Original Article

Evolutionary Psychology
April-June 2018: 1–5

DOI: 10.1177/1474704918776748
journals.sagepub.com/home/evp
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Does Adult Sex Ratio Predict Regional Variation in Facial Dominance Perceptions? Evidence From an Analysis of U.S. States

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Abstract

When the adult sex ratio of the local population is biased toward women, men face greater costs due to increased direct intrasexual competition. In order to mitigate these costs, men may be more attuned to cues of other men's physical dominance under these conditions. Consequently, we investigated the relationships between the extent to which people ($N = 3{,}586$) ascribed high dominance to masculinized versus feminized faces and variation in adult sex ratio across U.S. states. Linear mixed models showed that masculinized faces were perceived as more dominant than feminized faces, particularly for judgments of men's facial dominance. Dominance perceptions were weakly related to adult sex ratio, and this relationship was not moderated by face sex, participant sex, or their interaction. Thus, our results suggest that dominance perceptions are relatively unaffected by broad geographical differences in adult sex ratios.

Keywords

social perceptions, face perceptions, dominance judgements, adult sex ratio, intrasexual competition

Date received: July 21, 2017; Accepted: March 26, 2018

By contrast with previous assumptions, recent research suggests that direct (i.e., violent) competition among men is greater in geographic regions where the adult sex ratio of the local population is more female biased (Schacht, Rauch, & Mulder, 2014; Schacht, Tharp, & Smith, 2016). This relationship is thought to occur because the rarer sex, having greater "market value," is better positioned to pursue their sex-typical optimal mating strategy (Pollet & Nettle, 2008). Consequently, in male-biased populations, women have more choice, causing men to invest more effort in indirect competitive strategies that will increase their appeal as long-term partners (e.g., strategies aimed at increasing socioeconomic status and demonstrating willingness to commit to long-term relationships, e.g., Griskevicius et al., 2012; Schacht & Kramer, 2016). Conversely, in female-biased populations, men have more choice and, as such, are better able to pursue short-term mating strategies (Schacht & Borgerhoff Mulder, 2015) and engage in direct (i.e., violent) physical competition while maintaining their appeal as short-term partners to potential mates (Barber, 2009; Schacht et al., 2016).

In order to mitigate the potential costs of greater direct physical competition (e.g., increased risk of injury and/or loss of resources), men may be more attuned to cues of other men's physical dominance under these conditions. Such facultative responses could reduce the opportunity costs that might otherwise be incurred when the adult sex ratio of the local population is more male biased and direct physical competition among men is less intense.

In many nonhuman animals, sexually dimorphic physical characteristics play an important role in intrasex conflicts and the formation of dominance hierarchies (reviewed in Emlen,

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2008). In humans, several lines of evidence suggest that masculine facial characteristics play an important role in intrasexual competition (reviewed in Puts, 2010). For example, exaggerating male sex-typical characteristics in men's faces reliably increases their perceived dominance and strength (Jones et al., 2010; Perrett et al., 1998) and men with more masculine faces tend to be physically stronger (Fink, Neave, & Seydel, 2007; Windhager, Shaefer, & Fink, 2011). Masculine characteristics in men's faces might also act to directly protect against impact damage (Carrier & Morgan, 2015). Additionally, multiple studies have now demonstrated that men's faces contain valid cues to their threat potential (Doll et al., 2014; Han et al., 2017; Little, Třebický, Havlíček, Roberts, & Kleisner, 2015).

Since masculine facial characteristics appear to function primarily as a dominance cue (Puts, 2010) and there is greater direct physical competition among men in geographic regions with more female-biased adult sex ratios (Schacht et al., 2014; Schacht et al., 2016), men in geographic regions with more female-biased adult sex ratios may be more likely to ascribe high dominance to masculine men (i.e., be more attuned to cues of men's physical dominance). Such facultative responses could function to mitigate the costs of increased direct competition by allowing men in geographic regions where direct competition is most common to assess potential threats more thoroughly.

Women are thought to place a greater premium on physical dominance of potential mates when direct physical competition among men is higher (Brooks et al., 2010; Watkins, DeBruine, Little, Feinberg, & Jones, 2012), potentially because the benefits of dominance are increased and/or because the costs of aggression are decreased (Brooks et al., 2010). Consequently, women in regions with more female-biased adult sex ratios might also be more attuned to cues of men's physical dominance and therefore more likely to ascribe high dominance to masculine men. Consistent with this prediction, Watkins et al. (2012) reported that experimentally activating (i.e., priming) women's concerns about resource scarcity increased the extent to which they ascribed high dominance to masculine men. However, evidence that priming women with cues of male–male direct physical competition alters their preferences for masculine men is equivocal (Li et al., 2014; Little, DeBruine, & Jones, 2013).

Following recommendations regarding statistical tests for regional differences in human behavior (Pollet, Tybur, Frankenhuis, & Rickard, 2014), we used linear mixed models to take into account variation in dominance perceptions among individuals within each state (i.e., avoiding the problems associated with aggregating responses across individuals, see Pollet et al., 2014).

Method

Participants

A total of 917 heterosexual men (mean age = 23.7 years, SD = 5.91 years) and 2,669 heterosexual women (mean age = 22.1 years, SD = 4.90 years) participated in the online study (total N = 3,586, between the ages of 16 and 40). Online data collection has been used in many previous studies of regional differences in human behavior (DeBruine, Jones, Crawford, Welling, & Little, 2010, 2011; Kandrik, Jones, & DeBruine, 2015; Scott et al., 2014). Participants were recruited by following links from social bookmarking websites (e.g., http://stumbleupon.com) and were not compensated for participation. Participation took place between 2009 and 2012.

Face Stimuli

Stimuli were masculinized and feminized versions of 20 male and 20 female faces from an image set that have been subsequently made publicly available (DeBruine & Jones, 2017).

First, male and female prototype (i.e., average) faces were manufactured using established computer graphic methods that have been widely used in studies of face perception (Tiddeman, Burt, & Perrett, 2001). Prototypes are composite images that are constructed by averaging the shape, color, and texture of a group of faces, such as male or female faces. These prototypes can then be used to transform images by calculating the vector differences in position between corresponding points on two prototype images and changing the position of the corresponding points on a third image by a given percentage of these vectors (see Tiddeman et al., 2001, for technical details). The male and female prototypes were each manufactured by averaging shape, color, and texture information from 20 faces.

Here, 50% of the linear differences in 2-D shape between symmetrized versions of the male and female prototypes were added to or subtracted from face images of 20 young White male adults (age: M = 20.3 years, SD = 4.1) and 20 young White female adults (age: M = 18.4 years, SD = 0.7). This process creates masculinized and feminized versions of the individual face images that differ in sexual dimorphism of 2-D shape and that are matched in other regards (e.g., identity, skin color, and texture). Examples of masculinized and feminized versions of male and female faces are shown in Figure 1. Thus, 40 pairs of images were produced in total (each pair consisting of a masculinized and a feminized version of the same individual): 20 pairs of male face images and 20 pairs of female face images.

Procedure

Participants were shown the 40 pairs of face images (20 male and 20 female) and were asked to choose the face in each pair looked more dominant. Participants also indicated whether the more dominant face in each pair looked "much more dominant," "more dominant," "somewhat more dominant," or "slightly more dominant" than the other face in the pair. The order in which pairs of faces were shown was fully randomized for each participant and the side of the screen on which any particular image was shown was also randomized. This procedure has been used to assess variation in dominance perceptions in many previous studies (e.g., Watkins et al., 2010).

Figure 1. Examples of masculinized (left) and feminized (right) faces used in the study.

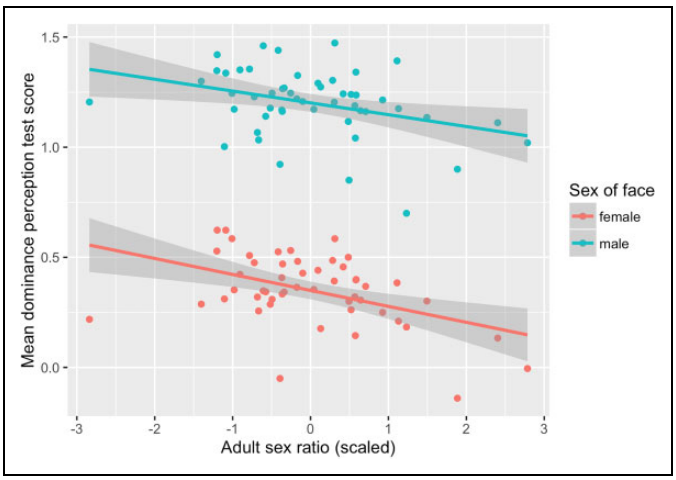

Figure 2. The relationship between adult sex ratio of U.S. states and average scores on dominance perception test for men's and women's faces. On the *y*-axis, zero equals chance.

Following previous studies of dominance perceptions (e.g., Watkins et al., 2010), responses on the dominance perception test were coded using the following scale (which was centered on chance in the current study):

0.5 to 3.5: masculinized face rated *slightly more dominant* (=0.5), *somewhat more dominant* (=1.5), *more dominant* (=2.5), or *much more dominant* (=3.5) than feminized face.

−0.5 to −3.5: feminized face rated *slightly more dominant* (=−0.5), *somewhat more dominant* (=−1.5), *more dominant* (=−2.5) or *much more dominant* (=−3.5) than masculinized face.

Adult Sex Ratio

Following previous research on regional variation in behavior in the United States (Kandrik et al., 2015), estimates of the adult sex ratio (total number of men aged between 15 and 49 years of age divided by the total number of women aged between 15 and 49 years of age) for each U.S. state (plus Washington, DC) were obtained from the 2010 US Census Bureau (American Community Survey, 2010). Higher values indicate a more male-biased adult sex ratio. Each participant's Internet protocol address was used to determine their location. Note that this is relatively accurate at a state level but does not allow for more fine-grained analyses of location.

Results

We used linear mixed models to investigate the relationship between state-level differences in adult sex ratio and scores on the dominance perception test. Analyses were conducted using R version 3.3.2 (R Core Team, 2016) with lme4 version 1.1-12 (Bates, Maechler, Bolker, & Walker, 2014) and lmerTest version 2.0-33 (Kuznetsova, Brockhoff, & Christensen, 2013). The dependent variable was scores on the dominance perception test (centered on chance). Independent variables were participant age (centered on mean for sample and scaled), participant sex (effect coded as male = 0.5 and female = −0.5), face sex (effect coded as male = 0.5 and female = −0.5), and the adult sex ratio for each state plus Washington, DC (centered on mean for states and scaled). The model included participant age and all possible interactions among participant sex, face sex, and adult sex ratio. The model included random intercepts for each item (i.e., face), state, and participant (nested in state). Random slopes were specified maximally following recommendations by Barr, Levy, Scheepers, and Tily (2013) and Barr (2013). Simulations reported in those studies show that not including these random slopes increases false positive rates to unacceptably high levels. Formulae and the output of this analysis (see Table 1) are given in Online Supplemental Materials. Our data and analysis files are publicly available at https://osf.io/q46ye/.

The intercept was significant ($\beta = .80$, $t = 25.1$, $p < .001$), indicating that masculinized faces were judged to be more dominant than feminized faces ($M = 0.80$, $SD = 1.60$). There was also a significant effect of face sex ($\beta = .85$, $t = 55.1$, $p < .001$), indicating that the effect of masculinity on dominance perceptions was larger for male ($M = 1.22$, $SD = 1.46$) than female faces ($M = 0.38$, $SD = 1.62$). The effect of masculinity on dominance perceptions tended to be larger in states with more female-biased sex ratios (see Figure 2), but this main effect of adult sex ratio ($\beta = -.04$, $t = -1.94$, $p = .056$) was not significant. The effect of masculinity on dominance perceptions tended to be larger among older participants, but this main effect of participant age was also not significant ($\beta = .03$, $t = 1.90$, $p = .058$). No other effects were significant or near significant (all absolute $\beta < .06$, all absolute $t < 1.37$, all $p > .17$). It should be noted within the United States; Washington DC is an outlier on numerous factors including but not limited to adult sex ratio (0.91; mean for all states = 1.01, $SD = 0.03$). Repeating this analysis with Washington DC

Table 1. Linear Mixed Model Output.

	Estimate	Std. Error	*df*	*t*	*p*
Intercept	.796	.032	32.8	25.12	<.001
Rater age	.025	.013	3,562.4	1.90	.058
Rater sex	.002	.031	3,579.9	0.06	.953
Face sex	.846	.015	3,576.7	55.09	<.001
Adult sex ratio	−.042	.021	76.4	−1.94	.056
Rater Sex × Face Sex	−.006	.032	26.0	−0.19	.849
Rater Sex × ASR	−.046	.043	1,976.7	−1.07	.283
Face Sex × ASR	.021	.021	3,583.8	1.00	.319
Rater Sex × Face Sex × ASR	.059	.043	38.7	1.37	.179

Note. ASR = adult sex ratio.

excluded from the data set showed the same pattern of significant and near-significant results (see Online Supplemental Materials).

Discussion

Consistent with previous work on dominance perceptions of faces (e.g., Jones et al., 2010; Perrett et al., 1998), masculinized versions of faces were perceived as looking more dominant than feminized versions. Puts (2010) proposed that this tendency to ascribe high dominance to masculinized faces primarily reflects adaptations for identifying particularly formidable men who pose greater threat potential. Consistent with this proposal, we found that identical manipulations of sexually dimorphic aspects of facial morphology produced greater effects on dominance perceptions when applied to images of male faces than when applied to images of female faces.

Although the effect of masculinity on dominance perceptions tended to be larger in states with more female-biased sex ratios, this effect was both weak and nonsignificant. Thus, despite high power from our large sample size and linear mixed models, our results do not give clear support for the hypothesis that the extent to which people are attuned to facial cues of dominance varies with factors that could influence rates of direct competition, here adult sex ratio (Brooks et al., 2010; Li et al., 2014; see also Watkins et al., 2012). Controlling for other socioecological factors that predict regional variation in responses to facial sexual dimorphism (e.g., urbanization, Scott et al., 2014) may clarify the role of adult sex ratios in face perception. Indeed, since urbanization predicts responses to facial sexual dimorphism (Scott et al., 2014) and urbanization and adult sex ratio are sometimes correlated (e.g., Barber, 2000), it remains unclear whether effects of urbanization on responses to sexual dimorphism are mediated by adult sex ratio, effects of adult sex ratio on responses to sexual dimorphism are mediated by urbanization, or urbanization and adult sex ratio have independent effects on responses to sexual dimorphism.[1]

Our results suggest that the tendency to ascribe high dominance to masculinized faces is relatively robust across the range of sex ratios tested in the current study. Of course, more fine-grained analyses (i.e., analyses examining smaller geographic regions) may yet reveal clearer evidence of a link between markers of the intensity of competition among men and dominance perceptions. Further work is needed to address this issue.

In conclusion, we show a large effect of sexually dimorphic facial morphology on dominance perceptions in a large U.S. sample of men and women. The observed effect of facial morphology was particularly pronounced for dominance judgments of men's faces and weakly negatively related to adult sex ratio. These results, together with those showing that Japanese and White UK participants ascribe high dominance to masculinized faces (Perrett et al., 1998), demonstrate robust effects of sexually dimorphic facial morphology on dominance perceptions.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This project was supported by European Research Council Grants awarded to Ben Jones (OCMATE) and Lisa DeBruine (KINSHIP), a Marie Curie Research Fellowship (MULTIPREF) awarded to Anthony Lee, and an Economic and Social Research Council PhD studentship awarded to Michal Kandrik.

Note

1. We thank the editor for raising this issue with us. We conducted an exploratory analysis, also suggested by the editor (David Puts), to test whether a state-level measure of urbanization (from the 2010 Census) predicted dominance perceptions in our data. This analysis showed no evidence for any significant effects of urbanization (see Online Supplemental Materials for details of this analysis and full results). Nonetheless, we agree this would be a potentially important issue to consider in other samples with a wider range of urbanization and/or adult sex ratios.

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