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A domain-specific opposite-sex bias in human preferences for manipulated voice pitch

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Women's preferences for masculine characteristics in men's voices and men's preferences for feminine characteristics in women's voices are thought to reflect adaptations that identify high-quality (e.g. healthy) mates. Consistent with this proposal, we found that men had stronger preferences than women for women's voices with raised pitch (i.e. feminized female voices) and that women had stronger preferences than men for men's voices with lowered pitch (i.e. masculinized male voices). Importantly, however, no such opposite-sex bias was evident for attributions of dominance to voices with raised and lowered pitch; men's and women's voices with lowered pitch were perceived to be more dominant than those with raised pitch and these effects were equivalent for male and female listeners. Collectively, our findings suggest that preferences for voice pitch may function, at least in part, to identify high-quality mates and show that opposite-sex biases in preferences for voice pitch cannot be explained simply by greater general sensitivity to manipulated pitch in opposite-sex voices than in own-sex voices.

Female preferences for male vocalizations at frequencies that are equal to or lower than the average for the species studied have been reported in many nonhuman species. For example, Ryan & Keddy-Hector (1992) observed female preferences for males with either average or lower than average vocalization frequencies in a variety of fish, insect and anuran species. Similar findings have also been reported for fallow deer, *Dama dama* (Vannoni & McElligott 2008), baboons, *Papio hamadryas* (Pfefferle & Fischer 2006) and grey partridge, *Perdix perdix* (Beani & Dessi-Fulgheri 1995). Such findings have led researchers to investigate the effect of voice pitch on attractiveness judgements of voices in humans (e.g. Collins 2000; Puts 2005; Feinberg 2008).

Studies of vocal attractiveness in humans have typically investigated preferences for voice pitch (reviewed in Feinberg 2008). Studies in which naturally occurring variation in voice pitch was correlated with attractiveness ratings of the voices have reported positive associations between pitch and attractiveness for women's voices (e.g. Collins & Missing 2003; Feinberg et al. 2008a) and negative associations between pitch and attractiveness for men's voices (e.g. Collins 2000). Consistent with these findings, studies in which pitch alone was manipulated in voice recordings have found that raising the pitch of women's voices (Feinberg et al. 2008a; Jones et al. 2008) and lowering the pitch of men's voices (Feinberg et al. 2005a, 2008b; Vukovic et al. 2008) increases vocal attractiveness.

The findings described above have generally been interpreted as evidence that vocal cues to men's and women's mate quality that are associated with pitch influence judgements of vocal attractiveness (reviewed in Feinberg 2008). In other words, it has been suggested that preferences for raised pitch in women's voices and lowered pitch in men's voices reflect adaptations for identifying high-quality (e.g. healthy, fertile) mates. This interpretation is consistent with studies showing that vocal attractiveness in men and women is associated with other putative indices of health and fertility (e.g. facial attractiveness, Collins & Missing 2003; low waist - hip ratio in women or high shoulder - hip ratio in men, Hughes et al. 2004; low fluctuating asymmetry, Hughes et al. 2002, 2008). Moreover, voice pitch itself is negatively associated with indices of

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men's reproductive success in both natural fertility populations and university undergraduate samples (Puts 2005; Apicella et al. 2007) and is positively correlated with conception risk during the menstrual cycle in young adult women (Bryant & Haselton 2009) and with women's facial femininity (Feinberg et al. 2005b).

If preferences for sexually dimorphic pitch in human voices reflect adaptations for identifying high-quality mates, one might expect manipulating pitch to have greater effects on judgements of the attractiveness of opposite-sex voices than on judgements of own-sex voices. Indeed, such opposite-sex biases in attractiveness judgements are thought to be strong evidence for mate choice-relevant explanations of attractiveness judgements (see e.g. Rhodes 2006; Little & Jones 2003 and Little et al. 2008 for

attractiveness judgements of women's voices, dominance judgements of men's voices, or dominance judgements of women's voices).

In the 'judgements of men's attractiveness' condition, participants were played the six pairs of male voices (each pair consisting of raised- and lowered-pitch versions of the same speaker) and were asked to choose the voice in each pair that was more attractive. Pairs of voices were presented in a fully randomized order and the order in which the raised- and lowered-pitch voices in each pair were presented was also fully randomized. This method has been used to assess voice preferences in previous studies (Feinberg et al. 2008a, b; Jones et al. 2008; Vukovic et al. 2008). The same methodology was also used in the 'judgements of women's attractiveness' condition, except the pairs of voices consisted of the six pairs of female voices (each pair consisting of raised- and lowered-pitch versions of the same speaker).

In the 'judgements of men's dominance' condition, participants were played the six pairs of male voices (each pair consisting of raised- and lowered-pitch versions of the same speaker) and were asked to choose the voice in each pair that sounded more dominant. As in the attractiveness judgement conditions, pairs of voices were presented in a fully randomized order and the order in which the raised- and lowered-pitch voices in each pair were presented was also fully randomized. The same methodology was also used in the 'judgements of women's dominance' condition, except the pairs of voices consisted of the six pairs of female voices (each pair consisting of raised- and lowered-pitch versions of the same speaker).

The study was run online. Previous studies have shown that online tests of voice preferences produce patterns of results that are identical to laboratory-based tests (e.g. Feinberg et al. 2008a, b). All participants gave informed consent and all methods and procedures were approved by the School of Psychology (University of Aberdeen) Ethical Review Committee. Data from repeat IP addresses were not recorded, ensuring that no participant included in the data set had participated twice, had judged both men's and women's voices, or had judged both dominance and attractiveness. Although it is possible that participants in online studies may not necessarily report demographic information (e.g. their sex or age) accurately, such misreporting is unlikely to differ systematically between conditions and, consequently, is unlikely to bias our findings systematically.

Initial Processing of Data

For each of the 200 participants (100 men, 100 women) who judged the attractiveness of men's voices, we calculated the proportion of trials (out of six) on which the male voice with lowered pitch was chosen as the more attractive. Corresponding values were also calculated for each of the 200 participants (100 men, 100 women) who judged the attractiveness of women's voices.

For each of the 200 participants (100 men, 100 women) who judged the dominance of men's voices, we calculated the proportion of trials (out of six) on which the male voice with lowered pitch was chosen as the more dominant. Corresponding values were also calculated for each of the 200 participants (100 men, 100 women) who judged the dominance of women's voices.

These values are summarized in Fig. 1 and were used in subsequent analyses. Note that each of the participants provided only one data point for use in analyses (i.e. the proportion of trials on which they chose masculinized voices in the condition to which they were randomly assigned). Previous research on voice preferences has calculated scores in this way (Feinberg et al. 2008a, b; Jones et al. 2008). All analyses were carried out using SPSS version 15 (SPSS Inc., Chicago, IL, U.S.A.) and two-tailed P values are reported for each analysis.

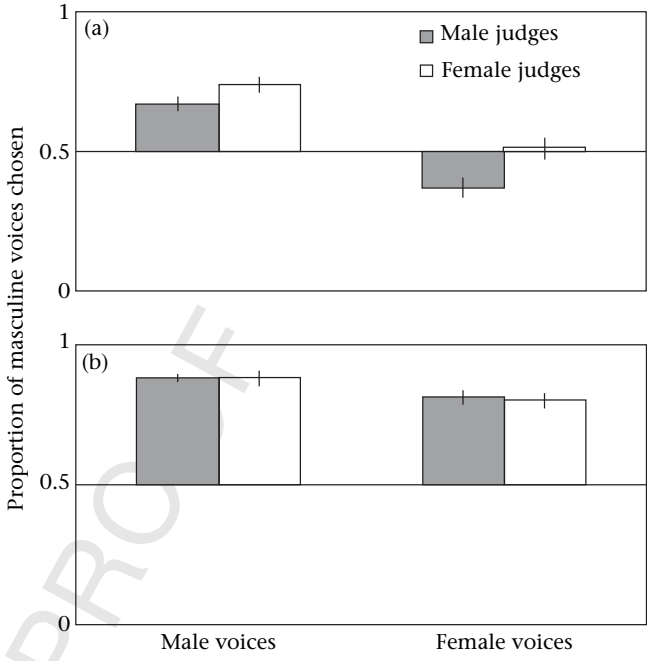

Figure 1. Mean scores and SEMs for perceptions of (a) attractiveness and (b) dominance by sex of voice and sex of judge (i.e. sex of participant). Masculine voices are those with lowered pitch. One hundred men and 100 women made each type of judgement.

RESULTS

Men's Voices: Attractiveness Judgements

An ANCOVA [dependent variable: proportion of masculinized voices chosen as more attractive; between-subjects factor: sex of participant (male, female); covariate: participant age] revealed the predicted significant main effect of sex of participant ($F_{1,199} = 4.54$, $P = 0.034$), whereby women chose male voices with lowered pitch more often than men (women: mean ± SEM = 0.74 ± 0.02; men: 0.67 ± 0.02). There was no significant main effect of participant age ($F_{1,199} = 0.10$, $P = 0.76$). This pattern of results was also obtained when an arcsine transform was applied to the dependent variable.

One-sample t tests comparing the proportion of trials on which male voices with lowered pitch were chosen as more attractive with what would be expected by chance alone (i.e. 0.5) showed that both men ($t_{99} = 7.47$, $P < 0.001$, mean ± SEM = 0.67 ± 0.02) and women ($t_{99} = 11.24$, $P < 0.001$, 0.74 ± 0.02) preferred men's voices with lowered pitch to those with raised pitch.

Women's Voices: Attractiveness Judgements

An ANCOVA [dependent variable: proportion of masculinized voices chosen as more attractive; between-subjects factor: sex of participant (male, female); covariate: participant age] revealed the predicted significant main effect of *sex of participant* ($F_{1,199} = 12.09$, $P < 0.001$), whereby men had stronger preferences than women for raised pitch in women's voices (men: mean ± SEM = 0.37 ± 0.03; women: 0.51 ± 0.03). There was no significant main effect of participant age ($F_{1,199} = 0.18$, $P = 0.67$). This pattern of results was also obtained when an arcsine transform was applied to the dependent variable.

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One-sample t tests comparing the proportion of trials on which female voices with lowered pitch were chosen as more attractive with what would be expected by chance alone (i.e. 0.5) showed that men (t_{99}=−5.00, $P < 0.001$, mean ± SEM = 0.37 ± 0.03), but not women (t_{99}=−0.06, $P = 0.95$, 0.51 ± 0.03), preferred women's voices with raised pitch to those with lowered pitch.

Men's Voices: Dominance Judgements

An ANCOVA [dependent variable: proportion of masculinized voices chosen as more dominant; between-subjects factor: sex of participant (male, female); covariate: participant age] revealed no significant effects of sex of participant ($F_{1,199} = 0.04$, $P = 0.84$) or participant age ($F_{1,199} = 0.07$, $P = 0.80$). This pattern of results was also obtained when an arcsine transform was applied to the dependent variable.

One-sample t tests comparing the proportion of trials on which male voices with lowered pitch were chosen as more dominant with what would be expected by chance alone (i.e. 0.5) showed that both men ($t_{99} = 22.33$, $P < 0.001$, mean ± SEM = 0.88 ± 0.01) and women ($t_{99} = 27.69$, $P < 0.001$, 0.88 ± 0.02) chose men's voices with lowered pitch more often than they chose those with raised pitch.

Women's Voices: Dominance Judgements

An ANCOVA [dependent variable: proportion of masculinized voices chosen as more dominant; between-subjects factor: sex of participant (male, female); covariate: participant age] revealed no significant effects of sex of participant ($F_{1,199} = 0.13$, $P = 0.72$) or participant age ($F_{1,199} = 2.37$, $P = 0.13$). This pattern of results was also obtained when an arcsine transform was applied to the dependent variable.

One-sample t tests comparing the proportion of trials on which female voices with lowered pitch were chosen as more dominant with what would be expected by chance alone (i.e. 0.5) showed that both men ($t_{99} = 16.00$, $P < 0.001$, mean ± SEM = 0.81 ± 0.02) and women ($t_{99} = 14.70$, $P < 0.001$, 0.80 ± 0.02) chose women's voices with lowered pitch more often than they chose those with raised pitch.

Comparing Perceptions of Attractiveness and Dominance

For men's judgements of men's voices, an ANCOVA [between-subjects factor: judgement (attractiveness, dominance); covariate: participant age] revealed a significant main effect of judgement ($F_{1,199} = 52.92$, $P < 0.001$), whereby lowering voice pitch had a greater effect on men's perceptions of the dominance of men's voices than on the attractiveness of men's voices (Fig. 1). There was no significant effect of participant age ($F_{1,199} = 0.66$, $P = 0.42$). A corresponding analysis for women's judgements of men's voices also revealed a significant main effect of judgement ($F_{1,199} = 34.13$, $P < 0.001$), whereby lowering voice pitch had a greater effect on women's perceptions of the dominance of men's voices than on the attractiveness of men's voices (Fig. 1). There was no significant effect of participant age ($F_{1,199} = 0.61$, $P = 0.44$). These patterns of results were also obtained when an arcsine transform was applied to the dependent variables.

For men's judgements of women's voices, an ANCOVA [between-subjects factor: judgement (attractiveness, dominance); covariate: participant age] revealed a significant main effect of judgement ($F_{1,199} = 182.75$, $P < 0.001$), whereby raising voice pitch increased perceptions of the attractiveness of women's voices while lowering voice pitch increased perceptions of the dominance of women's voices (see Fig. 1). The effect of participant age was not significant ($F_{1,199} = 0.20$, $P = 0.66$). A corresponding analysis for women's judgements of women's voices also revealed a significant main effect of judgement ($F_{1,199} = 79.42$, $P < 0.001$), whereby lowering voice pitch increased women's perceptions of the dominance of women's voices while manipulating pitch had no effect on women's perceptions of the attractiveness of women's voices (Fig. 1). The effect of participant age was not significant ($F_{1,199} = 1.82$, $P = 0.18$).

Analyses by Items

In our previous analyses, individual judges served as our unit of analysis. However, some researchers have suggested that it may be more appropriate f!

for women's voices with raised pitch (see also Feinberg et al. 2008a).

Collectively, our findings for attractiveness judgements of men's and women's voices suggest an opposite-sex bias in men's and women's preferences for voice pitch. Men reported stronger attraction than women to feminized women's voices and women showed stronger attraction than men to masculinized men's voices. Previous studies have reported associations between men's and women's vocal attractiveness and putative indices of health and fertility (Collins & Missing 2003; Hughes et al. 2002, 2004, 2008). Other studies have reported that voice pitch itself is negatively correlated with indices of men's reproductive success/potential (Puts 2005; Apicella et al. 2007) and is positively correlated with women's fertility during the menstrual cycle (Bryant & Haselton 2009) and with women's facial femininity (Feinberg et al. 2005b). Together with these findings, the opposite-sex bias in attraction to raised and lowered voice pitch that we observed is consistent with the proposal that preferences for voice pitch reflect, at least in part, adaptations for identifying high-quality mates (reviewed in Feinberg 2008). The opposite-sex biases in preferences for voice pitch were evident in analyses where individual subjects served as the unit of analysis and analyses where stimulus items served as the unit of analysis. This is noteworthy since some researchers have suggested that it may not be appropriate to carry out by-subjects analyses of data where all participants responded to the same stimuli (Kroodsma et al. 2001). Additionally, stronger preferences for raised pitch when men judge women's voices and stronger preferences for lowered pitch when women judge men's voices have been reported in studies using different sets of stimuli (Feinberg et al. 2008a; Jones et al. 2008), suggesting that the opposite-sex biases observed in the current study are not peculiar to the specific sample of voices that we used.

We also tested for an equivalent opposite-sex bias in attributions of dominance to voices manipulated in pitch. This comparison was carried out to test whether the opposite-sex bias that we observed for attractiveness judgements simply reflects an opposite-sex bias in sensitivity to manipulated pitch in voices (i.e. greater sensitivity to manipulated pitch in opposite-sex than own-sex voices). Previous studies have reported that lowering the pitch of men's voices increases perceptions of dominance (e.g. Puts et al. 2006). We replicated this effect of lowered pitch for both men's and women's perceptions of the dominance of men's voices and also found that both men and women perceived women's voices with lowered pitch to be more dominant than women's voices with raised pitch. By contrast with the opposite-sex bias we observed for attractiveness judgements, however, we found no evidence for an opposite-sex bias in the effect of voice pitch on perceptions of dominance.

That an opposite-sex bias in preferences for voice pitch was observed for attractiveness judgements of voices, but not for perceptions of dominance, suggests that the opposite-sex bias in attractiveness judgements is not simply due to an opposite-sex bias in sensitivity to manipulated voice pitch generally. If dominance plays a key role in sexual selection (Darwin 1871), especially in species such as *Homo sapiens* where even the winners of male - male competition must often still be chosen by females in order to acquire a mate, determining the dominance of males would be expected to be of relatively equal importance to both sexes. Our findings for men's and women's dominance attributions to men's voices support this proposal.

We found that lowering the pitch of men's voices had a significantly greater effect on men's perceptions of the dominance of men's voices than on men's perceptions of the attractiveness of men's voices. That manipulating the pitch of men's voices did not have identical effects on men's perceptions of the attractiveness and dominance of other men suggests that men's preferences for masculine characteristics in other men does not simply reflect perceptions of dominance, as has previously been suggested (Penton-Voak et al. 2001; Feinberg et al. 2008b). While our findings show that men's attractiveness judgements of other men and perceptions of those men's dominance are not identical, our findings do not clarify the motivations that underpin men's judgements of the attractiveness of other men. Investigation of this issue is likely to be an interesting and fruitful topic for future research. Further research is also needed to clarify whether perceptions of dominance when listening to voices reflect attributions of physical dominance or attributions of social dominance.

In summary, our findings present further evidence that voice pitch is an important cue for both attractiveness judgements and perceptions of dominance. Men's voices with lowered pitch are perceived as more attractive and more dominant than those with raised pitch. Women's voices with raised pitch are perceived as more attractive, but less dominant, than those with lowered pitch. Consistent with previous studies, we also found that men had stronger preferences than women for raised pitch in women's voices while women had stronger preferences than men for lowered pitch in men's voices. Importantly, however, no such opposite-sex bias occurred for perceptions of dominance, suggesting that opposite-sex biases in judgements of voices are sensitive to the type of judgement made. This context-sensitive opposite-sex bias in perceptions of voices supports the proposal that preferences for voice pitch reflect, at least in part, adaptations that identify high-quality mates and cannot be explained by more general mechanisms, such as greater sensitivity to pitch manipulations in opposite-sex voices.

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