Self-rated attractiveness predicts individual differences in women's preferences for masculine men's voices

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ABSTRACT

Masculine physical traits may signal men's underlying health and are associated with indices of men's reproductive fitness. Here we show that preferences for low (i.e. masculine) pitch in men's voices are positively related to self-rated attractiveness among women who are not using hormonal contraceptives. This relationship between masculinity preferences and self-rated attractiveness was evident when women judged the attractiveness of men's voices that were played forward, but was not present when women judged the attractiveness of men's voices that had been reversed. This variation in women's preferences for masculinized men's voices complements previous studies showing positive relationships between preferences for masculinity in men's faces and women's self-rated attractiveness and may be adaptive if attractive women are better able to attract and/or retain masculine mates. Interestingly, we observed no significant relationships between preferences for masculinized men's voices and self-rated attractiveness among women using hormonal contraceptives. These latter null findings are consistent with previous studies in which potentially adaptive variation in masculinity preferences were also absent among women using hormonal contraceptives.

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1. Introduction

Masculine physical traits in men are associated with testosterone level (Dabbs & Mallinger, 1999; Penton-Voak & Chen, 2004; Roney, Hanson, Durante, & Maestripieri, 2006) and may signal men's underlying health if men with strong immune systems are better able to withstand the immunosupressive effects of high levels of testosterone (e.g. Zahavi, 1975). Consistent with this proposal, masculine physical traits are associated with measures of men's health (Rhodes, Chan, Zebrowitz, & Simmons, 2003; Thornhill & Gangestad, 2006). Additionally, masculine physical traits are also associated with indices of men's reproductive potential (Hughes, Dispenza, & Gallup, 2004; Puts, 2005; Rhodes, Simmons, & Peters, 2005) and, in natural fertility populations, men's reproductive fitness (Apicella, Feinberg, & Marlowe, 2007). Although masculine physical traits in men are associated with some characteristics that are attractive in a mate (e.g. health), they are also associated with negative characteristics that are not desirable in a mate (e.g. low interest in children and long-term relationships, Rhodes et al., 2005; Roney et al., 2006). Thus, women may vary their masculinity preferences according to the relative importance of the costs and benefits of choosing a masculine partner to each individual (Little, Burt, Penton-Voak, & Perrett, 2001; Penton-Voak et al., 2003).

In some non-human species (e.g. guppies and stickleback), attractive females demonstrate stronger preferences for males displaying cues associated with good underlying health than do relatively unattractive females (e.g. Bakker, Kunzler, & Mazzi, 1999; Lopez, 1999). Similar findings have also been reported in studies of individual differences in women's preferences for masculinity in men's faces (Little et al., 2001; Little & Mannion, 2006; Penton-Voak et al., 2003). For example, Little et al. (2001) found that women who rated their own attractiveness as particularly high demonstrated stronger preferences for masculine men than did women who rated their own attractiveness as relatively low. Penton-Voak et al. (2003) reported similar findings to Little et al. (2001) using objective measures of women's attractiveness (waist-hip ratio and other-rated facial attractiveness), and also found that objective measures of women's attractiveness were positively associated with self-rated attractiveness. Stronger preferences for masculine men among attractive women may be adaptive if attractive women are better able to attract and/or retain masculine mates, and thus are better able to offset the possible negative consequences of choosing a masculine partner (Little & Mannion, 2006; Little et al., 2001; Penton-Voak et al., 2003).

Recently, Little and Mannion (2006) found that viewing highly attractive women decreased women's self-rated attractiveness and also found that masculinity preferences were stronger after viewing unattractive women than after viewing attractive women. This latter finding suggests that it is women's subjective impressions of their own market value (i.e. their self-rated attractiveness), rather than objective indices of their attractiveness, that are important for these individual differences in masculinity preferences (Little & Mannion, 2006). Since men who have attractive faces also tend to have attractive voices (Saxton, Caryl, & Roberts, 2006), suggesting that men's facial and vocal attractiveness are cues to a common underlying quality (Saxton et al., 2006; see also Hughes et al., 2004), sources of individual differences in women's face preferences may also predict variation in women's voice preferences (Feinberg, 2008).

In humans, fundamental frequency (the primary acoustic correlate of voice pitch) is sexually dimorphic, with men displaying lower voice pitch than women (Childers & Wu, 1991). Furthermore, women tend to prefer men's voices with low pitch (Collins, 2000; Feinberg, DeBruine, Jones, & Little, 2008; Feinberg, Jones, Little, Burt, & Perrett, 2005). While individual differences in women's preferences for masculine facial cues have been widely investigated (e.g. Little & Mannion, 2006; Little et al., 2001; Penton-Voak et al., 2003), there has been far less research into between-individual differences in women's preferences for masculine cues in men's voices (Feinberg et al., 2008). Feinberg et al. (2008) recently emphasized the importance of establishing whether self-rated attractiveness predicts women's preferences for masculinity in men's voices.

We tested for an association between self-rated attractiveness and the strength of women's preferences for masculinized (i.e. lowered pitch) recordings of men's voices when these voice recordings were played forward and when these same voice recordings were played in reverse. We compared preferences for masculinized men's voices that were played forward and backward in light of evidence that different neural substrates are involved in processing forward and reversed speech (see Belin, Fecteau, & Bedard, 2004 for a review; see also Binder et al., 2000). That forward and reversed speech are processed by different substrates raises the possibility that preferences for masculine voices, and individual differences in the strength of these preferences, may not necessarily occur for judgments of reversed speech as these may not be processed as 'mate choice relevant' stimuli. Since previous studies have found that potentially adaptive variation in women's mate preferences (Feinberg et al., 2008; Puts, 2006) and potentially adaptive variation according to context (Little, Jones, Penton-Voak, Burt, & Perrett, 2002) do not necessarily occur in women using hormonal contraceptives, we tested the voice preferences of women reporting no use of hormonal contraceptives and also of women reporting hormonal contraceptive use. We tested for associations between self-rated attractiveness and voice preferences, rather than between objective measures of women's attractiveness and voice preferences, in light of Little and Mannion's (2006) recent evidence that it is subjective impressions of women's own attractiveness that are important for these individual differences in women's mate preferences.

Among women reporting no use of hormonal contraceptives, we predicted that self-rated attractiveness would be positively associated with preferences for masculinity when judging men's voices in the forward playback conditions, but not when judging men's voices in the reversed playback conditions. By contrast, among women reporting hormonal contraceptive use, we predicted that self-rated attractiveness would not necessarily be associated with masculinity preferences.

While many studies have shown that men prefer women's voices with high pitch (Collins & Missing, 2003; Feinberg, DeBruine, Jones, & Perrett, in press), Jones, Feinberg, DeBruine, Little, and Vukovic (2008) recently found that men demonstrated stronger preferences for attractive (i.e. raised) voice pitch in women's voices that demonstrated positive social interest in the listener (i.e. were saying 'I really like you') than in women's voices that demonstrated negative social interest in the listener (i.e. were saying 'I don't really like you'). Integrating physical and social cues in this manner may function to facilitate efficient allocation of mating effort (see also Jones, DeBruine, Little, Conway, & Feinberg, 2006). To test for similar integration of social and physical cues in women's preferences for men's voices, we compared women's preferences for lowered pitch in men's voices demonstrating either positive or negative interest in the listener. We did not necessarily predict that vocal cues of social interest would modulate women's preferences for men's voices in the same way as was seen for men's preferences for women's voices in Jones et al. (2008), however. Successful deceit about men's levels of commitment and interest may be more harmful to women than vice versa, since mating is more costly to women than men (i.e. requires greater investment, Trivers, 1972). Consequently, women may be less sensitive to (i.e. trusting of) explicit vocal cues of men's interest and commitment when forming mate preferences.

2. Methods

2.1. Participants

One hundred and twenty-three women took part in the study (Mean age = 19.72 years, SD = 2.85 years; all undergraduate students at the University of Aberdeen). Fifty-eight of these women reported no use of hormonal contraceptives and 65 women reported that they were currently using hormonal contraceptives (55 using oral contraceptives, 10 using implants, patches or injections). An independent samples t-test showed no significant difference in age between these two groups of women (t(121) = −0.81, p = .418).

2.2. Stimuli

We recorded four men (mean age = 26.75 years; SD = 3.10 years) speaking the phrases "I really like you" and "I don't really like you" using an Audio-Technica AT4041 microphone. Voices were recorded in a quiet room using WavePad recording software in mono at a sampling rate of 44.1 kHz at 16-bit amplitude quantization. Next, we manufactured two versions of each voice recording: one with raised (i.e. feminized) voice pitch and one with lowered (i.e. masculinized) voice pitch using the methods described below. These four male speakers were selected at random from consenting staff and students between the ages of 20 and 45 in our Psychology Department.

Voices were raised and lowered in pitch using the pitch-synchronous overlap add (PSOLA) algorithm in Praat to +/− 0.5 ERBs (equivalent rectangular bandwidths) of the original frequency. The methods used here have been used successfully in other voice attractiveness studies (e.g. Feinberg et al., 2005). While the PSOLA method alters voice pitch, other aspects of the voice are unaffected (e.g. speech rate, formant frequency; see Feinberg et al., 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 logarithmic scale in comparison to the natural frequencies (i.e. Hz, Stevens, 1998). The ERB scale was used here because of its better resolution at human average speaking frequencies than the tonotopic Bark scale, the semitone (Western music) scale, or the Mel scale (Stevens, 1998). This better resolution is a consequence of the fact that the ERB scale takes into account the

Table 1
Descriptive statistics for voice stimuli used in our study

Speech content	Pitch Manipulation	Mean average pitch (Hz)	SD of average pitch (Hz)	Mean average pitch (ERB)	SD of average pitch (ERB)
I really like you	raised	122.9	5.8	3.6	0.1
I really like you	lowered	85.5	4.2	2.6	0.1
I don't really like you	raised	115.1	8.7	3.4	0.2
I don't really like you	lowered	79.0	5.6	2.4	0.2

Note that variation in the standard deviations of the mean average pitches for raised and lowered voices measured in Hz is expected given the logarithmic relationship between ERB and Hz.

temporal contribution to frequency resolution (Stevens, 1998). A manipulation roughly equivalent to 20 Hz was used because it has previously been shown to alter women's attractiveness ratings of men's voices (Feinberg et al., 2005). After pitch manipulation, amplitudes were scaled to 70 dB using root-mean-square (RMS) amplitude calculations for constant presentation volume. Finally, we manufactured reversed versions of these pitch-manipulated voices by reversing each recording using WavePad audio software.

The process described above created sixteen pairs of voices in total (each pair consisting of masculinized and feminized versions of the same recording): four pairs of voices saying "I really like you", four pairs of voices saying "I don't really like you", four pairs of voices saying "I really like you" in which the recordings were reversed, and four pairs of voices saying "I don't really like you" in which the recordings were reversed. Descriptive statistics for the manipulated voices are given in Table 1.

2.3. Manipulation check

To establish whether our pitch manipulation affected women's perceptions of masculinity, we played the 16 pairs of voices to 19 women (ages: M = 25.30 years, SD = 7.07 years) and asked them to indicate which voice in each pair was the more masculine. The order in which the pairs of voices were played was fully randomized, as was the order in which the lowered and raised pitch versions in each pair were played. Analyses showed that the lowered pitch versions were chosen as the more masculine significantly more often than would be expected by chance alone (i.e. 50% of the time) in each of the four conditions (Wilcoxon signed ranks tests: all Z > 4.0, all p < .001; mean percentage of trials on which lowered voice pitch was chosen >93% in each condition). These findings confirm that the lowered pitch versions of our stimuli are perceived as more masculine than the raised pitch versions in each of the four conditions.

2.4. Procedure

Participants were played the 16 pairs of voices (where each pair consisted of masculinized and feminized versions of the same recording) and were asked to choose which voice in each pair was the more attractive. Participants were also asked to indicate the strength of each preference by choosing from the options 'much more attractive', 'more attractive', 'somewhat more attractive', and 'slightly more attractive'. Participants listened to these recordings on headphones. The order in which pairs of voices were presented was fully randomized. The order in which masculinized and feminized versions in each pair were played was also fully randomized. Since participants were judging the attractiveness of the pitch manipulation, rather than the individual speakers, the relatively low number of speakers used to generate our stimuli is unlikely to have affected our results (see, e.g., Feinberg et al., 2005, 2008; Jones et al., 2008).

Additionally, participants reported their age and rated their own physical attractiveness on a 1 (very unattractive) to 7 (very attractive) scale. Participants were also asked to report whether or not they were currently using any form of hormonal contracep-

tive. The order in which participants completed the voice preference test and questionnaire was fully randomized.

2.5. Initial processing of data

Responses on the voice preference test were coded as strength of preference for masculinized (i.e. lowered pitch) voices using the following 0–7 scale:

0 to 3: feminized voice rated 'much more attractive' (=0), 'more attractive' (=1) 'somewhat more attractive' (=2), or 'slightly more attractive' (=3) than masculinized voice.

4 to 7: masculinized voice rated 'slightly more attractive' (=4), 'somewhat more attractive' (=5), 'more attractive' (=6) or 'much more attractive' (=7) than feminized voice.

For each participant, the average strength of preference for masculinity was calculated separately for each of the four conditions (positive utterance played forward, positive utterance played backward, negative utterance played forward, negative utterance played backward).

3. Results

3.1. Women reporting no use of hormonal contraceptives

First, we carried out one-sample t-tests comparing the strength of preferences for masculine voices in each of the four conditions with what would be expected by chance alone (i.e. 3.5). Women's preferences for masculine voices were significantly greater than chance when judging both positive utterances (t(57) = 3.22, p < .002) and negative utterances (t(57) = 3.86, p < .001) in the forward playback conditions. By contrast, women's preferences for masculine voices were not significantly different from chance when judging positive utterances (t(57) = 0.78, p = .440) and negative utterances (t(57) = −1.18, p = .072) in the backward playback conditions.

Responses were further analyzed using ANCOVA [within-subjects factors: direction of playback (forward, backward), valence of utterance (positive interest, negative interest); covariate: self-rated attractiveness]. This analysis revealed the predicted significant interaction between direction of playback and self-rated attractiveness (F(1,56) = 11.18, p < .001), which qualified the main effect of self-rated attractiveness (F(1,56) = 2.82, p = .099). There were no other significant effects or effects that approached significance (all F < 2.80, all p > .10).

To interpret the significant interaction between direction of playback and self-rated attractiveness, we tested for significant correlations between self-rated attractiveness and the average strength of preference for masculinity in the forward playback conditions and separately in the backward playback conditions. As we predicted, self-rated attractiveness was positively and significantly associated with the strength of preference for masculinity in the forward playback conditions (r = 0.34, N = 58, p = .010, Fig. 1a), but not in the backward playback conditions (r = 0.09, N = 58, p = .95, Fig. 1b).

Repeating these analyses (ANCOVA, correlations) controlling for possible effects of participant age did not alter our findings.
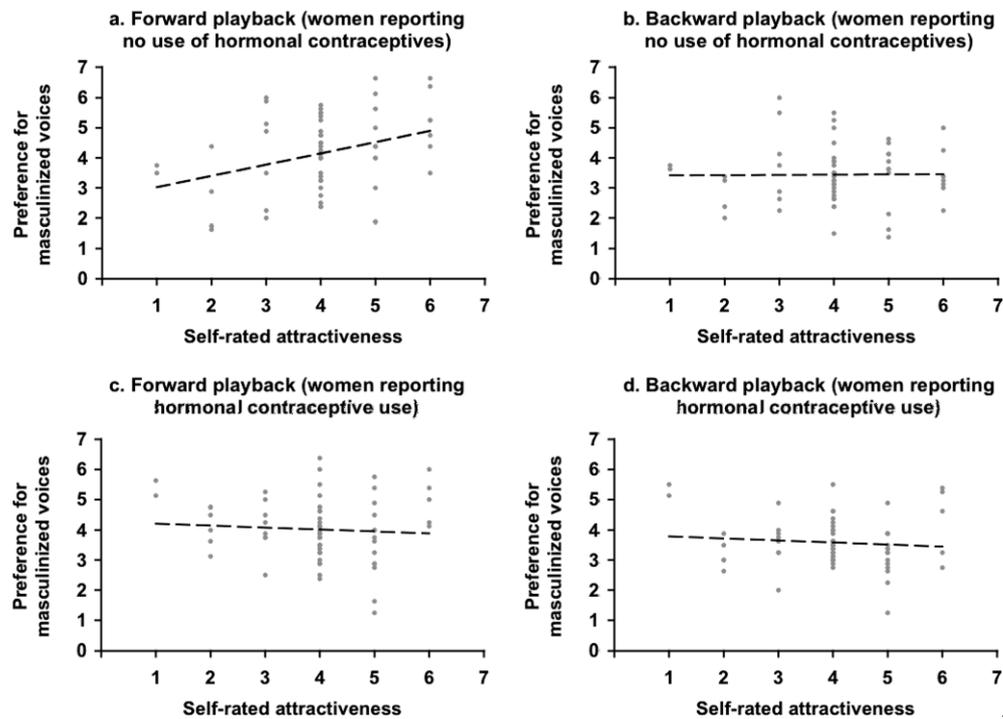
Fig. 1. Correlations between self-rated attractiveness and the strength of women's preferences for low (i.e. masculine) pitch in men's voices.

3.2. Women reporting use of hormonal contraceptives

As in the previous section of our Results, we first carried out one-sample t-tests comparing the strength of preferences for masculine voices in each of the four conditions with what would be expected by chance alone (i.e. 3.5). Women's preferences for masculine voices were significantly greater than chance when judging both positive utterances (t(64) = 4.57, p < .001) and negative utterances (t(64) = 2.94, p < .005) in the forward playback conditions. By contrast, women's preferences for masculine voices were not significantly different from chance when judging positive utterances (t(64) = 1.20, p = .236) and negative utterances (t(64) = 0.31, p = .755) in the backward playback conditions.

ANCOVA [within-subjects factors: direction of playback (forward, backward), valence of utterance (positive interest, negative interest); covariate: self-rated attractiveness], revealed no significant effects (all F < 2.65, all p > 0.1). The interaction between self-rated attractiveness and direction of playback, which was significant in women reporting no use of hormonal contraceptives, was not significant in this analysis (F(1,63) = .001, p = .975).

For comparison to the analyses for women reporting no use of hormonal contraceptives, we tested for significant correlations between self-rated attractiveness and the average strength of preferences for masculinity in the backward playback conditions and separately in the forward playback conditions. These analyses revealed no significant relationships (forward conditions: r = −.07, N = 65, p = .583, Fig. 1c; backward conditions: r = −.09, N = 65, p = .469, Fig. 1d).

Repeating these analyses (ANCOVA, correlations) controlling for possible effects of participant age did not alter our findings.

3.3. Additional analyses

Although our analyses have shown that self-rated attractiveness is positively related to women's preferences for masculinity in the forward playback conditions among women reporting no use of hormonal contraceptives, but not among women reporting

hormonal contraceptive use, these analyses do not indicate whether this relationship is significantly stronger in women reporting no use of hormonal contraceptives than in women using hormonal contraceptives. Consequently, we compared the correlation coefficients for the associations between self-rated attractiveness and masculinity preferences in the forward playback conditions in our two samples of women using the Fisher r-to-z transformation. As we predicted, the relationship between self-rated attractiveness and masculinity preference in the forward playback conditions was significantly stronger among women reporting no use of hormonal contraceptives than among women reporting hormonal contraceptive use (Z = 2.29, p = .022). A corresponding analysis for masculinity preferences in the backward playback conditions revealed no significant difference (Z = 0.97, p = .329). Women using hormonal contraceptives and those not using hormonal contraceptives did not differ significantly in their self-rated attractiveness (independent samples t-test: t(121) = 0.33, p = .740). Mean self-rated attractiveness of women not using hormonal contraceptives was 4.07 (SEM = 0.16). Mean self-rated attractiveness of women using hormonal contraceptives was 4.00 (SEM = 0.14).

4. Discussion

In the forward playback conditions, women reporting no use of hormonal contraceptives and women reporting hormonal contraceptive use both preferred the masculinized (i.e. lowered pitch) men's voices to the feminized (i.e. raised pitch) versions. These findings are consistent with previous studies that have shown that women tend to prefer low pitch in men's voices (Collins, 2000; Feinberg et al., 2005, 2008). By contrast with our findings for masculinity preferences in the forward playback conditions, neither group of women demonstrated preferences for masculinized men's voices when these voices had been reversed. These findings demonstrate that women's preferences for low pitch in men's voices do not simply reflect a general preference for low pitch in auditory stimuli of any kind.

Although we found that women generally preferred masculinized men's voices in the forward playback conditions, we also found evidence for individual differences in the strength of these preferences. Among women reporting no use of hormonal contraceptives, we found that self-rated attractiveness was positively related to the strength of women's preferences for masculinized men's voices in the forward playback conditions, but not in the backward playback conditions. Indeed, self-rated attractiveness was found to be a significantly better predictor of women's preferences for masculinized men's voices in the forward playback conditions than when these voices were reversed. Our findings for a positive association between women's self-rated attractiveness and preferences for masculinized men's voices therefore complement previous studies reporting positive relationships between preferences for masculinity in men's faces and measures of women's own attractiveness, including self-rated attractiveness (Little & Mannion, 2006; Little et al., 2001; Penton-Voak et al., 2003). Such individual differences in women's masculinity preferences may be adaptive if attractive women are better able to attract and/or retain masculine mates, and thus are better able to offset the possible negative consequences of choosing a masculine partner (Little & Mannion, 2006; Little et al., 2001; Penton-Voak et al., 2003). We used self-rated attractiveness in our study, rather than objective measures of women's attractiveness, since Little and Mannion (2006) have shown that it is women's subjective impressions of their own market value (i.e. their self-rated attractiveness) that are particularly important for the effects of attractiveness on women's masculinity preferences (Little & Mannion, 2006).

In our study, self-rated attractiveness predicted the strength of preferences for masculinized voices in the forward playback conditions among women not using hormonal contraceptives, but not in the backward playback conditions. This pattern of results establishes that the systematic variation in women's masculinity preferences that we observed cannot be explained by a general response bias whereby women who rate themselves as particularly attractive are also particularly willing to use extreme values on rating scales when judging attractiveness generally. Furthermore, these findings are consistent with evidence that different neural substrates underpin the processing of forward and backward voices (see Belin et al., 2004 for a review; see also Binder et al., 2000) and implicate mechanisms dedicated for processing typical human speech in women's voice preferences.

Although we found a positive relationship between preferences for masculinized men's voices in the forward playback conditions and self-rated attractiveness among women reporting no use of hormonal contraceptives, we found no similar relationship among women reporting hormonal contraceptive use. This null finding for women reporting hormonal contraceptive use is consistent with findings from previous studies that observed potentially adaptive variation in masculinity preferences among women reporting no use of hormonal contraceptives, but not among women reporting hormonal contraceptive use (Feinberg et al., 2008; Puts, 2006). It remains unclear whether hormonal contraceptive use has a causal disruptive effect on women's mate preferences or is associated with other factors that might mask or disrupt variation in masculinity preferences (for example, Little et al., 2002 found oral contraceptive users reported a greater number of sexual partners than non users). Further research is needed to investigate these two possibilities.

Jones et al. (2008) previously found that men demonstrated stronger preferences for attractive (i.e. raised) voice pitch in women's voices that demonstrated positive social interest in the listener (i.e. were saying 'I really like you') than in women's voices that demonstrated negative social interest in the listener (i.e. were saying 'I don't really like you'). Integrating physical and social cues in voice preferences in this manner may function to facilitate effi-

cient allocation of mating effort (i.e. allocation of more mating effort to attractive individuals who appear likely to reciprocate). By contrast with these findings for men's preferences for women's voices, our current study found no effects of explicit vocal cues to possible mating interest on women's preferences for pitch in men's voices. As we noted in our Introduction, effects of explicit cues of interest on women's preferences for men's voices would not necessarily be predicted if deceit about prospective romantic partners' levels of mating interest and commitment is more costly for women than for men. Future research using less easily 'fakeable' cues of men's mating interest (e.g. pro-social prosody) may yet reveal interactions among men's physical and social vocal cues in women's preferences.

In summary, we found that preferences for masculinized (i.e. lowered pitch) men's voices were positively associated with self-rated attractiveness among women who were not using hormonal contraceptives. Such preferences may be adaptive if attractive women are better able to obtain and/or retain attractive mates (Little & Mannion, 2006; Little et al., 2001; Penton-Voak et al., 2003). Importantly, this relationship between self-rated attractiveness and masculinity preferences showed some evidence of domain-specificity, occurring for judgments of voices in the forward playback conditions, but not for judgments of reversed speech. No significant associations were observed between masculinity preferences and self-rated attractiveness in an equivalent sample of women who were using hormonal contraceptives, presenting converging evidence that potentially adaptive individual differences in women's mate preferences do not necessarily occur among women using hormonal contraceptives. Early research into individual differences in mate preferences (Huston, 1973; Walster, Aronson, Abrahams, & Rottman, 1966) concluded that matching for attractiveness occurs only when there is a possibility of actual rejection by potential romantic partners (i.e. occurs only in the domain of actual mate choice), but does not affect decisions in hypothetical preference tests (i.e. does not occur in the domain of mate preferences). By contrast, our findings suggest that the need to avoid rejection and to allocate mating effort efficiently has shaped psychological adaptations that affect attractiveness judgments in situations where there is no possibility of actual rejection.

Acknowledgments

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