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Original Article

# Environment contingent preferences: Exposure to visual cues of direct male–male competition and wealth increase women's preferences for masculinity in male faces

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ABSTRACT

Previous studies show that parasite prevalence and mortality/health are related to cultural variation in women's preferences for attractive and masculine traits in men. Other studies have suggested that both male–male competition and wealth may also be important correlates of cross-cultural variation in women's masculinity preferences. Here we examined whether exposure to cues of direct male–male competition, violence, or wealth influenced women's face preferences. We showed women slideshows of images with cues of low and high direct male–male competition/violence or wealth and measured their visual preferences for masculine face traits. Recent visual experience changed women's preferences for facial masculinity, with women preferring more masculine male faces after exposure to images of men engaged in direct physical competition, images of weapons, or images depicting items of high monetary value. Recent visual experience had no significant effects on preferences for masculinity in same-sex faces. Given that high levels of direct physical competition and violence among males may increase the importance of direct intra-sexual competition, it may be adaptive for women to shift visual preferences in favor of males with face cues indicating physical strength and dominance over investment in such environments. Similarly, in wealthy environments investment may be less important than other aspects of quality and so it may be adaptive for women to shift visual preferences in favor of males with face cues indicating other aspects of quality over investment. Overall, our data demonstrate that preferences can be strategically flexible according to recent visual experience and support the notion of environment contingent preferences.



## 1. Introduction

Across many animal species, sexual dimorphism is an important trait involved in sexual selection (Andersson, 1994). Sexually dimorphic traits in human faces have received much attention by those interested in evolutionary approaches to human preferences and perception (see e.g., Thornhill & Gangestad, 1999). Sexually dimorphic traits (relative masculinity/femininity) in human male faces has been proposed to relate to both inter-sexual selection (Little, Jones, & DeBruine, 2011; Thornhill & Gangestad, 1999), influencing attraction to the opposite sex, and intra-sexual selection (Swaddle & Reierson, 2003), relating to competition between members of the same sex. In terms of attractiveness to the opposite sex, there are benefits that could be associated with sexual dimorphism: (1) indirect benefits, genetic benefits that are passed to offspring such as genes associated with strong immune systems, and (2) direct benefits, benefits that are directly passed to mates or offspring such as resources or avoidance of disease.

### 1.1. Variation in preferences for men's masculinity

Evidence for the attractiveness of sex-typical masculine facial traits (e.g., large jaws, prominent brows) in male faces is mixed: some studies have shown masculine preferences (e.g., Cunningham, Barbee, & Pike, 1990; DeBruine et al., 2006; Grammer & Thornhill, 1994), while other studies have shown preferences for feminine faces (Perrett et al., 1998; Little & Hancock, 2002). Many studies, however, also demonstrate systematic variation in women's preferences for male facial masculinity and the direction of preference for masculine traits does not preclude adaptive individual differences. Women prefer relatively more masculine-faced men when they think themselves or are rated as attractive (Little, Burt, Penton-Voak, & Perrett, 2001; Penton-Voak, Little, Jones, Burt, Tiddeman, & Perrett, 2003), when they already have a partner (Little, Jones, Penton-Voak, Burt, & Perrett, 2002), at peak fertility in the menstrual cycle (Penton-Voak et al., 1999; Jones, DeBruine, Perrett, Little, Feinberg, & Smith, 2008), and when rating for short-term relationships (Little et al., 2002). These findings have been interpreted as consistent with ideas that masculinity in male faces is associated with indirect benefits, (i.e., they are assocaited with genetic quality, Thornhill & Gangestad, 1999), as these are conditions under which we might expect women

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to be most attentive to heritable genetic benefits. Of course this does not preclude that facial masculinity is in part preferred due to direct benefits or that it plays a role in male–male competition.

### 1.2. Trade-offs inherent in preferences

Individual variation in attraction to masculinity may be related to a trade-off between quality and investment (Gangestad & Simpson, 2000; Little et al., 2002). High-quality individuals may invest less in each partner (and offspring) or be more likely to cheat on/desert partners. High-quality individuals may not make ideal long-term partners in a species, such as humans, with extended parental investment (Burley, 1986; Moller & Thornhill, 1998). For example, masculine-faced men are perceived as dominant but also as poor-quality parents (Perrett et al., 1998). Indeed, while masculine-faced men report better health (Thornhill & Gangestad, 2006) and are physically stronger (Fink, Neave, & Seydel, 2007) but also have more short-term partners (Boothroyd, Jones, Burt, DeBruine, & Perrett, 2008) which suggests low investment in relationships. In this framework, masculinity in men is associated with both indirect and direct benefits with a trade-off between investment and quality. For example, masculinity may be negatively linked to levels of investment (direct benefit) but also positively to quality in terms of genes for health/dominance (indirect benefits) and current health/resources (direct benefits). Such a trade-off is consistent with many aspects of masculinity preferences such as increased preferences for masculinity in short-term contexts (Little et al., 2002) or at peak fertility (Penton-Voak et al., 1999; Jones et al., 2008).

### 1.3. Environmental influences on preference

Previous studies have mainly focused on individual differences based on factors intrinsic to the choosing individuals (e.g., physical attractiveness), but we may also expect variation according to extrinsic ecological conditions that influence the relative value of investment versus other (e.g., good genes/dominance) benefits from partners. For example, resource scarcity and pathogen stress in the environment an individual inhabits might influence the trade-off between preferring a high-investing partner and one with a high-quality immune system or who is more dominant/healthy. Such reasoning may help explain observed cross-cultural differences in preferences for male masculinity.

Penton-Voak, Jacobson, and Trivers (2004) found stronger preferences for male masculinity in rural Jamaica than in the UK and Japan. One reason they suggested for this finding is that a higher pathogen prevalence in Jamaica may result in increased preferences for masculinity in male faces, as health benefits, both direct and indirect, may be more salient under higher disease stress. The Hadza, a tribe of African hunter gathers, have also been found to exhibit stronger preferences for facial symmetry, another putative cue of mate quality that is also correlated with facial masculinity in Hadza men (Little et al., 2008), than do participants in the UK (Little, Apicella, & Marlowe, 2007). A difference in pathogen load between samples may also explain increased preferences for symmetry in the Hadza because individuals close to the equator have higher pathogen loads (Low, 1990) and outdoor living is likely to increase exposure to pathogens. Another study has examined a cross-cultural sample of 30 countries, calculating both the average female preference for male facial masculinity and a composite health index derived from World Health Organization statistics (DeBruine, Jones, Crawford, Welling, & Little, 2010). This study found that poorer health (i.e. higher mortality and incidence of disease) was related to stronger female preferences for male masculinity (DeBruine et al., 2010). This relationship between health factors and masculinity preferences was replicated in a follow-up study of differences in the average masculinity preference of women in US states (DeBruine, Jones, Little, Crawford, & Welling, 2011).

Results from these cross-cultural studies indicate that health risks are a potentially important determinant of mate preferences, but such studies are correlational and do not address how such associations arise. There are of course other factors that vary across culture and often co-vary with health, such as wealth. Indeed, a reanalysis of the data presented in DeBruine et al. (2010) suggested that factors associated with relative wealth and male–male competition (i.e., homicide rates) are associated with variation in preferences for face masculinity in women across cultures (Brooks, Scott, Maklakov, Kasumovic, Clark, & Penton-Voak, 2011), although this pattern was not replicated in a further study of regional differences across US states (DeBruine et al., 2011).

One way to disentangle the reasons behind such variation is through experimental exposure. If preferences are sensitive to environmental cues then we predict that preferences will vary accordingly. One study has demonstrated that imagining oneself as being in either a high- or low-resource availability scenario affected women's preferences, with a low-resource environment leading to higher preferences for feminine-faced men for long-term partnerships (Little, Cohen, Jones, & Belsky, 2007). A harsh, low-resource environment then appears to promote a strategy wherein women favor lower-quality but potentially higher-investing men for long-term relationships. In contrast, another study demonstrated that exposure to cues of pathogens increased women's preferences for male facial masculinity and symmetry, and hence quality over investment (Little, Jones, & DeBruine, 2011). Potentially, these patterns of data highlight different aspects of environmental influence on preferences. Resource availability and parasite prevalence may drive face preferences in different ways. Abundant resources may allow women to choose with lower concern for investment and so enable the selection of higher-quality partners whereas scarce resources may place pressure on women to choose investing partners, at the expense of quality. Parasite prevalence, on the other hand, will increase health risks/child mortality and so choosing a healthy partner may be more important than choosing an investing partner under conditions of high disease and parasite risk.

Alongside resource scarcity and parasite prevalence, the degree of male–male intra-sexual competition could also influence female preferences. Across cultures, variation in human mating systems (monogmamy vs. polygny) is related to variation in male resource control according to ecological variables as well as variation in male–male competition for status (Marlowe, 2000). Where males can control resources, we expect there to be an unequal distribution of resources, as some males will be better able to control resources than others. This would lead to female preferences for male traits indicating that males can successfully compete for and control resources. In groups in which direct male–male competition is prevalent, and status, or even survival, is dependent on successful competition, we would also expect females to prefer cues of successful male competition. While cues to the ability of acquiring resources may be varied, success in direct physical competition is likely partly related to physical strength and fitness. As a man's physical strength is positively related to ratings of facial masculinity and dominance (Fink et al., 2007), we can predict that masculinity in faces would be preferred in conditions where men physically competing with one another is more common.

### 1.4. The current experiments

Previous experimental work on exposure to visual cues of pathogens suggests a role of health concerns in generating preferences for masculinity. Other environmental cues of male–male competition and wealth also appear likely alter the balance of preferences for male facial masculinity according to how valuable

associated traits are under difference conditions. Here we address whether visual exposure to cues of male engagement in direct, combative competition versus indirect, non-combative competition (Experiment 1A), cues of violence (Experiment 1B), and cues of high wealth versus low wealth (Experiment 2) also affect women's preferences for male facial masculinity. Because masculine men may be better able to successful compete with other men and women would benefit from choosing men who can successfully compete in their current environment, we predicted that exposure to cues highlighting such competition or violence would also lead to increased preferences for masculinity in line with previous suggestions that high levels of direct male–male competition would be related to preferences for masculinity (Brooks et al., 2011). Given the fact that higher wealth may allow women to choose quality over investment, removing some of the potential costs of masculinity and the benefits of femininity, we predicted that exposure to cues of a wealthy environment would lead to higher preferences for masculinity in line with a previous experimental study in which cues of a resource rich environment led women to prefer more masculine male faces (Little et al., 2007). Finally, because the benefits described above of preferring masculine-faced individuals are mainly relevant for mate choice, we predicted that exposure effects would be relatively specific to opposite-sex faces in line with prior work on experimental exposure to pathogen cues (Little et al., 2011).

## 2. Experiment 1A: male–male competition

In Experiment 1A, we examined whether exposure to cues of direct male–male competition influenced women's preferences for male facial masculinity. Given the fact that facial masculinity is associated with dominance and strength, in environments with high levels of direct male–male competition masculine-faced men should be more successful than their feminine-faced competitors. Environmental cues of such competition may alter women's preferences in an adaptive fashion by encouraging selection of competitive male mates.

## 3. Methods

### 3.1. Participants

Participants were 77 women (aged 17 to 44 years, mean = 23.7, SD = 7.0). Participants were selected for being older than 16 and less than 46 years of age and reporting to be heterosexual. Participants were recruited for the study online via a research-based website and the study was conducted online. Previous research has shown that systematic variation in men's and women's face preferences observed in online studies is very similar to that seen in laboratory studies (e.g., Jones et al., 2005; Little, Jones, Burt, & Perrett, 2007). Data from men were collected but are not analyzed here.

### 3.2. Stimuli

#### 3.2.1. Sexually dimorphic face shape

All images were photographs of white individuals (aged 18 to 25 years) without spectacles or obvious facial hair. Photographs were taken under standardized lighting conditions and with participants posing with a neutral expression. To equate size, all images were aligned to standardize the position of the pupils in the image.

To measure preferences for sexually dimorphic secondary sexual features, we used pairs of composite face images. The pairs comprised one masculinized and one feminized version of the same face (see Fig. 1). Images were manufactured from photographs of 50 male and 50 female young, Caucasian adults. Composite images, composed of multiple images of different individuals, were used as base faces (10 male and 10 female composite images each made of 5 individual images). The composite images were made by creating an average

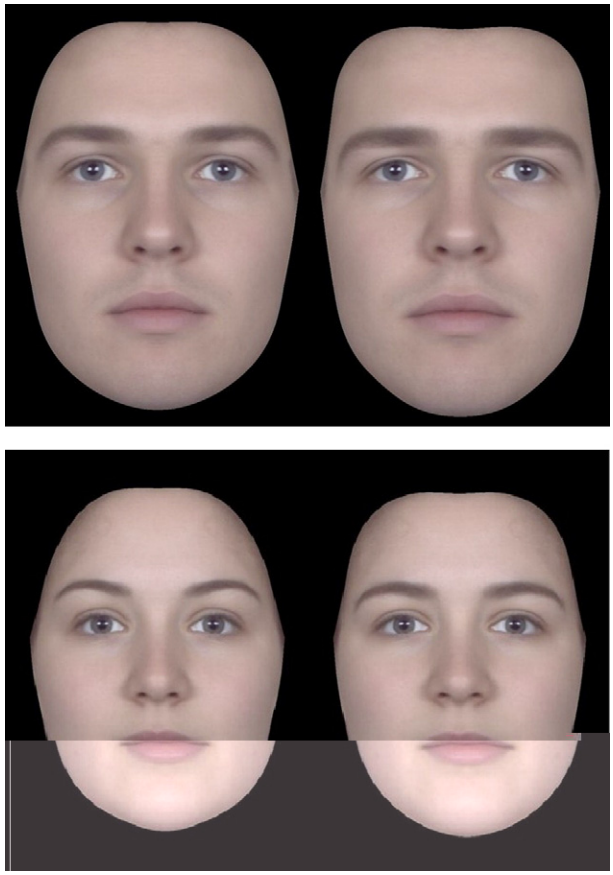

**Fig. 1.** Feminized (left) and masculinized (right) male and female faces.

image made up of five randomly assigned individual facial photographs. Faces were transformed on a sexual dimorphism dimension using the linear difference between a composite of all 50 male faces and a composite of all 50 female faces (following the technique reported in Perrett et al., 1998). Transforms represented ± 50% the difference between these two composites (100% would represent the complete transform and so starting from a female face + 100% toward male would make the face into a perceptually male shape). This meant that the face was transformed along the sexual dimorphism axis, either increasing masculinity or increasing femininity, and that the face retained its identity and perceived sex (i.e., male faces remained male in appearance). All composite images were made perfectly symmetric prior to transform so that transforms did not manipulate symmetry. Final images were 10 feminine/masculine pairs for each sex of face.

#### 3.2.2. Cues of direct/indirect male–male competition

Images of individuals participating in various sports were taken from the Internet using a Google search. Sports were selected that represented male–male direct, combative competition (boxing, wrestling, judo, and cage fighting) and more indirect, non-combative competition (golf, snooker, gymnastics, and pole vaulting). Images were selected for being of high quality (i.e., high resolution) and not displaying faces prominently. Two images were selected for each sport. Stimuli were validated by asking a new group of 11 participants (4 women, 7 men, mean age = 23.9 years, SD = 4.9) to: "Rate the image for how DIRECTLY PHYSICALLY COMPETITIVE you think the sport is." Images were presented individually and in a random order with a 7-point scale with 1 being low and 7 being high. Average scores were calculated for high- and low-competitive images for each rater. A paired-sample $t$-test revealed that high-competitive images were rated as significantly more directly physically competitive than low-

competitive images (high mean = 5.86, SD = 1.40, low mean = 3.48, SD = 1.40, $t_{10}$ = 3.76, $p$ = .004).

### 3.2.3. Procedure

Participants were randomly allocated to the high-competition ($N$ = 39) or low-competition ($N$ = 38) versions of the experiment. First, they were administered a short questionnaire assessing age, sex, and sexual orientation, followed by the main test. The main test consisted of three parts: an initial test that assessed participants' preferences for masculinity in same- and opposite-sex faces (the pre-exposure test), a slideshow of either direct- or indirect-competition images (the exposure phase), and a post-exposure test that was identical to the pre-exposure test. Participants were told "In this study you will see faces to rate for attractiveness. You will also see a slideshow of various sporting events and then be asked to judge the images again." No other information was provided about why the slideshow was presented.

In the pre-exposure test, the 10 pairs of masculine and feminine male faces and 10 pairs of masculine and feminine female faces were shown with both order and side of presentation randomized. Participants were asked to choose the face from the pair that they found most attractive. Clicking a button moved participants on to the next face trial. In the exposure phase, participants saw a slideshow of 8 images repeated two times (for a total of 16 images) with either cues of direct or indirect male–male competition. Images were presented for 3 s each (for a total of 48 s of exposure) with instructions: "Please try and look at these images carefully." Image order was randomized. The post-exposure test followed and was identical to the pre-exposure test.

## 4. Results

For each participant, we calculated the proportion of masculine faces chosen out of the 10 pairs of male and female faces. This was done separately for the pre- and post-exposure tests, giving a score pre-exposure and a score post-exposure for each sex of face.

One-sample $t$-tests against chance (50%), ignoring condition, revealed that women did not significantly prefer masculine male faces in either the pre-exposure ($M$ = .500, SD = .26, $t(76)$ = 0.00, $p$ = 1.00) or post-exposure tests ($M$ = .543, SD = .29, $t(76)$ = 1.32, $p$ = .191). By contrast, women did significantly prefer feminine female faces in both the pre-exposure ($M$ = .269, SD = .22, $t(76)$ = 9.01, $p$<.001) and post-exposure tests ($M$ = .351, SD = .26, $t(76)$ = 5.01, $p$<.001).

To examine the change in preference between pre- and post-exposure tests, scores in the pre-exposure test were subtracted from scores in the post-exposure test (Little et al., 2011a). Positive scores then indicate that preferences for masculinity increased after exposure, whereas negative scores indicate preferences for masculinity decreased after exposure.

A mixed-model ANOVA was carried out with change in preference as the dependent variable, *sex of face* (male vs. female) as a within-participant factor, and *condition* (direct competition vs. indirect competition) as a between-participant factor. This analysis revealed a significant interaction between *sex of face* and *condition* ($F_{1,75}$ = 6.36, $p$ = .014, $\eta_p^2$ = .078), a significant main effect of *condition* ($F_{1,75}$ = 7.77, $p$ = .007, $\eta_p^2$ = .094), and no significant main effect of *sex of face* ($F_{1,75}$ = 1.89, $p$ = .173, $\eta_p^2$ = .173).

To parse the three-way interaction, we conducted separate $t$-tests for judgments of male and female faces. Independent-samples $t$-tests comparing preferences between direct- and indirect-competition conditions revealed a significant difference for male faces ($t_{75}$ = 3.95, $p$<.001) and no significant difference for female faces ($t_{75}$ = 0.46, $p$ = .650).

To examine whether the difference scores were significantly different from chance (i.e., 0), we split the data by condition and conducted one-sample $t$-tests. For the direct competition condition, women significantly increased their preferences for masculinity in both male faces ($t_{38}$ = 3.98, $p$<.001) and female faces ($t_{38}$ = 3.23, $p$ = .003). For the indirect-competition condition, these revealed a non-significant decrease in preferences for masculinity in male faces ($t_{37}$ = −1.48, $p$ = .146) and a close-to-significant increase in masculinity preferences for female faces ($t_{37}$ = 1.91, $p$ = .063).

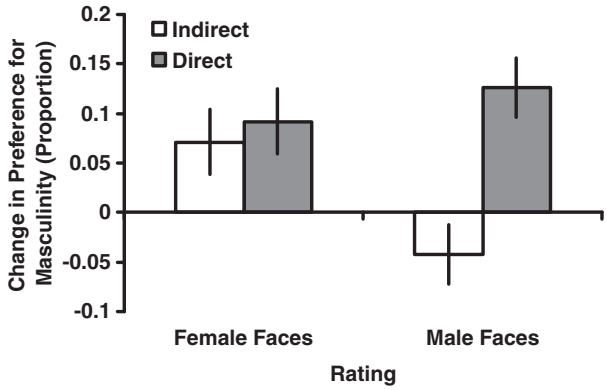


**Fig. 2.** Experiment 1A: change in preference ( ± 1 SEM) for masculinity in male and female faces after exposure to cues of male–male direct competition or indirect competition.

Together these analyses demonstrate that women's preferences for masculine male face traits are stronger after exposure to cues of direct combative male–male competition than after exposure to images with more indirect non-combative male–male competition. Furthermore, these changes in preferences were restricted to judgments of opposite-sex faces and did not occur for judgments of own-sex faces. For female faces, exposure increased women's preferences for masculinity in faces across both direct- and indirect-competition conditions. Mean proportion difference scores can be seen in Fig. 2.

## 5. Experiment 1B: weapons

Following Experiment 1A, we also examined whether exposure to cues of violence influenced women's preferences for male facial masculinity. Sporting competitions may not reflect dangerous male–male competition as they operate within strict rules. By using images of weapons versus peaceful scenes we readdressed how cues of potential violence in the environment influence women's preferences for male facial masculinity.

## 6. Methods

### 6.1. Participants

Participants were 51 women (aged 17 to 39 years, mean = 22.4, SD = 6.0). Participants were selected and recruited in the same way as Experiment 1A.

### 6.2. Stimuli

#### 6.2.1. Sexually dimorphic face shape

Images were the same as in Experiment 1A.

#### 6.2.2. Cues of violence

Images of weapons or of peaceful scenes were taken from the Internet using a Google search. Weapons were selected that represented violence (hand guns, shotguns, knives, knuckledusters) and peaceful scenes were landscapes (including trees, lakes, flowers). Images were selected for being of high quality and did not contain faces. Two images were selected for each weapon type. Stimuli were validated by asking a new group of 14 participants (9 women, 5 men,

mean age = 29.6 years, SD = 7.0) to: "Rate the image for how VIOLENT you think the imagery is." Images were presented individually and in a random order with a 7-point scale with 1 being low and 7 being high. Average scores were calculated for high- and low-violence images for each rater. A paired-sample *t*-test revealed that the weapon images were rated as significantly more violent than neutral images (high mean = 5.52, SD = 0.77, low mean = 1.45, SD = 0.28, $t_{13} = 18.82$, $p<.001$).

#### 6.2.3. Procedure

Participants were randomly allocated to the violent ($N = 25$) or peaceful ($N = 26$) versions of the experiment. The rest of the procedure was identical to Experiment 1A.

## 7. Results

For each participant, we calculated the proportion of masculine faces chosen out of the 10 pairs of male and female faces as in Experiment 1A.

One-sample *t*-tests against chance (50%), ignoring condition, revealed that women preferred masculine male faces in both the pre-exposure ($M = .568$, SD = .26, $t(50) = 1.87$, $p = .067$) and post-exposure tests ($M = .571$, SD = .26, $t(50) = 1.95$, $p = .057$), though these did not reach significance. Women significantly preferred feminine female faces in both the pre-exposure ($M = .306$, SD = .21, $t(50) = 6.63$, $p<.001$) and post-exposure tests ($M = .367$, SD = .25, $t(50) = 3.80$, $p<.001$).

To examine change in preference between pre- and post-exposure tests, scores in the pre-exposure test were subtracted from scores in the post-exposure test as in Experiment 1A.

A mixed-model ANOVA was carried out with change in preference as the dependent variable, *sex of face* (male vs. female) as a within-participant factor, and *condition* (violent vs. peaceful) as a between-participant factor. This analysis revealed a significant interaction between *sex of face* and *condition* ($F_{1,49} = 6.17$, $p = .016$, $\eta_p^2 = .112$), a close-to-significant main effect of *condition* ($F_{1,49} = 3.50$, $p = .067$, $\eta_p^2 = .067$), and no significant main effect of *sex of face* ($F_{1,49} = 2.13$, $p = .151$, $\eta_p^2 = .042$).

To parse the three-way interaction, we conducted separate *t*-tests for judgments of male and female faces. Independent-samples *t*-tests comparing preferences between direct- and indirect-competition conditions revealed a significant difference for male faces ($t_{49} = 3.03$, $p = .003$) and no significant difference for female faces ($t_{49} = 0.15$, $p = .881$).

To examine whether the difference scores were significantly different from chance (i.e., 0), we split the data by condition and conducted one-sample *t*-tests. For the direct competition condition, women significantly increased their preferences for masculinity in male faces ($t_{24} = 2.49$, $p = .020$) and but not for female faces ($t_{24} = 1.31$, $p = .204$). For the neutral condition, these revealed a close-to-significant decrease in preferences for masculinity in male faces ($t_{25} = -1.96$, $p = .061$) and a non-significant increase in masculinity preferences for female faces ($t_{25} = 1.45$, $p = .159$).

Together these analyses demonstrate that women's preferences for masculine male face traits are stronger after exposure to cues of violence than after exposure to peaceful images. Furthermore, these changes in preferences were restricted to judgments of opposite-sex faces and did not occur for judgments of own-sex faces. Mean proportion difference scores can be seen in Fig. 3.

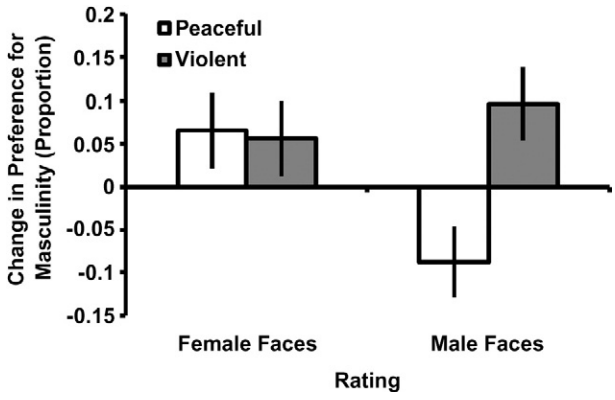


**Fig. 3.** Experiment 1B: change in preference (± 1 SEM) for masculinity in male and female faces after exposure to cues of violence or peaceful scenes.

## 8. Experiment 2: environmental and male wealth

Experiments 1A and 1B demonstrated a shift in preference for male facial masculinity following exposure to cues of male–male competition and violent images. In Experiment 2, we examined another possible correlate of masculinity preferences across cultures: wealth. We included exposure to cues of high and low environmental and male wealth but included a third condition in which mixed cues were presented. This mixed-wealth condition should cue participants to an environment in which extremes of wealth (high and low) are both present and may reflect conditions of high wealth inequality. Exposure to wealth cues could also drive adaptive shifts in preference as higher wealth may allow more freedom of choice for aspects of male quality while lower wealth may increase the importance of cues of investment. Additionally, cues of wealth inequality, the presence of both low- and high-wealth cues, may lead women to focus on competitive cues like masculinity because competitive men may be more likely to attain high wealth in such environments. Indeed, Brooks et al. (2011) find women's masculinity preferences are positively related to income inequality, a factor also positively related to homicide rates, a potential cue of male–male competition (Wilson & Daly, 1997). If absolute wealth is most important, we might expect the largest difference in preferences to be seen between high- and low-wealth conditions, with mixed wealth falling in between. If wealth inequality is more important than absolute wealth we might expect higher masculine preferences after exposure to mixed-wealth cues than either high- or low-wealth cues.

## 9. Methods

### 9.1. Participants

Participants were 171 women (aged 17 to 43 years, mean = 23.6, SD = 6.7). Participants were selected for being older than 16 and less than 46 years of age and reporting to be heterosexual. Participants were recruited in the same way as Experiment 1A.

### 9.2. Stimuli

#### 9.2.1. Sexually dimorphic shape

The same images as used in Experiment 1A were used.

#### 9.2.2. Cues of high/low environmental and male wealth

Images depicting cues of high and low environmental and male wealth were taken from the Internet using a Google search. Images were selected that represented cues to a wealthy environment (expensive food, high-end cars, male torsos in suits, and high-value male watches) and a less wealthy environment (cheap food, low-end cars, male torsos in t-shirts, and low-value male watches). Images were selected for being of high quality (i.e., high resolution) and not displaying faces. Two images were selected for each type and effectively formed high and low pairs. Stimuli were validated by asking the same group of 11 participants as in Experiment 1A (4 women, 7 men, mean age = 23.9 years, SD = 4.9) to: "Rate the image for how EXPENSIVE you think the item is." Images were presented individually and in a random order with a 7-point scale with 1 being

cheap and 7 being expensive. Average scores were calculated for high- and low-violence images for each rater. A paired-sample *t*-test revealed that low-violence images were rated as significantly more violent than low-violence images (high mean = 5.27, SD = 1.00, low mean = 2.90, SD = 0.84, $t_{10} = 7.91$, $p<.001$).

### 9.2.3. Procedure

Participants were randomly allocated to the high- ($N = 57$), mixed- ($N = 57$) or low-wealth ($N = 57$) versions of the experiment. The procedure was identical to experiment 1A except that wealth-related images were used for high- and low-wealth conditions, replacing the direct- and indirect-competition conditions. In this experiment we included an additional mixed-wealth condition in which both high- and low-wealth cues were presented. In this condition the eight high- and eight low-wealth images were presented once each for the same total presentation time. Participants saw a slideshow of high-wealth, low-wealth, or mixed-wealth images in the exposure phase.

## 10. Results

As in Experiment 1A, for each participant, we calculated the proportion of masculine faces out of the 10 pairs of male and female faces.

One-sample *t*-tests against chance (50%), ignoring condition, revealed that women significantly preferred masculine male faces in both the pre-exposure ($M = .547$, SD = .29, $t(170) = 2.16$, $p = .032$) and post-exposure tests ($M = .548$, SD = .28, $t(170) = 2.24$, $p = .026$). Women significantly preferred feminine female faces in both the pre-exposure ($M = .333$, SD = .22, $t(170) = 9.74$, $p<.001$) and post-exposure tests ($M = .371$, SD = .24, $t(170) = 6.91$, $p<.001$).

To examine the change in preference between pre- and post-exposure tests, scores in the pre-exposure test were subtracted from scores in the post-exposure test as in Experiment 1A.

A mixed-model ANOVA was carried out with change in preference as the dependent variable, ***sex of face*** (male vs. female) as a within-participant factor, and ***condition*** (high wealth vs. low wealth vs. mixed wealth) as a between-participant factor. This analysis revealed a significant interaction between ***sex of face*** and ***condition*** ($F_{2,168} = 9.98$, $p<.001$, $\eta_p^2 = .106$) a significant main effect of ***condition*** ($F_{2,168} = 8.40$, $p<.001$, $\eta_p^2 = .091$) and a close-to-significant main effect of ***sex of face*** ($F_{1,168} = 3.23$, $p = .074$, $\eta_p^2 = .019$).

Separate one-way ANOVAs for each sex of face revealed a significant effect of ***condition*** for male faces ($F_{2,168} = 17.01$, $p<.001$, $\eta_p^2 = .168$) but no significant effect of ***condition*** for female faces ($F_{2,168}<0.01$, $p = .996$, $\eta_p^2<.001$). For male faces, planned contrasts revealed that all conditions were significantly different from each other (all $p<.036$). For female faces, planned contrasts revealed that all conditions were not significantly different from each other (all $p>.925$).

To examine whether difference scores differed from chance (0), we split by condition and conducted one-sample *t*-tests. For the low-wealth condition, women significantly decreased their masculinity preferences for male faces ($t_{56} = -4.62$, $p<.001$) but not female faces ($t_{56} = 1.59$, $p = .117$). For the high-wealth condition, women significantly increased their masculinity preferences for male faces ($t_{56} = 3.49$, $p<.001$) but not female faces ($t_{56} = 1.25$, $p = .151$). For the mixed-wealth condition, women did not significantly change their masculinity preferences for either male faces ($t_{56} = 0.77$, $p = .443$) or female faces ($t_{56} = 1.38$, $p = .173$). Together, these analyses demonstrate that women's preferences for masculine male face traits are stronger after exposure to cues of high levels of environmental and male wealth than after exposure to images with lower or mixed levels of environmental and male wealth. Exposure to cues of mixed levels of wealth did not influence preferences, whereas exposure to cues of high wealth increased preferences for masculinity and low wealth decreased preferences for masculinity. Again, changes in preferences were restricted to judgments of opposite-sex faces and did not occur for judgments of own-sex faces. The pattern of results implicates absolute wealth over wealth inequality as the more important determinant of women's masculinity preferences. Mean proportion difference scores can be seen in Fig. 4.

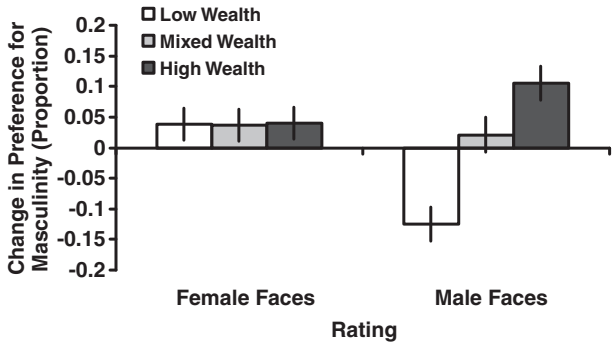


**Fig. 4.** Experiment 2: change in preference ( ± 1 SEM) for masculinity in male and female faces after exposure to cues of high, low, and mixed environmental and male wealth.

## 11. General discussion

Our data demonstrate that women moderate their preferences for sexually dimorphic facial cues according to their recent experience of visual environmental cues of direct male–male competition, violence, and wealth. Women preferred more masculine male faces after exposure to cues of direct male–male competition, violence or high wealth than after not being exposed to such cues. These data are in line with recent cross-cultural studies and previous experimental studies on preferences for masculinity. Previous studies have highlighted that pathogens are a cross-cultural variable that can account for variation in masculinity preferences (DeBruine, Jones, Crawford, Welling, & Little, 2011; DeBruine et al., 2011), and our data suggest that, alongside pathogens (Little et al., 2011), visual cues of direct male–male competition, violence, and wealth are also variables that can change preferences. In this way, no single factor may explain variation in masculinity preferences: pathogens, wealth, and male–male competition/violence can all contribute. These data highlight that the relative value of masculine men is tied to particular environments. For example, when pathogens are prevalent masculinity may be more important due to potential indirect or direct health benefits, when wealth is abundant direct paternal investment from feminine men may be less important, and when male–male violence is common, masculinity may be more important due to potential indirect strength or dominance benefits or direct benefits associated with successful intra-sexual competition. Such variation in preferences may reflect adaptive mechanisms that fine tune preferences according to the particular environment individuals find themselves in. We call these effects "environment contingent preferences." While we focused on facial masculinity, there is reason to expect that the effects here would generalize to other traits, such as masculinity in other domains (e.g. body shape or voice traits), other physical factors associated with health such as symmetry, behavioral traits such as aggression or generosity, or other factors such as own personal wealth.

While our experiments lack ecological validity, with only a short slideshow between preference tests, we found that minimal experience was required to influence preferences. Experience with similar visual cues in the real world may be more effective, given that such cues will be of greater salience, exposure will be for longer, and exposure is likely to be repeated over time. Demand characteristics may be present in some studies, with participants associating types of men with particular sports, for example. The abstract nature of the cues in Experiments 1B and 2 appear less likely to generate such

associations. Additionally, our online sample likely reflects a wider range of backgrounds than studies conducted within psychology departments and a sample potentially less prone to demand characteristics given less experience with such psychological testing. Effects of exposure were also only seen for judgments of opposite-sex faces and not same-sex faces indicating that effects appear salient for mate-choice decisions and not general aesthetic preferences. Specificity to opposite-sex faces also rules out low-level explanations for our effects.

We used visual cues that are likely to be associated with the relevant variables in modern Western samples. Focusing on Experiment 1A, there may, for example, be concerns about the relevance of using sporting competition. Success in sporting competitions, however, results in access to resources and/or mates in modern Western society. Sport, involving ritualized combat between men, is common cross-culturally, taking many forms such as Sumo in Japan and stick fighting in the Suri of Ethiopia, and has a long recorded history including fencing in the 16th century Germany and gladiatorial combat in Ancient Rome. It is clear that status and/or wealth could be gained in such competitions. This suggests that our cues are relevant in indicating competition between men and our conceptual replication using weaponry versus peaceful scenes additionally indicates that general cues of violence impact on women's preferences. For Experiment 2, the stimuli represented modern cues of wealth varying in expense. The stimuli are appropriate in cueing general aspects of wealth and associated advantages in modern Western society. While genuine resource scarcity, for example with risk of starvation, may have different effects, cues of low wealth may have equivalent effects to resource scarcity and future studies can examine this issue. In all three of our studies, images were used in which the meaning was perhaps specific to modern Western cultures. It is important to consider that these cues are unlikely to be innate and so are learnt over an individual's life. In this way, while specific visual cues may vary across culture and time, the effects observed here should be relevant to human ancestral populations and generalize across cultures when examining appropriate visual cues of wealth or violence.

The observed shifts may reflect adaptation to particular environments. In certain cultures or groups in which direct male–male competition is prevalent, status, or even survival, may be dependent on successful competition. In these conditions, it would be beneficial to women to select males demonstrating competitive ability, and physical strength is positively related to ratings of masculinity (Fink et al., 2007). Preferences for masculine men when exposed to stimuli indicating high levels of direct male–male competition or violence may then be adaptive. In terms of wealth, previous authors have noted that ecological harshness may favor a low mating effort/high parental investment strategy (Geary, Vigil, & Byrd-Craven, 2004; Mace, 2000), while others have noted a harsh environment may lead individuals to maximize their reproductive output by focusing on acquiring good genes for their offspring (Belsky, Steinberg, & Draper, 1991). Our data, combined with previous work, suggest that both arguments can be true and also suggest that mate preferences may be sensitive to the type of environmental harshness at play in terms of wealth versus pathogen prevalence. As noted in the introduction, cues of parasites and disease lead women to prefer cues of health in opposite-sex faces. Here, wealth may reflect variables associated with investment rather than health. When wealth is cued, women prefer more masculine faces, suggesting that perhaps under wealthy environmental conditions, issues of investment are not to the fore and women can focus on cues of different aspects of quality.

We additionally presented participants with cues of mixed wealth, showing high and low cues, to cue an environment in which there are discrepancies in wealth between males. Under such conditions we might expect male–male competition to be heightened. In fact, in our mixed-wealth condition, preferences for masculinity fell between preferences seen in the high- and low-wealth conditions, suggesting that exposure to high and low cues simply cancelled each other out. Perhaps this reflects that our condition was too artificial to properly cue a mixed-wealth environment. Alternatively, discrepancies in wealth between males may not directly affect face preferences in the way that cues of either high and low general environmental cues do.

We note that for preference shifts according to cues of wealth or competition/violence it is difficult to tease apart the role of indirect from direct benefits. This is because preferences for factors such as health or strength can relate to both. For example, preferring men who are healthy and strong can lead to the direct benefits of avoiding disease and men who can defend resources and also lead to the indirect benefits of passing genes for health and strength on to offspring. This reasoning also suggests that if women prefer traits in men that are associated with the ability to provide direct benefits then the ability to provide direct benefits and associated attractive traits may be passed to her offspring providing indirect benefits (Kokko, Brooks, Jennions, & Morley, 2003). It is then likely that both direct and indirect benefits from men play a role in generating variation in preferences for facial masculinity.

In conclusion, our experiments suggest that exposure to cues of direct male–male competition, violence, and wealth changes women's face preferences, increasing preferences for sex-typical, masculine male faces. These data complement findings from studies demonstrating individual and cross-cultural differences in mate preferences. Changing preferences according to visual cues could generate both variation between cultures and agreement within a culture. As individuals within a culture share similar visual experiences this can lead to within-cultural agreement. Visual experience will differ between cultures and can lead to cross-cultural variation while individual experience may account for some within-culture variability in preference. Overall, our data demonstrate that preferences can be strategically flexible according to recent visual experience and highlight sophisticated learning mechanisms involved in preferences specific to opposite-sex faces. Changing preferences seen here are consistent with the idea of environment contingent preferences in which humans monitor their current environment throughout their life and adjust their preferences in an adaptive fashion accordingly.

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