



Variation in perceptions of physical dominance and trustworthiness predicts individual differences in the effect of relationship context on women's preferences for masculine pitch in men's voices

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Several studies have found that women tend to demonstrate stronger preferences for masculine men as short-term partners than as long-term partners, though there is considerable variation among women in the magnitude of this effect. One possible source of this variation is individual differences in the extent to which women perceive masculine men to possess antisocial traits that are less costly in short-term relationships than in long-term relationships. Consistent with this proposal, here we show that the extent to which women report stronger preferences for men with low (i.e., masculine) voice pitch as short-term partners than as long-term partners is associated with the extent to which they attribute physical dominance and low trustworthiness to these masculine voices. Thus, our findings suggest that variation in the extent to which women attribute negative personality characteristics to masculine men predicts individual differences in the magnitude of the effect of relationship context on women's masculinity preferences, highlighting the importance of perceived personality attributions for individual differences in women's judgments of men's vocal attractiveness and, potentially, their mate preferences.

Masculine characteristics in men are thought to be associated with good health, but are also associated with antisocial behaviours and traits (Feinberg, 2008; Fink & Penton-Voak, 2002; Gangestad & Simpson, 2000; Jones *et al.*, 2008; Little, Jones, Penton-Voak, Burt, & Perrett, 2002). Consistent with this proposal, recent research has

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found that masculine men (e.g., men with masculine facial characteristics) are less prone to illness than are men with relatively feminine characteristics (Rhodes, Chan, Zebrowitz, & Simmons, 2003; Thornhill & Gangestad, 2006). Moreover, in a natural fertility population (i.e., the Hadza, Tanzania), voice pitch was negatively correlated with men's reproductive success (Apicella, Feinberg, & Marlowe, 2007). Similar findings have also been reported for indices of men's reproductive potential in samples of undergraduate men (Hughes, Dispenza, & Gallup, 2004; Puts, 2005). Although masculine characteristics are positively associated with men's health (Rhodes *et al.*, 2003; Thornhill & Gangestad, 2006), masculine characteristics are also associated with antisocial traits and behaviours that are not desirable in a long-term partner (Feinberg, 2008; Fink & Penton-Voak, 2002; Gangestad & Simpson, 2000; Jones *et al.*, 2008; Little *et al.*, 2002). For example, masculine men are more interested in short-term relationships, and less interested in long-term relationships, than relatively feminine men are (Boothroyd, Jones, Burt, DeBruine, & Perrett, 2008; Rhodes, Simmons, & Peters, 2005). Additionally, masculine male faces are ascribed more antisocial traits (e.g., dishonesty, physical dominance, bad parent) than relatively feminine male faces are (Boothroyd, Jones, Burt, & Perrett, 2007; Perrett *et al.*, 1998). Men with high levels of testosterone are also less likely to invest resources in their partners and offspring than are men with relatively low levels of testosterone (Gray, Kahlenberg, Barrett, Lipson, & Ellison, 2002).

In light of the findings described above, many researchers (Feinberg, 2008; Fink & Penton-Voak, 2002; Gangestad & Simpson, 2000; Jones *et al.*, 2008; Little *et al.*, 2002) have suggested that women's preferences for masculine versus feminine men may reflect how women resolve the trade off between the possible benefits associated with choosing a masculine partner (e.g., increased offspring health) and the possible costs (e.g., low commitment and investment). Since both the potential costs of choosing a masculine partner and the potential benefits of choosing a feminine partner will be considerably more pronounced in a long-term relationship than in a short-term relationship, researchers have suggested that the temporal context of the relationship sought (short- vs. long-term) may affect the extent to which women prefer masculine over feminine men, potentially helping women to maximize the benefits of the mate choices (Feinberg, 2008; Fink & Penton-Voak, 2002; Gangestad & Simpson, 2000; Jones *et al.*, 2008; Little *et al.*, 2002). Consistent with this proposal, several studies have reported that women tended to demonstrate stronger preferences for men with masculine voices (Puts, 2005) or faces (Little *et al.*, 2002; Penton-Voak *et al.*, 2003) when they assessed men's attractiveness as short-term partners than when they assessed men's attractiveness as long-term partners. However, these studies also revealed considerable variation among women in the extent to which relationship context affected masculinity preferences. For example, although Puts (2005) observed a significant overall effect of relationship context on women's masculinity preferences, this effect was qualified by a higher-order interaction between relationship context and fertility status, whereby women in the fertile phase of their menstrual cycle demonstrated a pronounced effect of relationship context on their preference for masculine versus feminine male voices but women tested during the non-fertile phase of their menstrual cycle did not. Similarly, Little *et al.* (2002) found that women who were not using hormonal contraceptives demonstrated stronger preferences for masculinity when judging the attractiveness of men's faces as potential short-term partners than as long-term partners, but observed no equivalent effect of relationship context in a sample of women using hormonal contraceptives. Finally, although Penton-Voak *et al.* (2003) observed a significant overall effect of relationship

context on women's masculinity preferences, this effect was qualified by an interaction between relationship context and women's own attractiveness, whereby relatively unattractive women demonstrated stronger preferences for masculine men as short-term partners than as long-term partners but attractive women did not. Indeed, in this latter study, the overall effect of relationship context was only marginally significant in analyses that did not include women's own attractiveness as a factor. Collectively, these findings highlight considerable variation in the extent to which the temporal context of the relationship sought modulates women's preferences for masculine men.

Individual differences in the magnitude of the effect of relationship context described may reflect, at least in part, variation among women in the extent to which they attribute more prosocial traits (e.g., trustworthiness) to feminine men than to masculine men and the extent to which they attribute more antisocial traits (e.g., physical dominance) to masculine men than to feminine men (Smith *et al.*, 2009). Indeed, Smith *et al.* (2009) recently demonstrated that variation among women in the extent to which they attributed trustworthiness to feminine men predicted individual differences in the effect of relationship context on women's preferences for masculine characteristics in men's faces, finding that women who perceived feminine men to be particularly trustworthy showed a greater effect of relationship context on masculinity preferences than did women who made weaker attributions of trustworthiness to feminine men. While this finding demonstrates the importance of variation in attributions of prosocial personality characteristics to feminine versus masculine men for individual differences in women's face preferences, there is no corresponding evidence for women's preferences for masculine characteristics in men's voices. Investigating the role of variation in the extent to which women attribute prosocial and antisocial personality characteristics to feminine and masculine male voices, respectively, is potentially important, however, since such research may both shed light on the psychological processes that contribute to individual differences in women's voice preferences and present novel converging evidence that variation in personality attributions is an important factor in individual differences in women's mate preferences.

In light of the above, we investigated whether individual differences in women's perceptions of the trustworthiness and physical dominance of masculine versus feminine male voices predict individual differences in the magnitude of the effect of relationship context on women's preferences for masculine versus feminine men. We predicted that women who demonstrate a particularly strong tendency to ascribe antisocial personality characteristics (e.g., physical dominance, untrustworthiness) to masculinized men's voices would show a greater effect of relationship context than women who demonstrate a relatively weak tendency to ascribe antisocial personality characteristics to masculinized men's voices. Such results would suggest that the extent to which women attribute antisocial personality characteristics to masculine men's voices predicts individual differences in the magnitude of the effect of relationship context on women's preferences for masculine men. We investigated the possible effects of individual differences in women's perceptions of men's trustworthiness and dominance in light of recent research demonstrating that these traits are particularly important for social perception (Oosterhof & Todorov, 2008).

Because Smith *et al.* (2009) found that variation in the extent to which women attributed trustworthiness to feminine men predicted individual differences in the effect of relationship context on women's preferences for masculine characteristics in men's faces in a sample of women who were not using hormonal contraceptives, but observed no equivalent relationship in a sample of women who were currently using hormonal

contraceptives, we also investigated whether hormonal contraceptive use affects the nature of the relationship between variation in perceptions of dominance and trustworthiness and individual differences in the effect of relationship context on women's preferences for masculine versus feminine voices. Since the effects of hormonal contraceptive use on women's perceptions of masculine male faces appear to be stronger than the corresponding effects on women's perceptions of masculine male voices (see Feinberg, DeBruine, Jones, & Little, 2008), hormonal contraceptive use may not necessarily affect the relationship between variation in attributions of personality traits to masculine voices and individual differences in women's voice preferences to the extent that it did in Smith *et al.*'s (2009) study of face preferences.

Methods

Stimuli

First, we recorded six men speaking the vowel sounds 'eh' as in bet, 'ee' as in see, 'ah' as in father, 'oh' as in note, and 'oo' as in boot. All individuals that were recorded were young white adult undergraduate students at the University of St Andrews. Recordings were made using an Audio-Techica AT4041 microphone in a quiet room using Soundforge recording software, in mono, and at a sampling rate of 44.1 kHz with 16-bit amplitude quantization. Next, we manufactured two versions of each voice recording: a version with lowered voice pitch (i.e., a masculinized version) and a version with raised voice pitch (i.e., a feminized version).

Voices were raised and lowered in pitch using the pitch-synchronous overlap add algorithm in Praat (Boersma & Weenink, 2007) to ± 0.5 equivalent rectangular bandwidths (ERBs) of the original frequency. The PSOLA method has been used successfully in other voice attractiveness studies (Feinberg *et al.*, 2006, 2008; Puts, 2005; Vukovic *et al.*, 2008). While the PSOLA method alters voice pitch, other aspects of the voice are perceptually unaffected (Feinberg *et al.*, 2008; Feinberg, Jones, Little, Burt, & Perrett, 2005). The manipulation performed here is roughly equivalent to ± 20 Hz in this particular sample, but takes into account the fact that pitch perception is on a log-linear scale in comparison to the natural frequencies (i.e., Hz, Traunmuller, 1990). The ERB scale was used here because of its better resolution at human average speaking frequencies than the tonotopic Bark, semitone, or Mel scales (Traunmuller, 1990). A manipulation roughly equivalent to 20 Hz was used because it has been shown to be sufficient to alter women's attractiveness ratings of men's voices in prior studies (Feinberg *et al.*, 2005, 2006; Vukovic *et al.*, 2008). After manipulation, amplitudes were scaled to a constant presentation volume.

This process created six pairs of male voices in total (each pair consisting of raised- and lowered-pitch versions of the same original recording). The raised-pitch versions of the voices had a mean pitch of 4.21 ERBs ($SD = 0.6$ ERBs; $M = 149.6$ Hz, $SD = 23.9$ Hz). The lowered-pitch versions of the voices had a mean pitch of 3.33 ERBs ($SD = 0.5$ ERBs; $M = 114.6$ Hz, $SD = 25.3$ Hz).

Procedure

Seventy women took part in this study (Mean age = 19.40 years, $SD = 1.35$ years). All of these women were undergraduate students at the University of Aberdeen who participated in the study in return for course credit.

Women were played the six pairs of voices in a randomized order and were asked to choose which voice in each pair was the more attractive for a short-term relationship. The order in which masculinized and feminized voices in each pair were played was fully randomized. In addition to choosing the more attractive voice in each pair, participants were also instructed to indicate the strength of this preference by choosing from the options 'much more attractive', 'more attractive', 'somewhat more attractive', and 'slightly more attractive'. This method for assessing women's preferences for masculinized versus feminized stimuli has been used in many previous studies of voice (e.g., Feinberg *et al.*, 2008; Vukovic *et al.*, 2008) and face (e.g., Buckingham *et al.*, 2006; Jones *et al.*, 2007; Welling *et al.*, 2007; Welling, Jones, & DeBruine, 2008) preferences.

In three other blocks of trials, women repeated the voice perception test described above, but judged the attractiveness of the voices for a long-term relationship, judged the physical dominance of the voices, or judged the voices' trustworthiness. The order in which participants completed the four blocks of trials (short-term attractiveness, long-term attractiveness, dominance, and trustworthiness) was fully randomized among participants.

Following previous studies of the effect of relationship context on women's mate preferences (e.g., Conway, Jones, DeBruine, & Little, 2010; DeBruine, 2005; Little, Cohen, Jones, & Belsky, 2007; Little & Mannion, 2006; Penton-Voak *et al.*, 2003), long- and short-term relationships were defined as follows:

Short-term relationship. You are looking for the type of person who would be attractive in a short-term relationship. This implies that the relationship may not last a long time. Examples of this type of relationship would include a single date accepted on the spur of the moment, an affair within a long-term relationship, and possibility of a one-night stand.

Long-term relationship. You are looking for the type of person who would be attractive in a long-term relationship. Examples of this type of relationship would include someone you may want to move in with, someone you may consider leaving a current partner to be with, and someone you may, at some point, wish to marry (or enter into a relationship on similar grounds as marriage).

Participants also reported whether or not they were using any form of hormonal contraceptive. Of the participants, 42 reported that they were using a form of hormonal contraceptive. The remaining 28 participants reported that they were not using any form of hormonal contraceptive.

Initial processing of data

Following previous studies of women's perceptions of men's voices (Feinberg *et al.*, 2008; Vukovic *et al.*, 2008), responses on the voice perception tests were coded using these scales:

- 0 = feminine voice judged much more attractive/dominant/trustworthy than masculine voice,
- 1 = feminine voice judged more attractive/dominant/trustworthy than masculine voice,
- 2 = feminine voice judged somewhat more attractive/dominant/trustworthy than masculine voice,

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3 = feminine voice judged slightly more attractive/dominant/trustworthy than masculine voice,

4 = masculine voice judged slightly more attractive/dominant/trustworthy than feminine voice,

5 = masculine voice judged somewhat more attractive/dominant/trustworthy than feminine voice,

6 = masculine voice judged more attractive/dominant/trustworthy than feminine voice,

7 = masculine voice judged much more attractive/dominant/trustworthy than feminine voice.

For each woman, we calculated their average score for judgments of men's attractiveness as short-term partners. Corresponding values were also calculated for judgments of men's attractiveness as long-term partners, perceptions of men's physical dominance, and perceptions of men's trustworthiness. For each of these four variables (attractiveness as short-term partner, attractiveness as long-term partner, physical dominance, trustworthiness), high scores indicated that women perceived masculine men as attractive, dominant, or trustworthy.

Results

First, we used one sample *t* tests to compare the scores for women's perceptions of men's voices with what would be expected by chance alone (i.e., 3.5). Women's preferences for masculine men as short-term partners and as long-term partners were significantly greater than chance (short-term context: $t(69) = 8.74, p < .001, M = 4.34, SEM = 0.10$; long-term context: $t(69) = 8.61, p < .001, M = 4.25, SEM = 0.09$). Women perceived masculine men as more physically dominant than feminine men ($t(69) = 16.35, p < .001, M = 4.90, SEM = 0.09$), but did not perceive masculine men as more trustworthy than feminine men ($t(69) = 1.38, p = .173, M = 3.65, SEM = 0.11$). Although women tended to show a slightly stronger masculinity preference in the short-term than long-term relationship context condition, this difference was not significant ($t(69) = 0.92, p = .36$).

Next, we analysed these scores using ANCOVA [within-subjects factor: *relationship context* (short-, long-term); between-subjects factor: hormonal contraceptive use (yes, no); covariates: *dominance score, trustworthiness score*]. As we predicted, there was a significant interaction between *relationship context* and *trustworthiness score* ($F(1, 64) = 4.55, p = .037$) and a significant interaction between *relationship context* and *dominance score* ($F(1, 64) = 4.83, p = .032$). There was also a significant main effect of *dominance score* ($F(1, 64) = 11.95, p < .001$). There were no other significant effects (all $F < 1.65$, all $p > .21$).

To interpret the significant interactions between *relationship context* and *trustworthiness score* and between *relationship context* and *dominance score*, we first calculated a score for each woman indicating the extent to which she preferred masculine men more as short-term partners than as long-term partners (i.e., we subtracted each woman's preference for masculinity in the long-term condition from her preference for masculinity in the short-term condition). This score is referred to hereon as the *relationship context difference score* (higher numbers indicate a greater tendency to prefer masculine men more as short-term partners than as long-term partners). Next, we conducted a regression analysis with *relationship context difference score* as the dependent variable and *dominance score* and *trustworthiness*

score as predictors ($F(2,67) = 4.62, p = .013$). There was a significant positive relationship between *relationship context difference score* and *dominance score* ($t = 2.09$, standardized $\beta = 0.24, p = .041$) and a significant negative relationship between *relationship context difference score* and *trustworthiness score* ($t = -2.12$, standardized $\beta = -0.24, p = .038$). Figure 1 illustrates these relationships. Repeating this regression analysis with *hormonal contraceptive use* included as an additional predictor did not alter our findings.

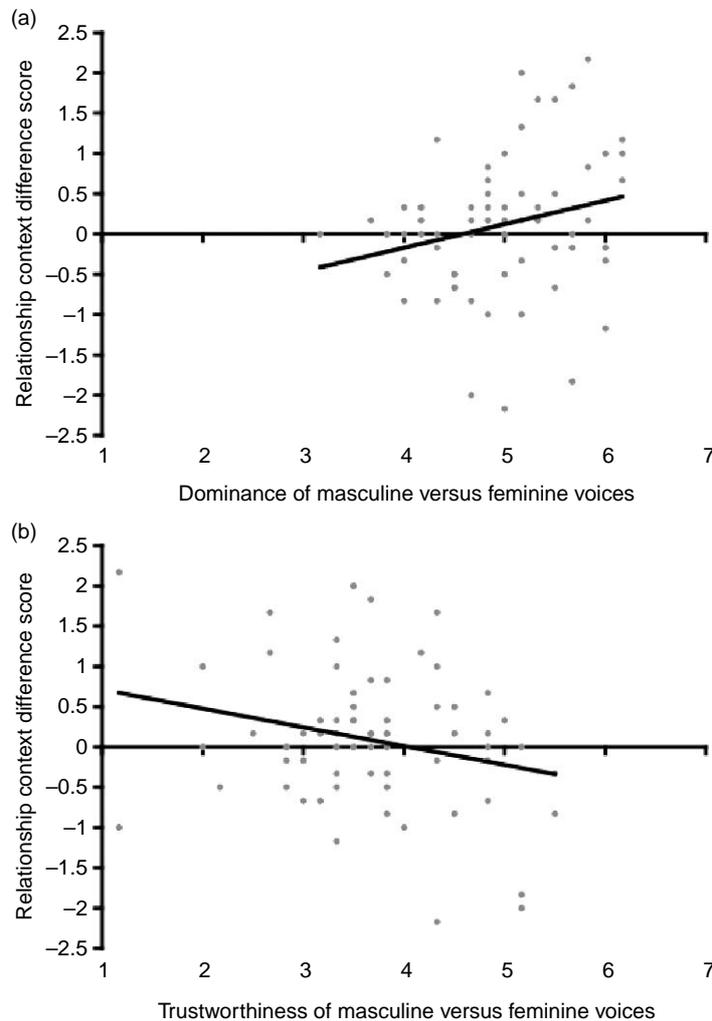


Figure 1. (a) The positive relationship between *relationship context difference score* and *dominance score* and (b) the negative relationship between *relationship context difference score* and *trustworthiness score*. These relationships show that individual differences in women's perceptions of the dominance and trustworthiness of masculine versus feminine men's voices predict individual differences in the effect of relationship context on women's preferences for masculine men. Higher numbers on the y-axis indicate a stronger tendency to perceive masculinized voices as more attractive for short-term than long-term relationships. Higher numbers on the x-axis indicate a stronger tendency to perceive masculinized voices as particularly dominant (panel a) or untrustworthy (panel b).

Discussion

Consistent with previous studies, women demonstrated strong preferences for men's voices with masculinized (i.e., lowered) pitch over those with feminized (i.e., raised) pitch (e.g., Feinberg *et al.*, 2005; Vukovic *et al.*, 2008). Although our analyses did not reveal a significant main (i.e., overall) effect of relationship context, further analyses supported our prediction that variation in women's perceptions of the trustworthiness and dominance of masculine versus feminine men's voices would predict individual differences in the magnitude of the effect of relationship context on women's masculinity preferences.

Our analyses indicated that, while masculine voices were generally perceived to be more physically dominant than feminine voices (see also Feinberg *et al.*, 2006; Puts, Gaulin, & Verdonili, 2006; Puts, Hodges, Cárdenas, & Gaulin, 2007), women who showed a particularly strong tendency to perceive masculine voices as more dominant than feminine voices demonstrated a greater increase in preferences for masculine men as short-term partners (relative to their preference for masculine men as long-term partners) than did women who showed a weaker tendency to perceive masculine voices as more dominant than feminine voices. Although we did not find an overall bias in women's perceptions of the trustworthiness of masculine versus feminine voices, our analyses indicated that women who showed a particularly strong tendency to perceive feminine voices as more trustworthy than masculine voices demonstrated a greater increase in preferences for masculine men as short-term partners (relative to their preference for masculine men as long-term partners) than did women who showed a relatively weaker tendency to perceive feminine voices as more trustworthy than masculine voices or who perceived masculine male voices to be more trustworthy than feminine voices. Additionally, the regression analysis indicated that these effects of perceptions of the dominance and trustworthiness of masculine men were independent. Collectively, these findings support the proposal that individual differences in the extent to which women demonstrate stronger preferences for masculine men as short-term partners than as long-term partners at least partly reflect variation in the extent to which women ascribe antisocial traits to masculine men (Smith *et al.*, 2009). Consistent with trade-off explanations of the effect of relationship context on women's preferences for masculine men (Feinberg, 2008; Fink & Penton-Voak, 2002; Gangestad & Simpson, 2000; Jones *et al.*, 2008; Little *et al.*, 2002), women who demonstrated a strong tendency to attribute antisocial traits (e.g., untrustworthy, physically dominant) to masculinized male voices demonstrated a greater effect of relationship context than did women who demonstrated a weaker tendency to attribute antisocial traits to masculinized male voices.

In our study, the overall difference between women's masculinity preferences when judging men's attractiveness as hypothetical short-term partners and hypothetical long-term partners was not significant. This null finding is, perhaps, surprising. Puts (2005) previously found that women tended to show stronger preferences for men with masculine voices as short-term partners than as long-term partners, though this effect was qualified by a higher-order interaction with women's fertility status, whereby women tested during the fertile phase of their menstrual cycle showed a pronounced effect of relationship context but women tested during non-fertile phases of their menstrual cycle did not. We note here, however, that Puts (2005) did not find a significant overall preference for masculine versus feminine voices, such as that observed in the current study and in other research on women's preferences for masculine characteristics in men's voices (e.g., Jones, Boothroyd, Feinberg, & DeBruine, in press;

Jones, Feinberg, DeBruine, Little, & Vukovic, 2010; Vukovic *et al.*, 2008). Thus, the relatively strong preferences for masculine voices that we observed for both the long- and short-term contexts in the current study may have biased against observing a significant overall effect of relationship context on women's masculinity preferences. Similarly, studies reporting overall effects of relationship context on women's preferences for male faces with masculine characteristics may also have had stronger tests for an overall effect of relationship context than our current study, since they also did not report strong overall preferences for masculine stimuli. Returning specifically to the differences between our and Puts' studies, Puts (2005) used different definitions of short- and long-term relationships, did not control for the possible effects of speech content on voice attractiveness and manipulated both pitch and formant frequency in voice recordings. It is possible that these methodological differences explain our different findings for the overall effect of relationship context on women's preferences for masculine voices. Regardless of these issues, however, our findings identify variation among women in the personality attributions that they make to masculine versus feminine voices as an additional factor that predicts individual differences in the magnitude of the effect of relationship context on masculinity preferences and are consistent with individual differences in the extent to which women demonstrate stronger preferences for masculine men as short-term partners than as long-term partners reported in previous research (e.g., Penton-Voak *et al.*, 2003; Smith *et al.*, 2009).

Although women who showed a particularly strong tendency to perceive feminine voices as more trustworthy than masculine voices demonstrated a greater effect of relationship context on masculinity preferences than did women who showed a relatively weaker tendency to perceive feminine voices as more trustworthy than masculine voices, we did not find an overall bias in women's perceptions of the trustworthiness of masculine versus feminine voices. The absence of such an overall bias is, perhaps, surprising, given that many previous studies have demonstrated that women perceive masculine male faces to be more trustworthy than feminine versions (Boothroyd *et al.*, 2007; Perrett *et al.*, 1998). However, previous research has also shown that the extent to which women attribute trustworthiness to feminine versus masculine men is influenced by their familiarity with masculine or feminine men (Buckingham *et al.*, 2006). This latter finding demonstrates that perceptions of the trustworthiness of masculine versus feminine men is not fixed and may, in fact, be recalibrated according to recent experience. While our findings do not shed any light on the reasons why masculinity in men's voices does not have the effect on perceptions of trustworthiness that has previously been reported for faces, it is noteworthy that variation in women's perceptions of the trustworthiness of masculinity versus femininity predicts individual differences in the magnitude of the effect of relationship context on women's preferences for masculinity in both men's faces (Smith *et al.*, 2009) and voices (the current study). Indeed, our findings for variation in the trustworthiness of masculine versus feminine voices and individual differences in the magnitude of the effect of relationship context on voice preferences suggest that variation in personality attributions may be an important factor for individual differences in women's preferences for masculine versus feminine men even when there is no general consensus about how masculine and feminine male voices differ in their apparent personality.

The interactions between the effect of relationship context and women's perceptions of men's dominance and trustworthiness were not qualified by further interactions with hormonal contraceptive use. By contrast, a recent study by Smith *et al.* (2009) found that variation in women's perceptions of the trustworthiness of feminine men's faces

predicted individual differences in the magnitude of the effect of relationship context on face preferences among women who were not using hormonal contraceptives, but not among women who were using hormonal contraceptives. That hormonal contraceptive use did not affect our findings for perceptions of men's voices, but appears to qualify similar findings for perceptions of men's faces, is consistent with Feinberg *et al.* (2008) who found that hormonal contraceptive use has a stronger effect on women's preferences for men's faces than it does on women's preferences for men's voices.

In sum, we show that individual differences in the extent to which women attribute antisocial personality characteristics (i.e., physical dominance, untrustworthiness) to masculine men predicts individual differences in the magnitude of the effect of relationship context on women's mate preferences. Women who perceived masculine men to be particularly untrustworthy and physically dominant demonstrated greater effects of relationship context on their preferences for masculine men. These findings support the proposal that individual differences in the magnitude of the effect of relationship context on women's masculinity preferences occur, at least in part, because of variation in the extent to which women perceive masculine men to possess personality traits that are particularly undesirable in a long-term partner (e.g., physical dominance and low trustworthiness). Thus, our findings highlight the importance of investigating the causes of systematic variation among women in the nature of the personality attributions that they make to men in order to better understand individual differences in women's mate preferences.

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