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EXPERIMENTAL EVIDENCE THAT WOMEN SPEAK IN A HIGHER VOICE PITCH TO MEN THEY FIND ATTRACTIVE

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Abstract. Although humans can raise and lower their voice pitch, it is not known whether such alterations can function to increase the likelihood of attracting preferred mates. Because men find higher-pitched women's voices more attractive, the voice pitch with which women speak to men may depend on the strength of their attraction to those men. Here, we measured voice pitch when women left voicemail messages for masculinized and feminized versions of a prototypical male face. We found that the difference in women's voice pitch between these two conditions positively correlated with the strength of their preference for masculinized versus feminized male faces, whereby women tended to speak with a higher voice pitch to the type of face they found more attractive (masculine or feminine). Speaking with a higher voice pitch when talking to the type of man they find most attractive may function to reduce the amount of mating effort that women expend in order to attract and retain preferred mates.

Keywords: voice, attractiveness, sexual dimorphism, sexual selection, mate choice

INTRODUCTION

Many studies have demonstrated that men prefer high pitch in women's voices (COLLINS and MISSING 2003; FEINBERG et al. 2008a; JONES et al. 2008a, 2010a). For example, men's attractiveness ratings of women's voices are positively correlated with voice pitch (COLLINS and MISSING 2003; FEINBERG et al. 2008a). Men also prefer female voices manipulated to have raised pitch to those manipulated to have lowered pitch (FEINBERG et al. 2008a; JONES et al. 2008a, 2010a; APICELLA and FEINBERG 2009), indicating that voice pitch is a direct cue to female voice attractiveness (FEINBERG et al. 2008a; JONES et al. 2008a, 2010a). High voice pitch in women may indicate fertility, as it is positively correlated with variation in conception risk during the menstrual cycle (BRYANT and HASELTON 2009) and with average (i.e., trait) estrogen levels (ABITBOL et al. 1999; FEINBERG et al. 2006).

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Women's voice pitch is also positively correlated with other physical characteristics that are thought to be indices of women's reproductive health, such as facial femininity and attractiveness (FEINBERG et al. 2005). Additionally, ratings of women's vocal attractiveness, which is highly correlated with their voice pitch (COLLINS and MISSING 2003; FEINBERG et al. 2008a), are negatively correlated with their waist-hip ratio (HUGHES et al. 2004), and positively correlated with body symmetry (HUGHES et al. 2002), conception risk during the menstrual cycle (PIPITONE and GALLUP 2008), and various indices of their reproductive potential (HUGHES et al. 2004). This evidence has lead many researchers to suggest that women's voices, and their voice pitch in particular, may signal their mate quality (BRYANT and HASELTON 2009; FEINBERG et al. 2008a; JONES et al. 2008a, 2010; VUKOVIC et al. 2010; see FEINBERG 2008 for a review). Consistent with this proposal, men demonstrate stronger preferences for raised pitch in women's voices than do women (FEINBERG et al. 2008a; JONES et al. 2008a, 2010a).

Although men prefer high voice pitch to low voice pitch in women (COLLINS and MISSING 2003; FEINBERG et al. 2008a; JONES et al. 2008, 2010a) and there are physiological constraints on vocal range, voice pitch is not a fixed trait (TITZE 1994). For example, singing different musical notes is an example of deliberate manipulation of voice pitch (TITZE 1994). Similarly, the voice pitch of a speaker can change depending on the listener. For example, speakers tend to raise their voice pitch when they are speaking to an infant (e.g., FERNALD and SIMON 1984; GRIESER and KUHL 1988), match their voice pitch to conversation partners who are higher in social status (GREGORY 1996), and speak with lower pitch when leaving voicemail messages for physically attractive individuals as part of a survey into attitudes to psychology (HUGHES et al. 2010). Additionally, men who perceive themselves to be more dominant than a competitor lower their voice pitch when speaking to him, while men who perceive themselves to be less dominant than a competitor raise their voice pitch when speaking to him (PUTS et al. 2006). While these findings demonstrate that speakers can alter their voice pitch according to the social context, no previous research has investigated the possible effects of courtship scenarios on women's voice pitch.

Given that men prefer high-pitched voices to low-pitched voices in women (COLLINS and MISSING 2003; FEINBERG et al. 2008a; JONES et al. 2008a, 2010a), and that voice pitch can change in response to social contexts (e.g., FERNALD and SIMON 1984; GREGORY 1996; GRIESER and KUHL 1988), women may alter their voice pitch in mating contexts. While the effect of mating contexts on women's voice pitch has not been experimentally investigated, other aspects of behaviour have been shown to change in response to courtship scenarios. For example, the number, duration, size, speed, and complexity of women's body movements covary with their interest in a partner during a dyadic interaction (GRAMMER et al. 1999) and women's hormone levels also change in response to interacting with an attractive man in ways that are consistent with increased sexual motivation (LÓPEZ et al. 2009).

In light of the above, we tested the hypothesis that women's voice pitch will co-vary with their attraction to the type of man they are speaking to in a mating context. We asked women to read a scripted message as if they were leaving a voicemail message to arrange a date with each of two pictured men. These two men were represented by a prototypical (i.e., composite) male face that had been manipulated in shape masculinity using well-established computer graphic methods (see, e.g., DEBRUINE et al. 2006; JONES et al. 2005). Additionally, we assessed the extent to which women preferred masculinity in the male faces that were shown in the voice recording part of the experiment (i.e., 'seen' faces) and also in a set of male faces that were not shown in the voice recording part of the experiment (i.e., 'unseen' faces). We then tested if the difference in voice pitch between the voicemail left for a masculine man and the voicemail left for a relatively feminine man was positively correlated with the extent to which women preferred masculine to feminine male faces.

This method has three main advantages over other possible methods. First, it is important to have variation in preferences for the faces in order to distinguish whether women's voice pitch is associated with their preferences or with some other aspect of the faces that is correlated with attractiveness. For example, if all women prefer the same attractive faces in a sample, one could not distinguish whether women speak with a higher pitch to faces they prefer or whether they speak in a higher pitch to faces that have some characteristic correlated with attractiveness. Because systematic variation in preferences for shape masculinity has been widely demonstrated (FEINBERG et al. 2008a; JONES et al. 2008b; LITTLE et al. 2001; PENTON-VOAK et al. 1999, 2003; RHODES 2006), manipulating masculinity (rather than attractiveness) ensures a spread of preference data that will allow us to correlate preferences (rather than physical characteristics of faces) with vocal responses. In doing so, we can directly link vocal responses to *attraction*, rather than attractiveness. This approach is modeled after a paradigm commonly used in neuropsychology, where correlations between individual differences in behavioural and neurobiological responses are used to clarify the role of specific brain regions in specific behaviours (e.g., CALDER et al. 2007). Second, recording scripted messages left to only a small number of faces (see also HUGHES et al. 2010) avoids participant fatigue, since repeating the scripted sentence many times would be tiring and have very low ecological validity. Unscripted recordings could be used in order to reduce fatigue and increase ecological validity, but since prosody varies depending on the sentence spoken, using a scripted message (rather than allowing participants to spontaneously generate their own) eliminates prosodic variation in pitch between different messages. Third, manufacturing stimuli from composite images ensures that stimuli are optimally representative of the intended category (TIDDEMAN et al. 2001), which is especially important when using a small number of stimuli (CONWAY et al. 2008). Indeed, this is why manipulated composite images have been used as stimuli in various studies of physiological and behavioural responses to faces (e.g., CONWAY et al. 2008; PERRETT et al. 1998; van LEEUWEN et al. 2009).

METHODS

Participants

Forty-five female undergraduate students (age: M = 20.2 years, SD = 3.32) at the University of Aberdeen participated in return for course credit. Only women reporting no use of hormonal contraceptives were tested in light of recent research suggesting that hormonal contraceptive use may disrupt potentially adaptive behaviors and preferences (e.g., FEINBERG et al. 2008b; LITTLE et al. 2002; PUTS 2006; ROBERTS et al. 2008; VUKOVIC et al. 2008), as well as altering voice pitch (AMIR et al. 2002).

Face stimuli

Following previous studies of perceptions of feminine and masculine faces (DEBRUINE et al. 2006; JONES et al. 2007), prototype-based image transformations were used to objectively and systematically manipulate sexual dimorphism of 2D shape in digital face images. Although other methods have been used to manipulate masculinity in face images (e.g., JOHNSTON et al. 2001), these methods have been shown to produce effects that are equivalent to those produced using the methods employed in our current study (DEBRUINE et al. 2006, 2010).

First, male and female prototype (i.e., average) faces were manufactured using established computer graphic methods that have been used widely in other studies of face perception (e.g., DEBRUINE et al. 2006; JONES et al. 2007, 2010b). Prototypes are composite images that are constructed by averaging the shape, color and texture of a group of faces, such as male or female faces. These prototypes can then be used to transform images by calculating the vector differences in position between corresponding points on two prototype images and changing the position of the corresponding points on a third image by a given percentage of these vectors (see ROWLAND and PERRETT 1995; TIDDEMAN et al. 2001 for technical details). Here, prototypes were manufactured using images of 24 young adult white men and 24 young adult white women (JONES et al. 2010b).

Next, following JONES et al. (2010b), 75% of the linear differences in 2D shape between symmetrized versions of the male and female prototypes were added to or subtracted from the male prototype image. This process created a masculinized and feminized version of the male prototype face (*Figure 1*), which were shown in the voicemail recording part of the experiment. These faces are referred to hereon as the 'seen' faces. Following DEBRUINE et al. (2006), masculinized and feminized versions of a further 10 face images of individual young adult white men were also manufactured by adding or subtracting 50% of the linear differences in 2D shape between symmetrized versions of the male and female prototypes from the individual images. These faces are referred to hereon as the 'unseen' faces, because they were not presented during the voicemail recording part of the experiment and were

only used to assess women's preferences for masculinized versus feminized versions of male faces. Previous studies have demonstrated that masculinized versions are perceived as more masculine, more dominant, and physically stronger than the feminized versions (e.g., DEBRUINE et al. 2006; JONES et al. 2010b; WELLING et al. 2007), confirming that using these methods to manipulate face shape affects perceptions of masculinity in the intended manner.

Figure 1. The feminized (left) and masculinized (right) protoype faces

Procedure

There were three parts to the experiment: voicemail recording, masculinity preference test for seen faces (i.e., those shown during the voicemail recording part), and a masculinity preference test for unseen faces (i.e., faces that were not shown during the voicemail recording part). The order in which participants completed these parts was fully randomized.

In the voicemail recording part of the experiment, the participant was shown the masculinized prototype face and left a voicemail message for him and, in a separate trial, was shown the feminized prototype face and left a voicemail message for him. The order of these trials was randomized between participants. On each trial, participants were shown the face image of one of the men (i.e., the masculinized or feminized prototype) along with the following instructions: "You met this person in a bar last night and he gave you his number. You called him tonight, but he's not home. Read the text below to leave a voicemail." The participant then read aloud the following text: "Hi, we met at the bar last night. I was just calling you to see if you wanted to go out sometime. Call me back." These messages were re-

corded using an Audio-Technica AT4041 microphone in a quiet room using Quicktime recording software, in mono, and at a sampling rate of 44.1 kHz with 16-bit amplitude quantization.

In the masculinity preference test for seen faces, participants were shown the masculinized and feminized prototype face images and asked to indicate which one was more attractive and the strength of this preference on a scale from 0 to 7 (0 = feminine face rated as much more attractive than the masculine face, 7 = masculine face rated as much more attractive than the feminine face). This face pair was presented within a block of unrelated trials consisting of other face pairs that did not differ in masculinity (i.e., filler trials).

The masculinity preference test for unseen faces was identical to that for seen faces, except that the 10 pairs of masculinized and feminized versions of the individual male faces (i.e., the unseen faces) were presented in a fully randomized order. We calculated the strength of masculinity preference for each participant by averaging scores on the 0 to 7 scale for the 10 pairs of faces in this sample.

Acoustic Analysis of Voice Recordings

Voices were analyzed for pitch using the autocorrelation function in Praat (BOERSMA and WEENINK 2009), using parameters described elsewhere (FEINBERG et al. 2008a). Mean voice pitch directed to the masculinized man was 222.8 Hz (*SD* = 28.3). Mean voice pitch directed to the feminized man was 224.1 Hz (*SD* = 24.8).

RESULTS

Initial analyses were conducted using ANCOVA. The dependent variable was *strength of masculinity preference*, the within-subjects factor was *masculinity preference test version* (seen faces, unseen faces), and the covariate was *difference in voice pitch*. *Difference in voice pitch* was calculated by subtracting the pitch directed to the feminine face from the pitch directed to the masculine face and ranged from –40.9 Hz to 26.5 Hz (M = –1.28 Hz, SD = 13.9 Hz; unsigned M = 10.5 Hz, SD = 9.18 Hz). All variables were normally distributed (all Kolmogorov-Smirnov $Z <$ 1.03, all $p > .24$).

The ANCOVA revealed a significant main effect of *difference in voice pitch* ($F_{1,43} = 5.58$, $p = .023$), whereby the strength of masculinity preference was positively correlated with average voice pitch ($r = .34$, $p = .023$, $N = 45$; *Figure 2*). There was no effect of *masculinity preference test version* ($F_{1,43} = 0.23$, $p = .63$). There was also no interaction between *masculinity preference test version* and *difference in voice pitch* ($F_{1,43} = 2.37$, $p = .13$), which indicates that *difference in voice pitch* was equally well correlated with both versions of the masculinity preference test.

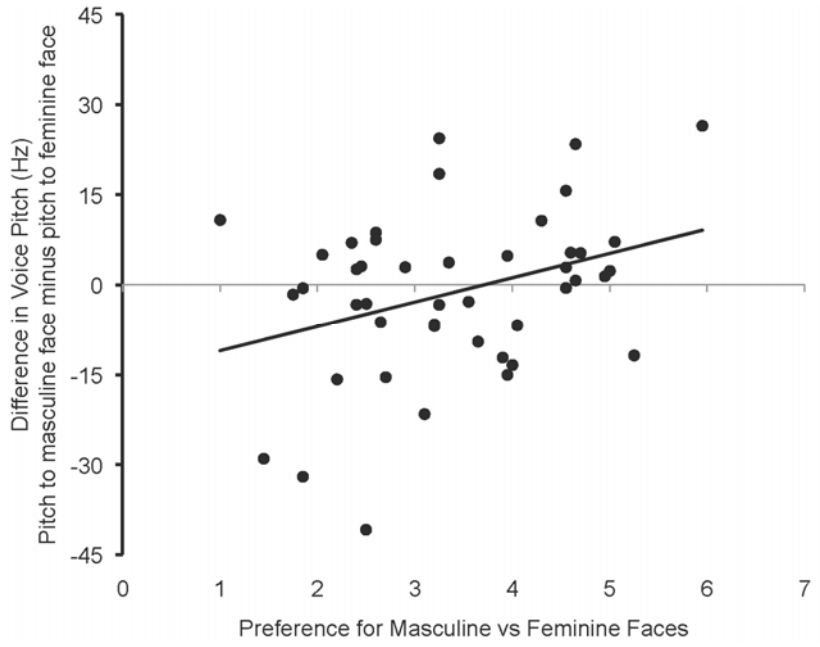

Figure 2. Difference in voice pitch (i.e. pitch to masculine face minus pitch to feminine face) was positively correlated with the strength of preference for masculine faces, averaged over both masculinity preference tests. A positive difference in voice pitch indicates greater pitch towards the masculine than the feminine face, and a negative difference in voice pitch indicates greater pitch towards the feminine than the masculine face

DISCUSSION

In order to test whether women modulate their voice pitch in response to men's facial attractiveness in a mating context, we recorded women leaving a voicemail message to arrange a date with each of two versions of a composite face that differed in facial masculinity. We also measured women's preference for the masculine *versus* feminine prototype faces and their preferences for masculinity in a sample of individual male faces that were not shown in the voicemail recording part of the experiment. We found that the extent to which women preferred masculine faces, irrespective of whether preferences were assessed using faces that were or were not presented during the voicemail recording part of the experiment, was positively correlated with the extent to which they spoke with a higher voice pitch when leaving a voicemail for the masculine man than when leaving a voicemail for the relatively feminine man. As we had predicted, women tended to speak with a higher voice pitch to the type of man that they found more attractive; women who demonstrated a particularly strong preference for masculine men tended to speak with

higher voice pitch to the masculine man and women who demonstrated a particularly strong preference for feminine men tended to speak with higher voice pitch to the feminine man (see *Figure 2*).

Because our study is correlational, the magnitude of differences in pitch is dependent on the strength of preference for the masculinized versus feminized faces. Therefore, the exact magnitude of pitch differences to preferred and non-preferred men remains unclear. However, the 20% of women with the strongest masculinity preference spoke to the masculine face with a voice pitch on average 6.7 Hz higher than to the feminine face, while the 20% of women with the strongest femininity preference spoke to the feminine face with a voice pitch on average 6.6 Hz higher than to the masculine face. Because the just noticeable difference for change in voice pitch is ~3Hz (STEVENS 1998), in our paradigm, women with strong preferences for one face spoke to him with a detectably higher voice pitch. Further work is needed to establish whether attraction-contingent vocal responses in more ecologically valid settings are also detectable.

Since men show strong preferences for women's voices with raised pitch (COLLINS and MISSING 2003; FEINBERG et al. 2008a; JONES et al. 2008a, 2010a; APICELLA and FEINBERG 2009), speaking with higher voice pitch to men that they find particularly attractive may function to increase women's attractiveness to preferred potential mates. Moreover, such facultative responses may help women to optimize the effort that they expend in order to attract and retain preferred mates. Our experimental finding that women's voice pitch is higher when talking to men that they find particularly attractive complements findings from observational studies showing that women's proceptive behavior is modulated by their interest in the man with whom they are interacting (GRAMMER et al. 1999). Importantly, however, previous research showing that men and women speak with lower pitch when leaving voicemail messages for physically attractive individuals as part of a survey into attitudes to psychology (HUGHES et al. 2010), suggests that the effect of male attractiveness on women's voice pitch that was observed in our experiment may be relatively specific to mating contexts. Our results also compliment findings from a recent study showing that men's preferences for cues of proceptivity in women's voices are enhanced when voice pitch is raised (JONES et al. 2008a). We note here that we do not suggest that there is anything about masculinity specifically that will be particularly important for the modulation of women's vocal responses in mating contexts and suggest that similar attraction-contingent vocal responses are likely to occur when other attractive characteristics are manipulated.

Previous research has shown that raised pitch in women's voices is attractive (COLLINS and MISSING 2003; FEINBERG et al. 2008a; JONES et al. 2008a, 2010a; APICELLA and FEINBERG 2009), particularly to men (FEINBERG et al. 2008a; JONES et al. 2008a, 2010a). Here we present experimental evidence that women modulate their voice pitch as a facultative response that may function to reduce the amount of mating effort they must expend in order to attract and retain preferred mates. While previous research has emphasized the importance of women's context-free voice

pitch for their attractiveness and mating behavior (e.g., COLLINS and MISSING 2003; FEINBERG et al. 2008a; JONES et al. 2008a, 2010a; APICELLA and FEINBERG 2009), our findings emphasize the context-sensitivity of women's voice pitch and the possible effects of this context-sensitivity on men's perceptions of their mate value. By raising their voice pitch when speaking to men they consider attractive, women may increase their attractiveness to preferred mates while avoiding expending mating effort on non-preferred mates, potentially increasing their reproductive success.

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