

# Priming concerns about pathogen threat versus resource scarcity: dissociable effects on women's perceptions of men's attractiveness and dominance

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**Abstract** Previous experimental work suggests flexibility in women's mate preferences that appears to reflect the advantages of choosing healthy mates under conditions of pathogen threat and of choosing prosocial mates under conditions of resource scarcity. Following this work, we used an established priming paradigm to examine the effects of priming women's concerns about pathogen threat versus resource scarcity on their judgments of men's facial attractiveness and dominance. We found that women reported stronger attraction to masculine men when their concerns about pathogens were activated than when their concerns about resource scarcity were activated. In

contrast, we found that women were more likely to ascribe high dominance to masculine men when their concerns about resource scarcity were activated than when their concerns about pathogens were activated. This latter result may reflect the greater importance of identifying men who pose a substantial threat to women's resources and personal safety when resources are scarce and violence towards women is particularly common. Together, these findings suggest a double dissociation between the effects of pathogen threat and resource scarcity on women's perceptions of the attractiveness and dominance of masculine men, potentially revealing considerably greater specialization (i.e., context specificity) in the effects of environmental threats on women's perceptions of men than was apparent in previous research.

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## Introduction

In many nonhuman species, masculine physical characteristics in males are positively correlated with a wide range of traits that are important for sexual selection (see, e.g., Emlen 2008; Santos et al. 2011 for reviews), including dominance rank (e.g., Pelletier and Festa-Bianchet 2006; Marty et al. 2009), fighting ability (e.g., Bergeron et al. 2010), physical strength (e.g., Malo et al. 2009), and reproductive fitness (e.g., Preston et al. 2003). In human males, masculine physical characteristics are also correlated with a similarly wide range of traits. For example, masculine physical characteristics in men are positively correlated with measures of their reproductive potential (Puts 2005; Rhodes et al. 2005), reproductive success in a natural fertility population (Apicella et al. 2007),

strength of preference for uncommitted sexual relationships (Rhodes et al. 2005; Boothroyd et al. 2008, 2011), partner's sexual satisfaction (Puts et al. 2012a), and the likelihood of being unfaithful to a romantic partner (e.g., Hughes and Gallup 2003). Moreover, research on women's perceptions of masculine men suggests that women are, to some extent, aware of masculine men's unwillingness to commit to their romantic partners (e.g., O'Connor et al. 2011) and tendency to infidelity (e.g., O'Connor et al. 2012). Masculine physical characteristics in men are also positively correlated with several indices of good health, such as those derived from analyses of medical records (Rhodes et al. 2003), self-reported frequency and duration of respiratory diseases (Thornhill and Gangestad 2006), and urinary biomarkers of low oxidative stress (Gangestad et al. 2010). These findings linking masculinity to measures of men's health are consistent with recent work reporting a positive correlation between salivary testosterone and men's antibody response to a hepatitis B vaccine, which is an index of their immune function (Rantala et al. 2012). In addition to measures of health, masculine physical characteristics in men are positively correlated with indices of their dominance, such as measures of physical strength (Fink et al. 2007) and aggressiveness (Puts et al. 2012b). Indeed, masculine men are generally perceived to be more dominant than feminine men (see Puts 2010 for a review) and masculine physical characteristics are negatively correlated with men's willingness to distribute resources equally within groups (Price et al. 2011). Collectively, these findings suggest that masculinity may be a valid cue to aspects of men's mate quality, dominance, and personality.

A large body of research has focused on the trade-offs between the potential costs to women who choose masculine mates (e.g., low commitment and investment) and the possible benefits of these choices (e.g., healthy offspring). This research has generally proposed that factors altering how women resolve this trade-off may lead to variation in women's preferences for masculine men (for reviews, see Gangestad and Simpson 2000; Little et al. 2011a). For example, all other things being equal, women may prioritize the health-related advantages associated with choosing a masculine mate in environments that are characterized by high pathogen loads (Little et al. 2011b; Tybur and Gangestad 2011) but prioritize the prosocial-related advantages associated with choosing a relatively feminine mate in environments characterized by scarcity of resources (Little et al. 2007). Consistent with this proposal, a recent priming experiment demonstrated that women whose concerns about pathogens had been recently activated by completing a questionnaire about their vulnerability to disease subsequently demonstrated stronger preferences for masculine characteristics in potential mates than did women whose concerns about resource scarcity had been activated by completing a questionnaire about their financial worries (Lee and Zietsch

2011). This effect is consistent with other work suggesting that priming women with pictorial cues of potential sources of pathogens increases their preference for masculine men (Little et al. 2011b), although Park et al. (2012) recently found that priming women's concerns about pathogens did not alter their judgments of either attractive or unattractive men's faces. Lee and Zietsch's (2011) finding is also consistent with work demonstrating that having women imagine themselves in environments in which resources are scarce tends to increase their preferences for feminine men (Little et al. 2007). Correlational studies linking concerns about pathogens (Welling et al. 2007a; DeBruine et al. 2010a, 2010b, 2011a; Feinberg et al. 2012; Park et al. 2012) and resources (Moore et al. 2006; Moore and Cassidy 2007) to individual and regional differences in women's mate preferences also appear to implicate pathogen threat and resource scarcity in women's masculinity preferences.

While the findings described above suggest that women's preferences for masculine men are greater when their concerns about pathogens are activated than when their concerns about resource scarcity are activated, one would not necessarily expect this pattern of results to extend to other potentially important social judgments of masculine men. For example, dominance perceptions, which are thought to function to minimize the possible costs of aggressive conflict and reflect perceptions of men's resource holding potential (reviewed in Puts 2010), may respond very differently to these environmental factors. The costs of losing resources will be particularly great under conditions of resource scarcity. Moreover, dominant men are both particularly well placed to take others' resources (Sell et al. 2009a, 2009b) and less likely to share resources equally with others (Stirrat and Perrett 2010; Price et al. 2011). Consequently, women's need to discriminate between dominant, aggressive men and less dominant, more cooperative men may be greatest under conditions that increase competition for resources. This line of reasoning leads to the prediction that the likelihood of women ascribing high dominance to masculine men (i.e., what has previously been termed "dominance sensitivity," Watkins and Jones 2012) will be greater when women's concerns about resource scarcity are activated than when their concerns about other types of threat, such as pathogens, are activated. Indeed, some recent work suggests that men's perceptions of the dominance of masculine men are modulated by competition-related factors in ways that are consistent with precisely the type of compensatory response to increased vulnerability and/or increased costs of loss of resources (e.g., Watkins and Jones 2012). Given that violence towards women tends to be more common in environments where resources are scarce (Jewkes 2002), increased sensitivity to cues of men's dominance under conditions of resource scarcity might also be important as a means of identifying men who pose particularly serious threats to women's personal safety.

In the current work, we used a priming paradigm to directly compare the effects of activating women's concerns about pathogens and resource scarcity on their judgments of the attractiveness and dominance of masculine versus feminine men. While we expected preferences for masculine men to be greater after we activated women's concerns about pathogens than after we had activated women's concerns about resource scarcity (see, e.g., Lee and Zietsch 2011), we also anticipated that women would be more likely to ascribe dominance to masculine men after we activated their concerns about resource scarcity than after we activated their concerns about pathogens. In other words, we tested explicitly for a possible double dissociation (Shallice 1988) between the effects of different environmental threats on women's perceptions of the attractiveness and dominance of masculine men. Evidence for this double dissociation would be noteworthy given that it would demonstrate considerably greater specialization in the effects of environmental factors on women's responses to masculine men than has previously been demonstrated and would, therefore, evince complex (i.e., context specific) adaptive design in the cognitive architecture underpinning women's perceptions of masculine men. Previous research has highlighted the importance of investigating the context specificity of potentially adaptive social judgments since context-specific facultative responses to cues are difficult to explain as functionless by-products of general perceptual processes (e.g., Johnston et al. 2001; Little and Jones 2003; DeBruine et al. 2011b; Feinberg et al. 2012).

## Methods

### Participants

Ninety heterosexual women (mean age=21.6 years; SD=5.05 years) completed this online experiment. Participants were recruited from links on social bookmarking websites, such as stumbleupon. Previous research on individual differences in responses to masculinized versus feminized faces has demonstrated that laboratory and online studies produce equivalent results (e.g., Jones et al. 2007; Welling et al. 2008a). Responses from duplicate IP addresses were not recorded.

### Face stimuli

Following previous studies of perceptions of masculinized versus feminized faces (e.g., DeBruine et al. 2006, 2010a; Jones et al. 2010; Watkins et al. 2010a, 2010b), we used prototype-based image transformations to objectively and systematically manipulate sexually dimorphic aspects of 2D shape in digital face images. Following these studies, 50 % of the linear differences in 2D shape between symmetrized versions

of a male and a female prototype were added to or subtracted from digital face images of ten young White adult men (see Tiddeman et al. 2001 for technical details). The resultant masculinized and feminized versions of the individual face images differ in sexually dimorphic aspects of 2D shape but are matched in other regards (e.g., identity, symmetry, skin color, and texture, Rowland and Perrett 1995). Examples of masculinized and feminized face images are shown in Fig. 1. This process created ten pairs of male face images in total, each pair consisting of a masculinized and a feminized version of the same individual. Previous studies have demonstrated that this method for manipulating masculinity of 2D face shape affects perceptions of facial masculinity in the predicted manner (e.g., DeBruine et al. 2006, 2010a; Welling et al. 2007b, 2008b; Jones et al. 2010).

### Procedure

Following Lee and Zietsch (2011), we used an independent samples design to test the effects of priming women's concerns about environmental threats on their perceptions of men (see also, e.g., Little et al. 2007). The experiment consisted of two parts: an initial priming phase and a face perception test.

In the initial priming phase of the experiment, participants were randomly assigned to complete one of two questionnaires designed to prime concerns about a specific type of environmental threat (resource scarcity or pathogens). The questionnaires were matched so that each contained 15 statements to which participants rated their agreement on a 7-point scale (1=strongly disagree and 7=strongly agree) and have been used by Lee and Zietsch (2011) to prime pathogen and resource threat in their recent work on women's mate preferences. Duncan et al.'s (2009) Perceived Vulnerability to Disease Questionnaire was used to prime pathogen threat and included items such as "In general, I am very susceptible to colds, flu and other infectious diseases." Lee and Zietsch's (2011) Financial Concerns Questionnaire was used to prime resource scarcity and included items such as "I worry about the rising cost of food."

Immediately after the initial priming phase of the experiment, participants completed a face perception test in which they were shown the ten pairs of faces (each pair consisting of a masculinized and feminized version of a male face image) and were instructed to indicate either which face in each pair they thought was the more attractive or which face in each pair they thought looked more dominant. The order in which the pairs of face images were shown was fully randomized, as was the side of the screen on which the masculinized and feminized versions were presented. This method for assessing perceptions of the attractiveness or dominance of masculinized versus feminized versions of men's faces has been used in many previous studies (e.g., DeBruine et al. 2006, 2010a, 2010b; Little et al. 2011b; Watkins and Jones 2012) and masculinity

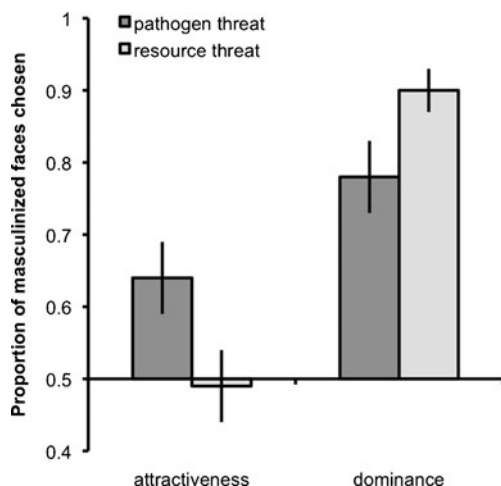
**Fig. 1** Examples of masculinized (*left*) and feminized (*right*) versions of men's faces used in our experiments



preferences assessed using this method have previously been shown to predict women's actual partner choices (DeBruine et al. 2006; Burriss et al. 2011). Participants were randomly allocated to either the attractiveness judgment condition or dominance judgment condition.

#### Statistical analyses

For each woman, we calculated the proportion of trials on which she chose the masculinized face in the face perception test. These scores are summarized in Fig. 2 and were initially analyzed using a univariate ANOVA in which *judgment type* (attractiveness, dominance) and *priming condition* (resource threat and pathogen threat) were included as between-subjects factors.



**Fig. 2** The significant interaction between judgment type and priming condition (see text for details). Bars show means and SEM

Next, we used independent samples *t* tests to interpret the interaction between *judgment type* and *priming condition*.

Finally, we used one-sample *t* tests comparing scores with the chance value of 0.5 to test whether or not women chose masculinized versions of men's faces significantly more often than feminized versions in each condition.

#### Results

There was an effect of *judgment type* ( $F(1, 86)=35.25$ ;  $p<0.001$ ; and partial  $\eta^2=0.29$ ), whereby women generally selected masculine faces more often when judging men's dominance than when judging men's attractiveness (Fig. 2). However, this main effect was qualified by the significant interaction between *judgment type* and *priming condition* ( $F(1, 86)=9.19$ ;  $p=0.003$ ; and partial  $\eta^2=0.10$ ) (Fig. 2). The main effect of *priming condition* was not significant ( $F(1, 86)=0.09$ ;  $p=0.77$ ; and partial  $\eta^2<0.01$ ). Repeating this analysis with an additional between-subjects factor (*questionnaire score*; whether or not the participant scored above or below the median score on the questionnaire they completed in the priming phase of the experiment) showed the same pattern of significant results; the interaction between judgment type and priming condition was significant ( $F(1, 82)=8.90$ ;  $p=0.004$ ; and partial  $\eta^2=0.10$ ) and was not qualified by a three-way interaction among judgment type, priming condition, and questionnaire score ( $F(1, 82)=0.20$ ;  $p=0.66$ ; and partial  $\eta^2=0.002$ ). This latter (null) result indicates that the priming effects observed in our analyses were not moderated by women's responses on the questionnaires.

Women chose the masculinized faces as the more *attractive* significantly more often in the pathogen threat condition than in the resource threat condition ( $t(44)=2.20$ ;  $p=0.0331$

and  $d=0.65$ ), but chose masculinized men as the more *dominant* significantly more often in the resource threat condition than in the pathogen threat condition ( $t(42)=2.10$ ;  $p=0.042$ ; and  $d=0.64$ ). These results indicate the predicted double dissociation between the effects of priming women's concerns about pathogens and resource scarcity on their perceptions of the attractiveness and dominance of masculine men.

Additional independent samples  $t$  tests showed that women were significantly more likely to choose masculinized faces when judging men's dominance than when judging men's attractiveness in the resource scarcity conditions ( $t(40)=7.21$ ;  $p<0.001$ ; and  $d=2.22$ ). Although women also tended to be more likely to choose masculinized faces when judging men's dominance than when judging men's attractiveness in the pathogen threat conditions, this difference was not significant ( $t(46)=1.91$ ;  $p=0.062$ ; and  $d=0.55$ ). Note that the interaction in our initial analysis indicated that the difference between dominance and attractiveness judgments in the resource scarcity condition was significantly greater than it was in the pathogen threat condition (Fig. 2). These results indicate that the extent to which masculinizing men's faces increases women's perceptions of men's dominance more than attractiveness is sensitive to current environmental threats.

Women judged masculinized versions of men's faces to be more attractive than feminized versions in the pathogen threat condition ( $t(24)=3.02$ ;  $p=0.006$ ; and  $d=0.60$ ) but not in the resource threat condition ( $t(20)=-0.19$ ;  $p=0.85$ ; and  $d=0.04$ ). One-sample  $t$  tests also showed that women generally perceived masculinized versions of men's faces to be more dominant than feminized versions in both the resource threat ( $t(20)=14.91$ ;  $p<0.001$ ; and  $d=3.25$ ) and pathogen threat ( $t(22)=5.37$ ;  $p<0.001$ ; and  $d=1.12$ ) conditions.

## Discussion

Women randomly allocated to the pathogen threat priming condition showed stronger preferences for masculinized versions of men's faces than did women randomly allocated to the resource scarcity priming condition. Additionally, women in the pathogen threat priming condition chose masculinized faces as the more attractive significantly more often than they chose feminized faces, but this was not true of women in the resource scarcity priming condition. These findings are consistent with other recent work in which women whose concerns about pathogens were activated reported stronger attraction to masculine men than did women whose concerns about resource scarcity were activated (Lee and Zietsch 2011). Our findings are also consistent with other priming experiments suggesting that pathogen threat and resource scarcity influence women's preferences for masculinity in men's faces (Little et al. 2007, 2011b) and

correlational studies in which these factors predicted variation in women's mate preferences (Moore et al. 2006; Moore and Cassidy 2007; Welling et al. 2007a; DeBruine et al. 2010a, 2010b, 2011a; Feinberg et al. 2012; Park et al. 2012). Thus, our findings for environmental threat and women's preferences for masculine men are consistent with the proposal that trade-offs in the costs and benefits of choosing masculine mates cause women to prefer relatively masculine men when pathogens are prevalent and prefer relatively feminine men when resources are scarce (reviewed in Little et al. 2011a).

Women perceived masculinized versions of men's faces to be more dominant than feminized versions in both the resource scarcity and pathogen priming conditions. However, we also found that the likelihood of women ascribing high dominance to masculine men (i.e., their dominance sensitivity, Watkins and Jones 2012) was modulated by the priming condition that they were randomly allocated to. As we had predicted, women in the resource scarcity priming condition were more likely to ascribe high dominance to masculine men than were women in the pathogen threat priming condition. This effect of activating concerns about resource scarcity versus concerns about pathogens on women's dominance sensitivity may reflect the greater importance of identifying dominant men under conditions where resources are scarce and violence towards women is more common (Jewkes 2002). Indeed, our findings for environmental threats and dominance perception complement other recent work suggesting that men's perceptions of other men's dominance are also modulated by factors that alter the costs of incorrectly judging other men's dominance (e.g., the outcome of recent intrasexual conflict, Watkins and Jones 2012). A different, but not necessarily mutually exclusive explanation, for the priming effect observed on dominance perceptions is that activating women's concerns about resources increases their tendency to associate male dominance with cues of physical strength (rather than, say, social status), rather than increasing the salience of dominance cues, per se. While our current data do not distinguish between these two explanations, experiments in which women's perceptions of men's social and physical dominance were assessed in separate blocks of trials would, potentially, allow these two explanations to be tested. Despite this limitation of the current work, we note that our experiment is the first to show that activating women's concerns about environmental threats can modulate their perceptions of masculine versus feminine men's dominance, complementing other recent experiments that have demonstrated that activating women's concerns about environmental threats can modulate their perceptions of the attractiveness of masculine versus feminine men (Little et al. 2007, 2011b; Lee and Zietsch 2011). Moreover, the size of the priming effects for attractiveness ( $d=0.65$ ) and dominance ( $d=0.64$ ) judgments were

virtually identical, suggesting that concerns about environmental threats may influence attractiveness and dominance judgments to similar extents.

Together, our findings of stronger preferences for masculine men when concerns about pathogens were activated and greater likelihood of ascribing high dominance to masculine men when concerns about resources were activated presents evidence for a double dissociation between the effects of environmental threats on women's perceptions of men's attractiveness and dominance. This double dissociation is noteworthy since it reveals a higher degree of specialization in the effects that concerns about environmental threats have on women's social judgments of men's faces than was apparent in previous work. Demonstrating this type of context-specific effect on women's facultative responses to men's facial characteristics is potentially important for our understanding of adaptive design in face processing abilities since context-specific facultative responses to facial cues are particularly difficult to explain as functionless by-products of general perceptual processes, such as changes in the ability to detect simple physical properties of the stimulus (e.g., Johnston et al. 2001; Little and Jones 2003; DeBruine et al. 2011b). Indeed, the context-specific effects that we observed here complement Little et al. (2011b) who recently found that priming women's concerns about pathogens modulated their preferences for sexually dimorphic characteristics in men's but not women's faces. Thus, our findings add to a growing literature suggesting that evolutionary pressures relating to mate choice and aggressive conflict have shaped the cognitive architecture that underpins women's perceptions of men's faces.

The main effect of judgment type in our experiment replicates a well-established effect, whereby masculine characteristics appear to have a greater overall effect on women's perceptions of men's dominance than they do on women's perceptions of men's attractiveness (reviewed in Puts 2010). This pattern of results suggests that masculine characteristics in men are more closely associated with perceptions of dominance than attractiveness and is consistent with the proposal that masculine characteristics function primarily to advertise information about men's ability to compete for resources with other men (Puts 2010; Scott et al. 2012). However, this pattern of results is also consistent with trade off theories of women's masculinity preferences, which propose that the costs of choosing masculine mates, such as those associated with the antisocial personality traits that they possess, can detract considerably from the appeal of masculine men as romantic partners (e.g., Little et al. 2011a). Indeed, Puts (2010) acknowledged that systematic variation in women's masculinity preferences will lead to variability in the extent to which masculine characteristics in men are more closely associated with perceptions of dominance than attractiveness. The interaction between judgment

type (attractiveness versus dominance) and priming condition (pathogen threat versus resource scarcity) in our experiment presents the first direct empirical evidence that this is indeed the case; the extent to which masculine facial cues had a greater effect on women's perceptions of men's dominance than attractiveness varied according to the priming condition women had been randomly allocated to. Indeed, the effect size for the difference between the effect of masculinity on dominance and attractiveness judgments was over four times greater in the resource scarcity priming condition ( $d=2.22$ ) than in the pathogen threat priming condition ( $d=0.55$ ). Notably, while Puts (2010) suggested that variability in the extent to which masculine characteristics in men are more closely associated with perceptions of dominance than attractiveness would be driven by changes in women's masculinity preferences, here we show that changes in women's perceptions of masculine men's dominance according to recent concerns about environmental threats can also contribute to this variability. Thus, while our findings present further evidence that masculine characteristics have greater overall effects on perceptions of men's dominance than attractiveness, they also show that environmental factors can modulate the extent to which this is the case. Given this flexibility in the extent to which masculinity is, on average, associated more strongly with women's judgments of men's dominance than attractiveness, the theoretical importance of the difference in the size of the effects of masculinity on dominance and attractiveness judgments should, perhaps, be treated with some caution. Nonetheless, we acknowledge here that our experiment compares women's preferences for masculine versus feminine men with women's, rather than men's, perceptions of the dominance of masculine versus feminine men. We also acknowledge that, although the magnitude of the difference varies between conditions, our data do show greater effects of masculinity on perceptions of men's dominance in both priming conditions. Although the priming effects in the current experiment were moderate, the effect sizes elicited by this 'minimal manipulation' suggest that the corresponding effect in the real world could well be substantial (see Prentice and Miller 1992 for discussion).

In summary, we found that (1) women's masculinity preferences were stronger after we had activated their concerns about pathogens than after we had activated their concerns about resource scarcity and (2) women were more likely to ascribe high dominance to masculine men after we had activated their concerns about resource scarcity than after we had activated their concerns about pathogens. These facultative responses to concerns about environmental threats are consistent with trade off theories of women's mate preferences (e.g., Little et al. 2011a) and the proposal that dominance sensitivity increases under conditions where there is a greater likelihood of aggressive conflict occurring

and/or the costs of losing resources are likely to be particularly pronounced (Watkins and Jones 2012). Importantly, our results suggest a double dissociation between the effects of environmental threats on women's judgments of men's attractiveness and dominance, potentially revealing considerably greater specialization in the effects of concerns about environmental threats on women's perceptions of men's qualities than has previously been demonstrated. Indeed, the context-specific effects of environmental threats observed in our priming experiment cannot straightforwardly be explained as a simple, functionless byproduct of the perceptual system and, thus, suggest adaptive design in women's face processing abilities. The ability to rapidly recalibrate potentially critical social perceptions, such as dominance and attractiveness judgments, in response to the specific nature of the environmental threats encountered may have been particularly important for ancestral women, since female dispersal was particularly common (Seielstad et al. 1998) and may have required women to recalibrate their preferences and behaviors according to these new conditions, groups, and environments in order to maximize their reproductive fitness.

### Ethical standards

These experiments comply with the current laws of the country in which they were performed.

**Conflict of interest** The authors declare that they have no conflict of interest.

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