A sex difference in the context-sensitivity of dominance perceptions

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Abstract

Although dominance perceptions are thought to be important for effective social interaction, their primary function is unclear. One possibility is that they simply function to identify individuals who are capable of inflicting substantial physical harm, so that the perceiver can respond to them in ways that maximize their own physical safety. Another possibility is that they are more specialized, functioning primarily to facilitate effective direct (i.e., violent) intrasexual competition for mates, particularly among men. Here we used a priming paradigm to investigate these two possibilities. Facial cues of dominance were more salient to *women* after they had been primed with images of angry men, a manipulation known to activate particularly strong self-protection motivations, than after they had been primed with images of angry women or smiling individuals of either sex. By contrast, dominance cues were more salient to *men* after they had been primed with images of women than when they had been primed with images of men (regardless of the emotional expressions displayed), a manipulation previously shown to alter men's impressions of the sex ratio of the local population. Thus, men's dominance perceptions appear to be specialized for effective direct competition for mates, while women's dominance perceptions may function to maximize their physical safety more generally. Together, our results suggest that men's and women's dominance perceptions show different patterns of context-sensitivity and, potentially, shed new light on the routes through which violence and intrasexual competition have shaped dominance perceptions.

Introduction

Dominance perceptions are fundamental to human social interaction (e.g., Oosterhof & Todorov, 2008; Puts, 2010). However, although previous research suggests that people from different cultures (e.g., Keating et al., 1981; Perrett et al., 1998; Undurraga et al., 2010) and people of diverse ages (e.g., Keating & Bai, 1986) judge others' dominance in similar ways, the specific function of dominance perceptions is still poorly understood. Some researchers have suggested that dominance perceptions simply function to identify individuals who are capable of inflicting substantial physical harm, so that the perceiver can respond to them in ways that maximize their own physical safety (e.g., by avoiding them, Oosterhof & Todorov, 2008). Alternatively, dominance perceptions may be more specialized, functioning primarily to facilitate effective direct (i.e., violent) intrasexual competition for mates, particularly among men (Puts, 2010). Because distinguishing between these two proposals could provide important insight into the routes through which physical violence and intrasexual competition for mates have shaped the visuo-cognitive processes that support social interactions, the current research tested these two suggestions about the primary function of dominance perceptions.

Self-protection motivations are hypothesized to moderate aspects of social cognition and perception that have implications for survival (e.g., Kenrick et al., 2010). For example, people are particularly quick to classify angry expressions in face images, especially when the angry expressions are presented in the context of male faces (Becker et al., 2007). These findings

suggest that viewing images of angry faces, and of angry men in particular, activates self-protection motivations (Kenrick et al., 2010; see also Ackerman et al., 2006). If dominance perceptions function primarily to identify individuals capable of inflicting physical harm, as some researchers have suggested (e.g., Oosterhof & Todorov, 2008), then activating self-protection motivations should increase the salience of dominance cues. Thus, priming participants with angry male faces should increase the extent to which participants ascribe dominance to individuals displaying cues associated with physical dominance more than would priming participants with images of angry female faces or smiling faces of either sex. Additionally, this effect of priming participants with angry male, but not angry female, faces could be sex-specific in other ways. For example, activating self-protection motivations may have greater effects on the cognitions and perceptions of individuals who are less well equipped (or perceive themselves to be less well equipped) to defend themselves physically (e.g., Fox et al., 2001; Kenrick et al., 2010). Given sex differences in both physical strength and aggression (see, e.g., Archer, 2009; Sell et al., 2009), activating self-protection motivations may have a greater effect on women's perceptions of others' dominance than it will on men's perceptions of others' dominance.

While testing the effect of activating self-protection motivations on the salience of dominance cues would test for evidence that dominance perceptions simply function to identify individuals capable of inflicting physical harm, other types of primes could be used to test the proposal that dominance perceptions serve a more specialized purpose and function primarily to

minimize the potential costs of direct intrasexual competition for mates, particularly among men (see, e.g., Puts, 2010). Although competition among men tends to be increased in societies with a greater proportion of men than women (i.e., societies with male-biased sex ratios), this competition is generally indirect (i.e., non-violent) and focused on gaining access to economic resources (e.g., Barber, 2009; Del Giudice, 2012). Indeed, Griskevicius et al. (2012) recently showed that priming men with cues to a male-biased sex ratio increased the extent to which men were willing to sacrifice larger financial gains in the future for smaller, immediate gains (i.e., the extent to which they seek immediate access to economic resources). By contrast, in societies with female-biased sex ratios, relationship commitment tends to be relatively low and sexual promiscuity relatively common (Barber, 2000, 2009, 2011; Schmitt, 2005), which increases direct (i.e., violent) competition for mates among men, at least in modern societies (Barber, 2011; Del Giudice, 2012). Indeed, this may explain why rates of violent crime tend to be higher in countries with more female-biased sex ratios (Barber, 2000, 2009, 2011).

Several recent studies have shown that watching slideshows consisting primarily of either images of men or images of women alters behavioral responses, such as attractiveness judgments or financial decisions, in ways that suggest participants use their recent visual experience to gauge the sex ratio of the local population (Griskevicius et al., 2012; Watkins et al., 2012a). These findings demonstrate that priming paradigms can be used to explore the effects of cues to the sex ratio of the local population on aspects of social

behavior and perception (Griskevicius et al., 2012; Watkins et al., 2012a). Thus, if dominance perceptions primarily function to minimize the potential costs of direct competition for mates among men (e.g., Puts, 2010), cues of others' dominance may be more salient to men in environments with a female-biased sex ratio (i.e., after they have been primed with a slideshow of images of women's faces) than in environments with a male-biased sex ratio (i.e., after they have been primed with a slideshow of images of men's faces). This effect could be specific to judgments of men's dominance or could occur for judgments of others' dominance more generally. For example, while some aspects of men's facultative responses to facial cues of dominance appear to be specific to judgments of other men's dominance (Watkins et al., 2010a), other studies suggest that men are also sensitive to cues of dominance of women (e.g., Perrett et al., 1998; Sell et al., 2009).

While the prediction that cues of others' dominance will be more salient to men in environments with a female-biased sex ratio may initially seem to be somewhat at odds with Griskevicius et al's (2012) finding that priming men with cues to a male-biased sex ratio increased the extent to which men favored smaller, immediate gains over larger gains in the future, Griskevicius et al's (2012) finding presumably reflects the well-established correlation between male-biased sex ratios and indirect (i.e., non-violent) competition (Barber, 2009; Del Giudice, 2012). By contrast, our prediction that priming men with cues that there is a greater proportion of women than men in the local population will increase the extent to which dominance cues are salient is based on the reported positive correlations between female-biased sex

ratios and measures of the intensity of direct (i.e., violent) competition (Barber, 2000, 2009, 2011).

To test the predictions described above, we investigated the effects of priming with images of angry men, smiling men, angry women, or smiling women on men's and women's perceptions of others' dominance. So that we could assess the effects of these different types of primes on the *salience* of cues of physical dominance (i.e., the extent to which participants perceived physically dominant individuals to be more dominant than less physically dominant individuals, Watkins & Jones, 2012), we assessed participants' perceptions of the dominance of masculinized versus feminized versions of men's and women's faces. We chose this image manipulation (masculinized versus feminized) because many recent studies have demonstrated that masculine characteristics are positively correlated with measures of actual physical dominance, such as strength and aggression (e.g., Fink et al., 2007; Windhager et al., 2011; Puts et al., 2011), and because masculinized versions of faces are reliably perceived to be more dominant than feminized versions (Jones et al., 2010; Perrett et al., 1998; Watkins et al., 2010a).

Methods

Participants

One hundred women (mean age=20.95 years, SD=3.13 years) and 100 men (mean age=22.49 years, SD=3.58 years) completed the experiment online. Participants were recruited from links on social bookmarking websites, such as www.stumbleupon.com. Previous research on perceptions of facial

dominance has demonstrated that laboratory and online studies produce equivalent results (Senior et al., 1999a, 1999b; see also Watkins et al., 2010a, 2010b).

Face stimuli

The methods we used to manufacture stimuli to assess perceptions of the dominance of masculinized versus feminized versions of men's and women's faces have been used in many previous studies of dominance perceptions (e.g., DeBruine et al., 2006; Perrett et al., 1998; Watkins & Jones, 2012). Manipulating sexually dimorphic shape cues in face images using these methods has been shown to alter perceptions of men's and women's facial dominance in the predicted manner (e.g., DeBruine et al., 2006; Watkins et al., 2010a, 2012b). Moreover, responses to masculinity stimuli manufactured using these methods are very similar to responses to facial masculinity stimuli that were manufactured using other methods (e.g., DeBruine et al., 2006, 2010).

First, we manufactured a male prototype (i.e., average) face by using specialist software (Tiddeman et al., 2001) to average the shape, color, and texture information from images of 50 young white men's faces. A female prototype face was also manufactured in this way by averaging the shape, color, and texture information from images of 50 young white women's faces. The 100 individual face photographs (50 male and 50 female) were taken under standardized lighting conditions and against a constant background.

Individuals posed for these photographs with neutral expressions and direct gaze.

Next, we randomly selected 10 male and 10 female images from the set of 100 face images. We created a masculinized and a feminized version of each of the 10 individual male and 10 individual female images by adding or subtracting 50% of the linear (i.e., vector) differences in 2D shape between symmetrized versions of the male and female prototypes to (or from) each individual image. This process created 20 pairs of face images in total (10 male pairs and 10 female pairs), with each pair consisting of a masculinized and a feminized version of one of the individual face images. Examples of these stimuli are shown in Figure 1. Note that our masculinized and feminized versions of faces differed in sexually dimorphic shape characteristics only (i.e., were matched in other regards, such as identity, color, texture, Tiddeman et al., 2001).

INSERT FIGURE 1 AROUND HERE

Manipulation check

We conducted an initial pilot study to check that the masculinized and feminized versions of faces differed reliably in perceived masculinity. In this pilot study, the 20 pairs of face images (each pair consisting of a masculinized and feminized version of the same face) were presented to 52 women and 21 men (mean age=24.55 years, SD=8.73 years), who were instructed to indicate which face in each pair looked more masculine. Pairs of faces were

presented in a fully randomized order and the side of the screen on which a given image was shown was also randomized. One-sample t-tests were used to compare the proportion of trials on which participants correctly identified the masculinized face with what would be expected by chance alone (i.e., 0.5). These analyses confirmed that the masculinized versions of faces were perceived to be more masculine than feminized versions of faces when judging men's ($t(72)=23.13$, $p<.001$, $d=2.71$, $M=.90$, $SEM=.02$) and women's ($t(72)=24.72$, $p<.001$, $d=2.89$, $M=.91$, $SEM=.01$) masculinity. Corresponding by-items analyses, in which face pairs, rather than participants, served as the primary unit of analysis, showed the same pattern of results (men's faces: $t(9)=24.79$, $p<.001$, $d=7.77$, $M=.90$, $SEM=.02$; women's faces: $t(9)=32.11$, $p<.001$, $d=10.20$, $M=.91$, $SEM=.01$). These results are consistent with prior work showing that manipulating sexually dimorphic shape cues in face images using these methods alters perceptions of men's and women's facial masculinity (e.g., DeBruine et al., 2006; Welling et al., 2007, 2008).

A second pilot study was also conducted, in which 125 participants (64 women and 61 men, mean age=21.96 years, SD=3.08 years) were instructed to indicate which face in each pair looked more dominant, rather than masculine. By-subjects analyses confirmed that the masculinized versions of faces were perceived to be more dominant than feminized versions of faces when judging men's ($t(124)=17.93$, $p<.001$, $d=1.60$, $M=.81$, $SEM=.02$) and women's ($t(124)=3.69$, $p<.001$, $d=0.33$, $M=.60$, $SEM=.03$) dominance. Corresponding by-items analyses also showed this pattern of results (men's faces: $t(9)=17.21$, $p<.001$, $d=5.42$, $M=.81$, $SEM=.02$; women's faces:

t(9)=8.02, p<.001, d=2.50, M=.60, SEM=.01). These results are consistent with prior work showing that masculinizing shape cues in face images using these methods alters perceptions of men's and women's dominance (e.g., DeBruine et al., 2006; Jones et al., 2010; Perrett et al., 1998; Watkins et al., 2010a).

Procedure

The main experiment consisted of three parts; an initial pre-priming dominance perception test, a priming phase in which participants watched a slideshow of male or female face images displaying either angry or smiling expressions, and a post-priming dominance perception test.

In the pre-priming dominance perception test, each of the 200 participants were shown the 20 pairs of face images (10 male pairs and 10 female pairs, each pair consisting of a masculinized and feminized version of the same face) and were instructed to indicate which face in each pair looked more dominant. Trial order and the side of the screen on which any given image was presented were fully randomized. The purpose of this pre-priming test was to obtain a baseline estimate of participants' dominance perceptions, so that we could control for the possible effects of pre-existing individual differences in dominance judgments (e.g., Watkins et al., 2010b, 2012b).

Immediately after completing the pre-priming test, each participant watched a slideshow of images depicting either 30 angry male faces, 30 angry female faces, 30 smiling male faces, or 30 smiling female faces. These angry and

smiling faces were obtained from the Karolinska Directed Emotional Faces (KDEF) image set (Lundqvist & Litton, 1998). In the slideshows, each of the 30 faces shown was presented onscreen for 2 seconds (i.e., each slideshow lasted 60 seconds in total) and the order in which the images were presented was fully randomized. Following previous work that used similar slideshows to manipulate cues to the nature of the local population (e.g., Jones et al., 2007; Watkins et al., 2012a), participants were simply instructed to watch the images closely. The 100 women and 100 men who took part in the experiment were randomly allocated to one of the four slideshows. Previous work has successfully shown images of faces displaying emotional expressions to experimentally manipulate participants' motivations (e.g., Ackerman et al., 2006; Becker et al., 2007), while other work has successfully shown images of either male or female faces in order to experimentally manipulate cues to the sex ratio of the local population (Griskevicius et al., 2012; Watkins et al., 2012a).

Immediately after viewing the slideshow (i.e., immediately after completing the priming phase of the experiment), participants completed a post-priming dominance perception test that was identical to the pre-priming test.

Results

For each participant, we calculated the proportion of trials on which they chose masculinized faces as more dominant than feminized faces when judging men's faces in the pre-priming test, women's faces in the pre-priming

test, men's faces in the post-priming test, and women's faces in the post-priming test. These scores are summarized in Table 1.

INSERT TABLE 1 AROUND HERE

Consistent with prior work (e.g., Perrett et al., 1998; Watkins et al., 2010a), one-sample t-tests comparing the pre-priming test scores with what would be expected by chance alone (i.e., 0.5) showed that participants generally perceived masculinized faces to be more dominant than feminized faces at the start of the experiment when judging both men's faces ($t(199)=27.93$, $p<.001$, $d=1.98$, $M=.86$, $SEM=.01$) and women's faces ($t(199)=2.81$, $p=.005$, $d=0.20$, $M=.57$, $SEM=.02$). Also consistent with prior work (e.g., Watkins et al., 2010a), this effect of facial masculinity on dominance perceptions in the pre-priming tests was significantly greater for judgments of men's dominance than women's dominance ($t(199)=13.56$, $p<.001$, $d=0.96$). Repeating these analyses using Wilcoxon signed ranks tests in place of t-tests showed the same pattern of significant results.

Next, scores on the dominance perception test were analyzed using a mixed design ANOVA with the within-subjects factors *sex of face judged* (male, female) and *test phase* (pre-priming, post-priming) and the between-subjects factors *priming emotion* (angry, smiling), *priming sex* (male, female), and *participant sex* (male, female). This analysis revealed a significant main effect of *sex of face judged* ($F(1,192)=172.89$, $p<.001$, partial $eta^2=.47$), which reflected the general tendency to attribute dominance to masculinized faces

more often when judging men's faces (M=.86, SEM=.01) than when judging women's faces (M=.57, SEM=.02). There was also a significant three-way interaction among *test phase*, *priming sex*, and *participant sex* ($F(1,192)=6.89$, $p=.009$, partial $eta^2=.04$), which was qualified by the predicted significant four-way interaction among *test phase*, *priming emotion*, *priming sex*, and *participant sex* ($F(1,192)=5.79$, $p=.017$, partial $eta^2=.03$). No other effects were significant or approached significance (all $F<1.30$, all $p>.25$, all partial $eta^2<.01$), except for a five-way interaction among *test phase*, *sex of face judged*, *priming emotion*, *priming sex*, and *participant sex* that approached significance ($F(1,192)=3.91$, $p=.050$, partial $eta^2=.02$). Since we had no specific *a priori* prediction about the effects of *sex of face judged*, we did not explore the possible five-way interaction further in our main analyses. Indeed, Stevens (2007) recommends against exploring very high order interactions unless they were a strong *a priori* prediction. We note here, however, that repeating the ANOVAs we conducted to interpret the four-way interaction among *test phase*, *priming emotion*, *priming sex*, and *participant sex* with *sex of face judged* included as an additional within-subjects factor did not alter our findings or reveal any effects of (or interactions involving) *sex of face judged* (see additional analyses below). The five-way interaction reflected the priming effect that was observed for male participants tending to be greater for judgments of men's than women's faces (although not significantly so).

To interpret the significant four-way interaction among *test phase*, *priming emotion*, *priming sex*, and *participant sex* we conducted separate ANOVAs for

male and female participants with the within-subjects factor *test phase* (pre-priming, post-priming) and the between-subjects factors *priming emotion* (angry, smiling) and *priming sex* (male, female). Scores on the dominance perception tests were collapsed across the factor *sex of face judged* for these analyses.

The analysis for female participants revealed a significant three-way interaction among *test phase, priming emotion,* and *priming sex* ($F(1,96)=5.94$, $p=.017$, partial $eta^2=.06$, Figure 2) and no other significant effects (all $F<2.35$, all $p>.13$, all partial $eta^2<.025$). For women allocated to the angry priming emotion conditions, there was a significant interaction between the effects of *test phase* and *priming sex* ($F(1,48)=6.77$, $p=.012$, partial $eta^2=.12$); women who were primed with angry male images ($t(24)=2.30$, $p=.030$, $d=0.46$), but not those who were primed with angry female images ($t(24)=-1.68$, $p=.107$, $d=0.33$), significantly increased the proportion of trials on which they chose masculinized faces as more dominant between the pre-priming and post-priming tests. For women allocated to the smiling priming emotion conditions, there were no significant effects of *test phase* or *priming sex* and the interaction between these variables was not significant (all $F<0.50$, all $p>.48$, all partial $eta^2<.010$). Moreover, neither women who were primed with smiling male images ($t(24)=-0.41$, $p=.69$, $d=0.08$) nor women who were primed with smiling female images ($t(24)=0.59$, $p=.56$, $d=0.12$) significantly increased the proportion of trials on which they chose masculinized faces as more dominant between the pre-priming and post-priming tests. Together, these analyses show that the salience of facial cues

of dominance was increased in women primed with angry male faces, but not in women who were allocated to the other priming conditions. Repeating the initial ANOVA for female participants with *sex of face judged* included as an additional within-subjects factor did not alter the pattern of significant results or reveal any interactions involving *sex of face judged* (all $F<1.15$, all $p>.28$, all partial $eta^2<.013$). Repeating the paired-samples analyses using Wilcoxon signed ranks tests in place of t-tests showed the same pattern of significant results.

INSERT FIGURE 2 AROUND HERE

The analysis for male participants revealed a significant two-way interaction between *test phase* and *priming sex* ($F(1,96)=4.84$, $p=.030$, partial $eta^2=.05$, Figure 3) and no other significant effects (all $F<0.90$, all $p>.34$, all partial $eta^2<.010$). Men allocated to the female priming sex conditions tended to increase the proportion of trials on which they chose masculinized faces as the more dominant between the pre-priming and post-priming tests ($t(49)=1.53$, $p=.13$, $d=.22$), while men allocated to the male priming sex conditions tended to decrease the proportion of trials on which they chose masculinized faces as the more dominant between the pre-priming and post-priming tests ($t(49)=-1.66$, $p=.10$, $d=.24$). Wilcoxon signed ranks tests also showed this pattern of results. Note that, although neither of the individual changes between the pre-priming and post-priming tests was actually significant, these analyses of men's responses confirm that the effects of priming men with images of women's or men's faces were significantly

different from each other and occurred regardless of the emotional expressions displayed by the priming images. Repeating the initial ANOVA for male participants with *sex of face judged* included as an additional within-subjects factor did not alter the pattern of significant results or reveal any three- or four-way interactions involving *sex of face judged* (all $F<3.0$, all $p>.08$, all partial $eta^2<.03$).

INSERT FIGURE 3 AROUND HERE

Discussion

The proportion of trials on which *women* judged masculinized versions of faces to be more dominant than feminized versions was increased after viewing a slideshow of images of angry men, but not after viewing slideshows of angry women or smiling faces of either sex. Since previous work has shown that viewing images of angry men increases self-protection motivations (Ackerman et al., 2006; Becker et al., 2007), these findings support the proposal that dominance perceptions simply function to identify individuals who are capable of inflicting substantial physical harm so that the perceiver can respond to them in ways that maximize their own physical safety (Oosterhof & Todorov, 2008), at least in women.

By contrast with our findings for *women's* dominance perceptions, *men's* dominance perceptions were modulated by the sex of the faces they were exposed to during the priming phase, regardless of the emotional expression those faces displayed; the proportion of trials on which men chose

masculinized faces as more dominant tended to be increased after viewing images of women's faces, but tended to be decreased after viewing images of men's faces. Thus, although the changes in perception between the pre-priming and post-priming tests were not significant in either the male or female priming sex conditions ($p=.10$ and $p=.13$, respectively), these changes were significantly different from one another, demonstrating that *priming sex* had the predicted effect on men's dominance perceptions. More female biased-sex ratios are associated with increased direct (i.e., violent) competition for resources (Barber, 2011; Del Giudice, 2012), potentially because female biased-sex ratios are correlated with lower relationship commitment and greater sexual promiscuity (Barber, 2000, 2009, 2011; Schmitt, 2005). Furthermore, viewing female-biased or male-biased slideshows recalibrates behaviors and perceptions in ways that suggest recent visual experience recalibrates impressions of the sex-ratio of the local population (Griskevicius et al., 2012; Watkins et al., 2012a). Thus, the observed effect of *priming sex* on men's dominance perceptions supports the proposal that dominance perceptions in men are relatively specialized and function primarily to facilitate effective direct intrasexual competition for resources (Puts, 2010).

Griskevicius et al. (2012) recently reported that priming men with cues to a male-biased local population increased the extent to which they sacrificed long-term financial gains for smaller, immediate financial gains. Importantly, our results, which suggest that priming men with cues to a female-biased local population triggers changes in men's dominance perceptions that might

function to support effective violent competition for mates, are not incompatible with Griskevicius et al's (2012) findings; while our results appear to tap behaviors relating to direct (i.e., violent) competition for mates, Griskevicius et al's (2012) results appear to tap behaviors relating to more indirect, non-violent competition for economic resources. Indeed, when considered together, the differences between our and Griskevicius et al's (2012) findings complement the differences among correlational studies in which female-biased sex ratios were found to be positively correlated with violent crime rates, while male-biased sex ratios were found to be positively correlated with the intensity of indirect (i.e., non-violent) competition for access to financial resources among men (Barber, 2000, 2009, 2011).

That the effect of *priming sex* on men's dominance perceptions was not qualified by a higher order interaction involving *priming emotion* suggests that the priming effect observed for men in our experiment is not simply due to viewing images of women priming men's sexual motivation. Although previous studies have suggested that priming men's sexual motivation with images of women can influence their behavioral responses, these effects occur only when men are primed with images of attractive women and do not occur when men are primed with images of relatively unattractive women (e.g., Wilson & Daly, 2004). Since smiling has previously been shown to increase women's attractiveness and to elicit approach responses from men in courtship contexts (reviewed in Gueguen, 2008), the absence of an interaction between the effects of *priming sex* and *priming emotion* on men's dominance perceptions is difficult to explain in terms of increased sexual motivation.

Given the proposal that men's dominance perceptions may be somewhat specialized to facilitate effective direct (i.e., violent) intrasexual competition for mates (Puts, 2010), one might have expected the effect of cues to the sex ratio of the local population on men's dominance perceptions to occur for judgments of men's, but not women's, dominance. Similarly, if women's dominance perceptions are closely related to self-protection motivations, one might have expected the priming effect for female participants to be greater for judgments of men's than women's faces, given sex differences in physical strength and aggression (Archer, 2009; Sell et al., 2009). Although our data show that masculinization had a greater overall effect on judgments of men's dominance than on judgments of women's dominance (see also Watkins et al., 2010a), suggesting that physical dominance cues may generally be more salient in men's than women's faces, neither the effect of *priming sex* that was observed for male participants nor the interaction between *priming sex* and *priming emotion* that was observed for female participants were qualified by higher order interactions involving the sex of the faces judged in the dominance perception tests. These patterns of results may have occurred because changes in perceptions of women's dominance are a relatively low-cost, functionless byproduct of perceptual processes that evolved primarily to recalibrate perceptions of men's dominance in light of current environmental factors (i.e., there is little cost to changing dominance perceptions generally, rather than altering them for men's faces only). Alternatively, it is possible that the role of women's physical dominance in perceptions and behaviors related to both violent conflict and resource holding has been underestimated in

previous work. Consistent with the former proposal, facultative preferences for sexually dimorphic facial cues have been shown to occur for both own-sex and opposite-sex faces in circumstances where the change in perceptions of own-sex faces served no obvious function (e.g., Welling et al., 2007). Consistent with the latter proposal, however, Sell et al. (2009) have shown that participants can assess the physical strength and fighting ability of women from facial photographs somewhat accurately (albeit less accurately than they can make the corresponding judgments for male faces), demonstrating the existence of psychological adaptations for assessing women's physical dominance. Our current data do not distinguish between these two possibilities.

Although we used somewhat indirect methods for manipulating motivations relevant to self-protection and within-sex competition for mates, it is worth noting here that there is considerable evidence for the validity of these techniques. For example, previous studies have presented evidence that exposure to angry faces, and angry men in particular, triggers perceptual responses that might function to decrease risk of physical injury, particularly among those individuals who are least able to defend themselves physically (reviewed in Kenrick et al., 2010). A similar pattern of results is also evident in our own data, in which women showed increased dominance sensitivity after viewing images of angry men. There is also now evidence that experimentally manipulating cues to the sex ratio of the local population during priming phases of experiments triggers behaviors that are similar to those seen in correlational studies in which naturally occurring variation in sex

ratios predicted (i.e., was correlated with) variation in human behavior; experiments show that increasing cues that mates are abundant in the local population causes men to value financial resources more (Griskevicius et al., 2012) and women to become choosier in their mate preferences (Watkins et al., 2012). These patterns of results have also been observed in correlational studies in which naturally occurring variation in sex ratios was correlated with the extent to which men compete for financial resources (Barber, 2009; Del Giudice, 2012) and measures of women's choosiness in their mate choices (Pollet & Nettle, 2008). That the current study found that increasing cues that competitors for mates are abundant in the local population causes men to be more sensitive to cues of other men's dominance continues this theme of priming experiments and correlational studies showing similar patterns of results; correlational studies suggest that indices of violent competition for mates among men are greater in regions with more female-biased sex ratios (Barber, 2011; Del Giudice, 2012). Collectively, these results suggest that interpretations of our findings for women's and men's dominance perceptions that emphasize self-protection motivations and within-sex competition for mates, respectively, are justified. Indeed, while correlational studies suggest that sex ratio predicts non-violent competition for resources and violent competition for mates among men in different ways, our findings, together with those reported by Griskevicius et al. (2012) suggest that experimentally manipulating cues to the sex ratio of the local population may also have different effects on these two different types of competition among men. Exploring this possibility further may be a fruitful line of research.

We suggest that our findings are best explained by sex-specific responses to cues to probable conditions in the local population. However, recent visual experience with faces can also influence social judgments via perceptual aftereffects, whereby viewing faces that possess a specific characteristic decreases sensitivity to that characteristic in previously unseen faces (reviewed in Webster et al., 2011). However, we suggest that our findings are unlikely to reflect this type of perceptual aftereffect for three reasons. First, aftereffects induced by exposure to faces of a given sex or displaying a given emotional expression are typically equivalent in men and women (Webster et al., 2011). By contrast, our results for recent visual experience and dominance perceptions were different for male and female participants. Second, perceptual aftereffects do not generally transfer well from one sex of face to the other (e.g., Little et al., 2005) and, if they do, the size of the aftereffects is generally significantly smaller than when the faces shown in the exposure and test phases were the same sex (e.g., Jacquet & Rhodes, 2008). By contrast with this typical pattern for face aftereffects, the effect of viewing male or female faces on men's dominance perceptions in our experiment was unaffected by the sex of the faces judged in the test phases. Third, emotion aftereffects induced by viewing male or female faces are typically similar in magnitude (e.g., Bestelmeyer et al., 2010). By contrast, our findings for women's dominance perceptions suggest that viewing angry facial expressions in the context of male and female faces cause very different patterns of results. Together, these lines of reasoning mean that it is very difficult to explain our findings in terms of perceptual aftereffects alone. Nonetheless, we acknowledge that converging evidence for sex-specific

context-sensitivity in dominance judgments from studies using other types of priming techniques may well be needed to clarify the interpretation of our findings.

Most previous work on facultative responses to facial cues has investigated the effects of environmental factors on judgments of others' attractiveness (reviewed in, e.g., Little et al., 2011). By contrast with this emphasis on mate preferences, our findings add to a growing literature suggesting the existence of facultative perceptions of others' dominance (e.g., Burriss & Little, 2006; Watkins & Jones, 2012). However, while these previous studies focused on men's judgments of other men's dominance, here we show that women's perceptions of others' dominance can also be influenced by contextual factors. The facultative nature of dominance perceptions, and social judgments in general, may be important given that they tie up cognitive and perceptual resources, which are finite and should be allocated judiciously (Kenrick et al., 2010). Thus, modulating social judgments, such as dominance perceptions, according to the demands of one's own current circumstances (e.g., in light of cues that one's own safety may be at risk or that direct competition for resources is likely to be particularly intense) may help individuals to allocate their cognitive and perceptual resources efficiently. Additionally, heightened sensitivity to dominance cues in situations where violence is *un*common and there is *little* direct competition for resources may be counterproductive if it, for example, reduces the pool of potential co-operators and allies.

Here we show that the salience of facial cues of physical dominance is increased when *women* are primed with images of angry men, but not images of angry women or smiling individuals of either sex. This result suggests that activating self-protection motivations increases the salience of cues of others' dominance, supporting the proposal that dominance perceptions primarily function to identify individuals who are able to inflict physical harm so that the perceiver can respond in ways that maximize their own safety (Oosterhoff & Todorov, 2008), in women at least. We also show that the salience of facial cues of physical dominance is greater when *men* are primed with images of women than when they are primed with images of men, regardless of the emotional expressions displayed on these priming images. This result suggests that cues to the sex ratio of the local population biases men's dominance perceptions, supporting the proposal that dominance perceptions in men are relatively specialized for effective direct intrasexual competition for resources (Puts, 2010). Together, these sex-specific priming effects provide new insights into the routes through which physical violence and intrasexual competition for resources may have shaped the visuo-cognitive processes that support social interactions by revealing a sex difference in the effects of cues to the local environment on perceptions of others' dominance. While men's dominance perceptions appear to be primarily sensitive to factors relating to direct intrasexual competition, women's dominance perceptions appear to function primarily to protect themselves from physical harm more generally.

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776

777 **Table 1.** Mean proportion of trials (+/- SEM) for each combination of
778 participant sex (male, female), sex of face judged (male, female), test phase
779 (pre-priming, post-priming), priming emotion (angry, smiling), and priming sex
780 (male, female).
781

participant sex	priming condition	pre-priming and male faces	pre-priming and female faces	post-priming and male faces	post-priming and female faces
male	angry men	.86 (.03)	.58 (.06)	.79 (.04)	.56 (.07)
male	angry women	.87 (.04)	.52 (.07)	.85 (.04)	.60 (.07)
male	smiling men	.87 (.03)	.56 (.07)	.80 (.04)	.57 (.07)
male	smiling women	.86 (.03)	.63 (.06)	.88 (.03)	.62 (.07)
female	angry men	.88 (.03)	.55 (.07)	.94 (.02)	.59 (.08)
female	angry women	.84 (.04)	.58 (.07)	.81 (.05)	.50 (.08)
female	smiling men	.87 (.05)	.58 (.07)	.88 (.04)	.56 (.08)
female	smiling women	.84 (.05)	.55 (.07)	.84 (.05)	.58 (.08)

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784

785 **Figure 1.**

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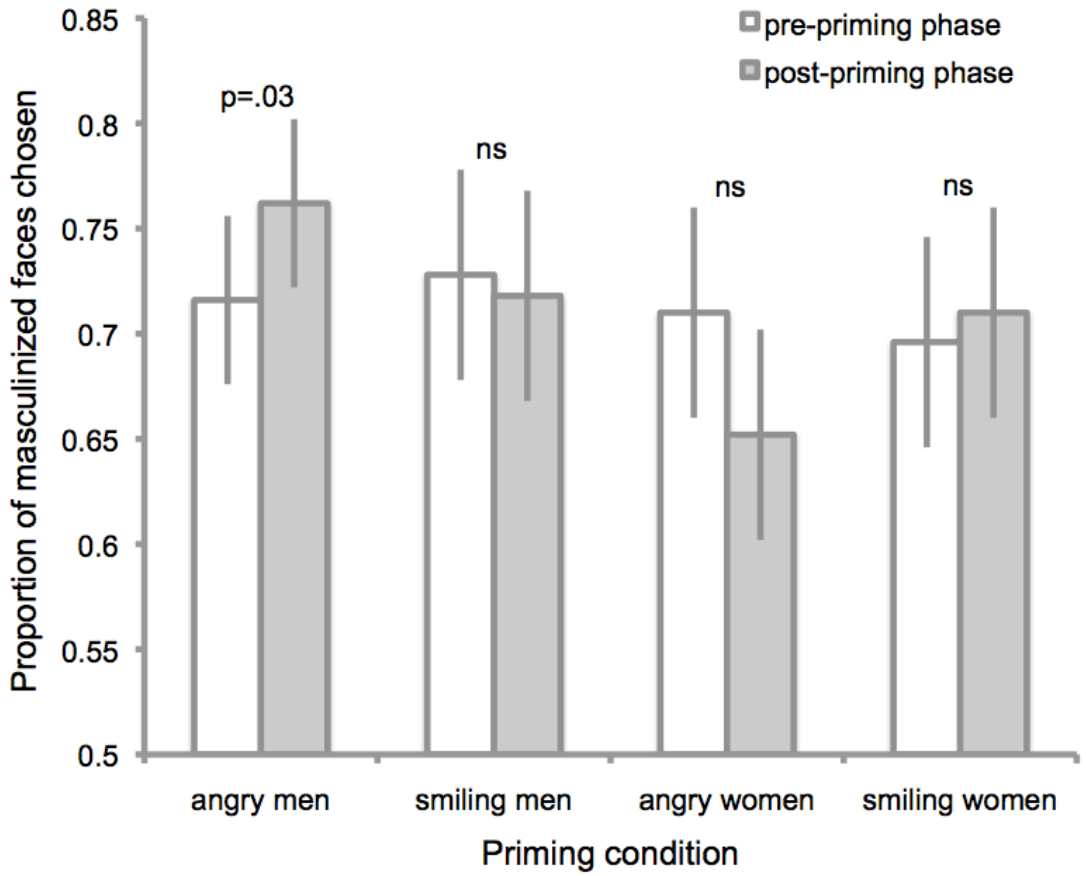
788 **Figure 1.** Examples of face stimuli used to assess dominance perceptions.

789 Masculinized versions of face images are shown in the left column and

790 feminized versions in the right column.

791

792 **Figure 2.**



793

794

795 **Figure 2.** The significant three-way interaction among *test phase, priming*
796 *emotion,* and *priming sex* that was observed for female participants. Women
797 who were primed with angry male images, but not women primed with angry
798 female images or smiling images of either sex, significantly increased the
799 proportion of masculinized faces chosen as more dominant between the pre-
800 priming and post-priming tests (p values indicate the results of paired samples
801 t-tests).

802

Figure 3.

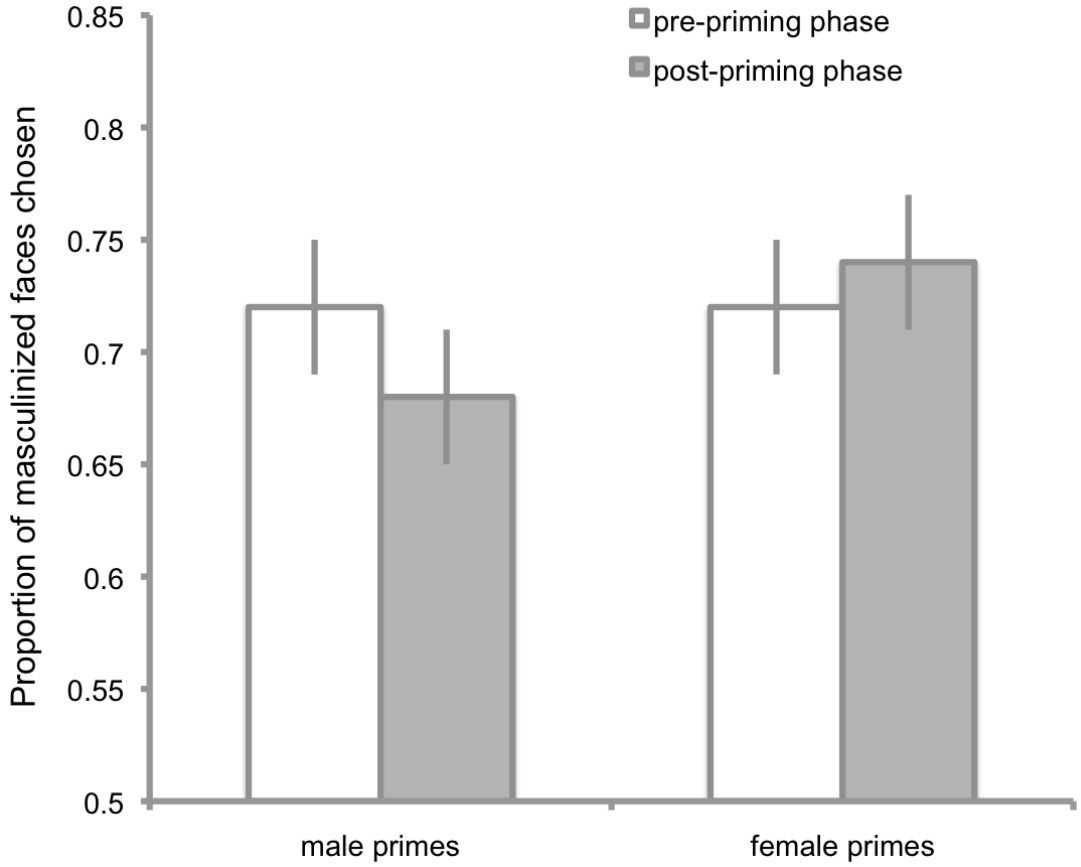


Figure 3. The significant two-way interaction between *test phase* and *priming sex* that was observed for male participants. Men who were primed with male images tended to decrease the proportion of masculinized faces they chose as more dominant between the pre-priming and post-priming phases (p=.10) and men who were primed with female images tended to increase the proportion of masculinized faces they chose as more dominant between the pre-priming and post-priming phases (p=.13).