrics, the culture comparison was not significant, $ts < 1.5$, $ps > .1$.

As eye height significantly differentiated judgments by Korean and Caucasian raters and also accurately predicted macaque sex, we examined whether it mediated the cultural difference in accuracy. The mediation analysis (Baron & Kenny, 1986; Preacher & Hayes, 2004) revealed that Korean raters' greater use of eye height fully mediated the relationship between culture and accuracy. Controlling for its use reduced the better performance of Koreans to a non-significant effect, and this drop was significant (see Fig. 2).

Discussion

This is the first study to demonstrate that humans can sex-differentiate primate faces, an achievement that likely reflects cross-species similarity in the cues that differentiate male from female faces. Specifically, we found that compared with female macaques, male macaques have larger and broader jaws, longer lower faces, wider faces, larger noses, and smaller eye heights, paralleling facial metrics that differentiate male from female humans (Fellous, 1997; Gangestad & Thornhill, 2003; Penton-Voak et al., 2001). Furthermore, we found that humans appropriately used each of these sexually-dimorphic cues to judge macaque sex. Thus, anthropomorphism enables people to accurately sex-differentiate macaque faces by appropriately generalizing from sexual dimorphism in human faces. These results add to previous evidences that social perceptions of specific exemplars tend to generalize from adaptively significant categories. For example, responses to adaptively significant facial cues, like those of a baby or an angry person, generalize to perceptions of people whose faces merely resemble babies or anger. Our results also suggest that objective similarities in the physical appearance of humans and animals may contribute to other instances of anthropomorphism, providing one answer to the question of what conditions increase or decrease anthropomorphism, and supporting the suggestion that anthropomorphism may be inextricably intertwined with the way we see humans (Kwan & Fiske, 2008).

We also found that Koreans performed better than Caucasians in sex-differentiating macaque faces, extending evidence of cultural variation in human sex-differentiating ability. Even though this effect was small, the magnitude of the difference between Asian and Caucasian judges was similar to that shown when judging human sex (e.g., Zhao & Bentin, 2008). Moreover, the superiority of East Asians in judging macaque sex disambiguates the East Asian advantage previously shown for human faces. Specifically, previous evidence that lower accuracy in sex-differentiating Asian faces was less marked for Asian judges (O'Toole et al., 1996) could have reflected either Asians' keener sensitivity to sexually dimorphic facial cues owing to the greater subtlety of such cues in East Asian faces or it could have reflected an own-race advantage. However, an own-race advantage cannot account for Korean judges' greater accuracy in sex-differentiating macaque faces. Thus, the present results support the conclusion that East Asians are more sensitive to facial sexual dimorphism, an effect shown for both human and macaque faces. In the case of macaques, the only cue to which Koreans were more sensitive was eye size, and greater use of this cue fully mediated their greater accuracy. Koreans' greater use of eye size is consistent with prior research suggesting that East Asians use cues in the eye region more so than do Caucasians when sex-differentiating human faces (Yamaguchi, Hirukawa, & Kanazawa, 1995).

Koreans' greater sensitivity to sexually-dimorphic cues suggests that these cues may play a more important role in person perception processes in East Asian cultures. For example, the tendency to attribute more stereotypically masculine traits to persons with a typically masculine versus feminine facial appearance, regardless of the person's sex (Sczesny et al., 2007) may be stronger for East Asians. Similarly, the tendency for congruence between emotion cues and sexual dimorphism cues (Zebrowitz et al., 2010) to yield quicker and more accurate recognition of fear in women and anger in men (Becker et al., 2007) may also be stronger in East Asians. These are interesting questions for future research.

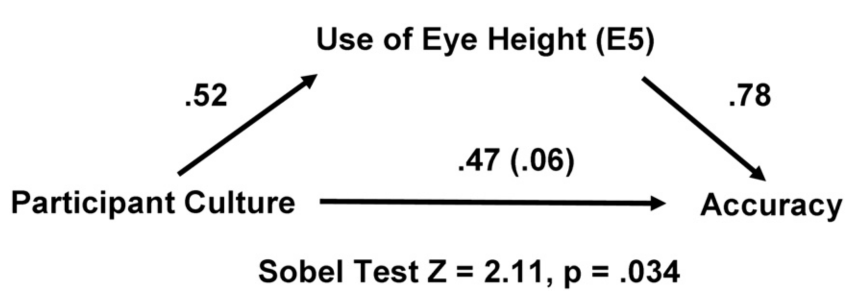

Fig. 2. Mediation model for the use of eye size mediating the relationship between participant culture (0 = White American, 1 = Korean) and accuracy. Participant culture was coded 0 = White American, 1 = Korean, thus indicating that positive correlations with participant culture indicate greater use of eye size and greater accuracy in Korean raters.

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