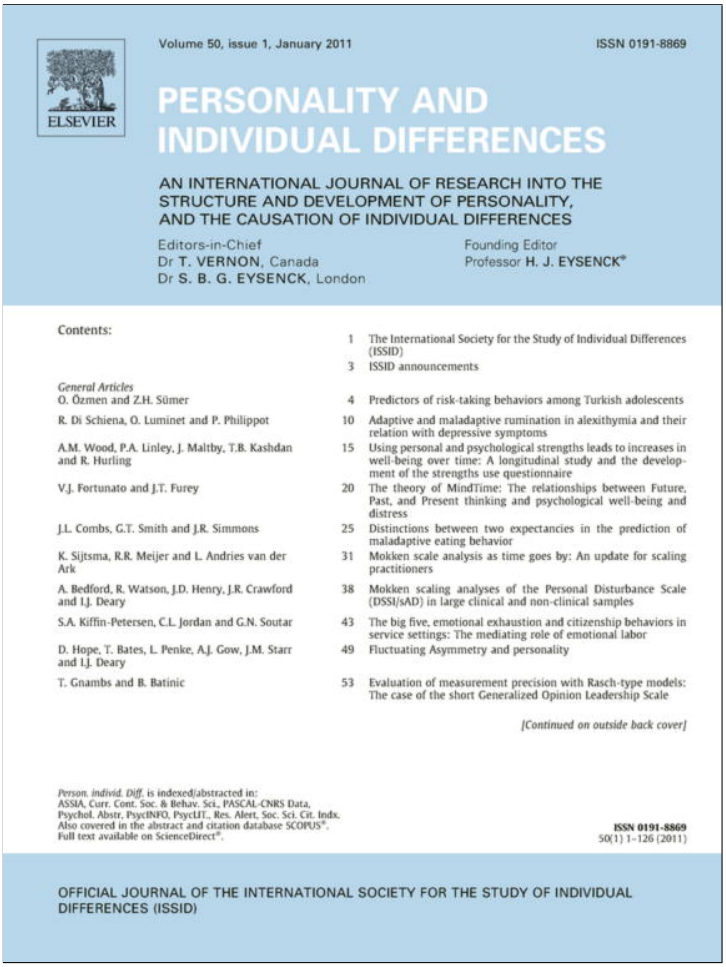

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Intrasexual competition among women: Vocal femininity affects perceptions of attractiveness and flirtatiousness

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ABSTRACT

Cognitive mechanisms for recognizing high quality sexual rivals should facilitate the economical allocation of mating effort. Women compete to attract male investment, and previous studies have shown that feminine voices are attractive to men. Here, we manipulated two sexually dimorphic acoustic parameters in women's voices, fundamental frequency and formant dispersion, by the same perceptual amounts and explored the effects on attractiveness to heterosexual men in short- and long-term mating contexts. Femininity in both acoustic parameters was more attractive to men, especially in short-term mating contexts, and formant dispersion had a larger effect than did fundamental frequency. We then explored the effects of these manipulations on women's perceptions of other women's flirtatiousness and attractiveness to men. Feminine voices were perceived as more flirtatious and more attractive to men, and women were most sensitive to formant dispersion, the acoustic parameter that had the stronger effect on men's preferences. These results support the interpretation that women use vocal femininity to track the threat potential of competitors.

1. Introduction

Among mammals, humans exhibit an extraordinary level of paternal investment (Geary & Flinn, 2001). Consequently, women exhibit extraordinarily intense competition for male investment (Trivers, 1972). Over human evolution, female mating competition appears to have been characterized predominantly by efforts to attract mates. Although women engage relatively infrequently in other forms of mating competition, such as rival-directed physical aggression (Archer, 2009; Puts, 2010), they endeavor to look attractive (Cashdan, 1996; Schmitt & Buss, 1996), and they possess anatomical traits, such as neotenous faces and body fat deposition on the hips and breasts, that evidence design by male mate choice (reviewed in Puts, 2010).

Women's voices may also have been shaped by men's preferences. Men and women differ by more than five standard deviations in voice pitch (Baken, 1987), 3.5 times the sex difference in height. Vocal sex differences are determined by multiple dimensions of the vocal folds and supra-laryngeal vocal tract. Longer, thicker vocal folds generate a lower rate of vocal fold vibration, or fundamental frequency (F_0), the acoustic parameter most closely associated with pitch (Titze, 2000). The length and shape of the vocal tract determine the formants: frequencies of high energy (Fitch & Giedd, 1999). Longer vocal tracts produce lower, more closely spaced formants, giving the voice a more resonant sound and fuller timbre. Formant dispersion (D_f) is the average distance between successive formants (Fitch, 1997). Because women have shorter, thinner vocal folds and shorter supra-laryngeal vocal tracts (Fant, 1960), they have a higher F_0 and D_f than men do.

Men's deeper voices may have been produced by male contest competition (use of force or threat to win mates: Evans, Neave, & Wakelin, 2006; Hodges-Simeon, Gaulin, & Puts, 2010; Puts, Gaulin, & Verdolini, 2006; Puts, Hodges, Cardenas, & Gaulin, 2007; Wolff & Puts, 2010) and female choice (Collins, 2000; Evans et al., 2006; Feinberg, Jones, Little, Burt, & Perrett, 2005; Puts, 2005). However, male mate choice may also have produced or maintained higher, more youthful-sounding voices in women. Indeed, several authors have found that high, feminine voices are attractive to heterosexual men (Apicella & Feinberg, 2009; Collins & Missing, 2003; Feinberg, DeBruine, Jones, & Perrett, 2008; Jones, Feinberg, DeBruine, Little, & Vukovic, 2008, 2010).

Men's preferences for women's voices may be context-dependent. On the one hand, feminine voices could be preferred more in long-term, committed mating contexts than in short-term, sexual ones because competition for male investment (Cashdan, 1996) should favor feminine traits to attract this investment. On the other hand, physical attractiveness tends to be more salient to

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men considering short-term, uncommitted relationships, whereas men considering long-term relationships place greater weight on parenting skills, honesty, intelligence, fidelity, and likeability (Buss & Schmitt, 1993; Greitemeyer, 2007; Li, 2007). Although men lower their standards in short-term mating contexts (Buss & Schmitt, 1993), their standards for physical attractiveness drop less than their standards for other qualities (Kenrick, Groth, Trost, & Sadalla, 1993), perhaps because physical attractiveness reflects fertility (Singh, 1995; Thornhill & Gangestad, 1999) or sexual availability (see below), which men appear to value more highly in short-term partners. Thus, men could prefer feminine voices more when judging women's attractiveness for short-term rather than long-term relationships.

Feminine voices may also indicate sexual interest and availability. Feminine voices are more attractive when verbal content indicates interest (Jones et al., 2008), and women's vocal attractiveness predicts their reported age of first sexual intercourse and numbers of sexual partners, extra-pair sexual partners, and sexual partners involved in another relationship (Hughes, Dispenza, & Gallup, 2004). Moreover, women with attractive, feminine bodies report being more flirtatious, having more sex partners, and are perceived as less faithful by observers (Mikach & Bailey, 1999; Singh, 2004), and women with attractive faces are perceived as more promiscuous (Brewer & Archer, 2007) and are more open to uncommitted relationships (Boothroyd, Jones, Burt, DeBruine, & Perrett, 2008). Women's voices appear to increase in femininity (Bryant & Haselton, 2009) and attractiveness (Pipitone & Gallup, 2008) near ovulation, when women are more interested in interacting with men (Guegen, 2009; Haselton & Gangestad, 2006) and in extra-pair copulations (Pillsworth & Haselton, 2006), also suggesting a link between vocal femininity and sexual interest.

If feminine voices are attractive to men and indicate sexual interest and availability, then women should be sensitive to vocal femininity when assessing possible competitors. To a woman competing for male investment, attractive, sexually interested and available women are potential threats worth monitoring. Moreover, information about the mate value of competitors can promote efficient allocation of mating effort toward attainable mating opportunities. Evidence indicates that women are indeed sensitive to the physical attractiveness of potential competitors. For example, women perceive other women that they rate as facially attractive to be greater threats to relationships (Brewer & Archer, 2007) and judge greater facial or bodily attractiveness in a rival to be highly distressing (Buss, Shackelford, Choe, Bunnk, & Dijkstra, 2000). Women also rate themselves as less desirable partners after viewing facial photographs of attractive women (professional models) (Gutierres, Kenrick, & Partch, 1999).

In the present study, we explored how women perceive the vocal femininity of potential rivals for mates. Before doing so, we first sought to:

(1) Replicate the finding that men prefer feminine voices.
(2) Investigate whether men's preferences for feminine voices are greater when judging women's attractiveness for short-term, sexual relationships or for long-term, committed relationships.
(3) Examine the relative effects of F_0 and D_f on these perceptions by manipulating each acoustic parameter by the same perceptual amount.

We then tested the following predictions about women's perceptions of the threat potential of other women:

(1) Women will evaluate more feminine voices as being more attractive to men.
(2) Women will evaluate more feminine voices as indicating greater sexual receptivity and proceptivity (i.e., flirtatiousness).
(3) Women's evaluations will be influenced more strongly by variation in the acoustic parameter with the greater effect on attractiveness to men.

2. Material and methods

2.1. JND study

2.1.1. Participants

We recruited 20 male and 20 female university students (ages 18–30) through on-campus advertizing, word of mouth, and announcements made in classes for a just-noticeable difference (JND) study. We asked participants to report any hearing impairments; none did.

2.1.2. Procedure

To explore the relative contributions of formant dispersion (timbre) and fundamental frequency (pitch) to perceptions of attractiveness and flirtatiousness, we needed to manipulate these acoustic parameters by equivalent perceptual amounts. We therefore conducted a JND study (Marks & Gescheider, 2002). Although other authors have determined JNDs for vocal parameters, JNDs may vary according to the specific methods and stimuli of each study (see Puts et al., 2007).

From another study, we obtained recordings of 160 women (20.43 years ± 1.53) reading the first six sentences of the Rainbow Passage (Fairbanks, 1960) in an anechoic, soundproof recording booth into a Shure SM58 vocal cardioid microphone. A curved wire projection from the microphone stand kept the participant's mouth a standard 9.5 cm from the microphone. Voices were recorded in mono at a sampling rate of 44,100 Hz using Goldwave software.

We divided recordings into the following clips (mean duration = 4 s): (1) "When the sunlight strikes raindrops in the air, they act as a prism and form a rainbow". (2) "The rainbow is a division of white light into many beautiful colors". (3) "These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon". (4) "There is, according to legend, a boiling pot of gold at one end". We selected four voices, each reading a different segment, and chose recordings that were articulated clearly, without unnecessary pauses.

We manipulated each voice in both F_0 and D_f using Praat voice analysis software v5.1.20. F_0 was manipulated in 18 (nine raised, nine lowered) increments of .05 equivalent rectangular bandwidths (ERB, Stevens, 1998), while D_f was manipulated in 18 increments of .25%. F_0 manipulations ranged from .05 to .50 ERB, and D_f manipulations ranged from 1.25% to 3.25%. We measured voice manipulations using Praat to ensure accuracy and precision and repeated unsatisfactory manipulations. All F_0 manipulations were within .01 of the expected ERB, and all D_f manipulations were within .09% of the expected shift. Next, we measured each manipulated voice for the parameter that we did not intend to manipulate (i.e., we measured D_f in voices manipulated in F_0 and F_0 in voices manipulated in D_f) to ensure that the secondary parameter was not altered. If this secondary parameter was shifted slightly during the manipulation, then it was manipulated back. When D_f was the manipulated parameter, F_0 shifts did not differ significantly from zero (beta = .089, $t = -.553$. $p = .583$); when F_0 was manipulated, D_f shifts did not differ significantly from zero (beta = .025, $t = .145$, $p = .886$).

We created the study interface using the stimulus presentation software Superlab v4.0. We paired each voice clip with the clip equidistant from the null (e.g., we paired a speaker's +.35 ERB clip with that speaker's −.35 ERB clip). Voice pairs were counterbalanced so

that half of the time the lowered voice was played first, and half of the time the raised voice was played first. Each rater listened to all voice pairs and indicated whether he or she could hear a difference between the two voices. To analyze the results, we tabulated every rater's response for a given equidistant pair, and then summed the totals for men and for women. Because there were no sex differences in responses, we pooled data from both sexes. We then interpolated the JND using the best-fit line for the two manipulation points above and below a 50% detection rate. For F_0, the JND was 0.215 ERB, and for D_f, the JND was 5.53%.

2.2. Main study

2.2.1. Participants

We recruited 63 male (mean age: 19.7) and 46 female (mean age: 18.8) university students through the university's psychology department research subject pool (age range = 18–29; sex difference: $t_{102} = 2.89$, $p = .005$). We asked participants to report any hearing impairments; none did. Participants completed a questionnaire targeting sexual orientation using the Kinsey scale (Kinsey, Pomeroy, & Martin, 1948). We retained the data of participants with Kinsey scores of 0–2 (0 = exclusively heterosexual, 6 = exclusively homosexual) on both the Kinsey Attraction and Fantasy scales for further analysis. Two women and one man did not meet these criteria, and one woman and three men did not answer these items. Results did not differ significantly if we included all participants in the analyses.

2.2.2. Procedure

We selected 72 voice clips from the same set of voice recordings and used the same criteria as in the JND study (articulated clearly, without unnecessary pauses), except that we used segments 1, 2, and 4 from the Rainbow Passage above, and the fourth segment included an additional sentence to make the stimuli more similar in length (mean length: 5.5 s): "People look, but no one ever finds it". We raised and lowered 36 voice clips by one JND in F_0, and the remaining 36 voice clips by one JND in D_f. We checked stimuli for accuracy and precision (manipulating back the secondary acoustic parameter, if necessary) using the procedures and criteria described above. F_0 manipulations did not differ significantly from target values (mean difference = .0001, $t_{71} = .14$, $p = .891$), and D_f was not shifted significantly in the process (mean difference from zero = .236, $t_{71} = -.18$, $p = .855$). D_f manipulations did not differ significantly from target values (mean difference = .367, $t_{71} = .43$, $p = .671$), and F_0 was not shifted significantly in the process (mean difference from zero = .292, $t_{71} = 1.52$, $p = .133$).

We split stimuli into two equal sets, each containing 18 masculinized vs. feminized F_0 pairs and 18 masculinized vs. feminized D_f pairs. We randomly assigned each participant to one stimulus set. Order of voice presentation (feminized or masculinized first) was counterbalanced within sets. Male participants evaluated voices on attractiveness for a short-term, sexual relationship and a long-term, committed relationship. Female participants evaluated voices on their attractiveness to heterosexual men and flirtatiousness. Order of presentation of the questions on which participants evaluated was counterbalanced across participants. Participants evaluated using a scale of 1–8, where 1 represents the strongest choice of the first voice, and 8 represents the strongest choice of the second voice.

2.2.3. Data treatment

After data collection, we recoded reverse-scored items so that a response of 1 represented the strongest choice of the masculinized voice, and a response of 8 represented the strongest choice of the feminized voice. We then calculated each participant's average preference for femininity across all items. A value of 4.5 would represent no overall preference for masculinity or femininity.

3. Results

3.1. Men

We analyzed men's data using repeated-measures ANOVA with two factors (acoustic parameter, characteristic assessed), each with two levels (F_0 vs. D_f and short- vs. long-term attractiveness, respectively). In general, men preferred feminized female voices (Fig. 1). D_f had a significantly larger main effect than did F_0 ($F_{1,58} = 45.70$, $p < .0001$). Vocal femininity affected short-term attractiveness more than it did long-term attractiveness ($F_{1,58} = 15.33$, $p < .001$). Post-hoc repeated-measures ANOVA revealed that F_0 and D_f individually had significantly larger effects on short-term attractiveness than they did on long-term attractiveness (F_0: $F_{1,58} = 17.08$, $p < .001$; D_f: $F_{1,58} = 9.78$, $p < .003$). Short-term and long-term attractiveness were both significantly more strongly related to D_f than to F_0 (D_f: $F_{1,58} = 26.47$, $p < .0001$; F_0: $F_{1,58} = 23.98$, $p < .0001$).

Men preferred a feminized F_0 for short- but not long-term relationships (one-sample t-test against null value of 4.5: short-term: $t_{58} = 6.63$, $p < .0001$; long-term: $t_{58} = 1.52$, $p = .133$). Men preferred a feminized D_f for both short- and long-term relationships (one-sample t-test against null value of 4.5: short-term: $t_{58} = 9.23$, $p < .0001$; long-term: $t_{58} = 5.22$, $p < .0001$).

3.2. Women

We analyzed women's data separately using repeated-measures ANOVA with two factors (acoustic parameter, characteristic assessed), each with two levels (F_0 vs. D_f and short- vs. long-term attractiveness, respectively). Overall, vocal femininity did not affect ratings of attractiveness more than flirtatiousness ($F_{1,42} = 2.23$, $p = .143$). However, post-hoc repeated-measures ANOVA revealed that F_0 had a marginally significantly larger effect on flirtatiousness than it did on attractiveness ($F_{1,42} = 4.03$, $p = .051$), but D_f did not differently affect attractiveness and flirtatiousness ($F_{1,42} = 0.62$, $p = .436$). D_f had a significantly larger main effect than did F_0 ($F_{1,42} = 37.61$, $p < .0001$). Attractiveness and flirtatiousness were both significantly more strongly related to D_f than to F_0 (attractiveness: $F_{1,42} = 25.25$, $p < .0001$; flirtatiousness: $F_{1,42} = 35.73$, $p < .0001$) (Fig. 2).

Women perceived voices feminized in either F_0 or D_f as more attractive to men (one-sample t-test against null value of 4.5: F_0:

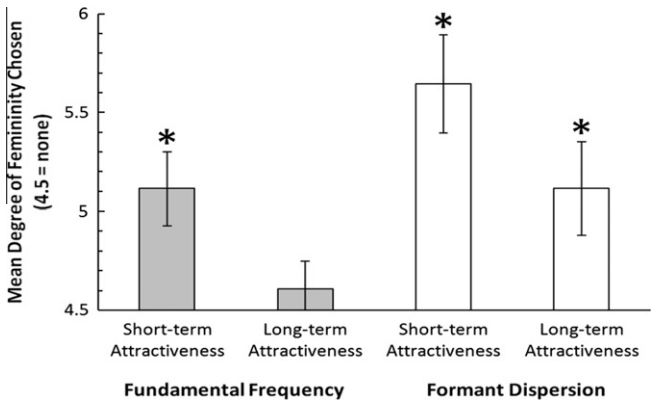

Fig. 1. Results for men. Formant dispersion had a larger overall effect than fundamental frequency. Vocal femininity had significantly larger effects on short- than on long-term attractiveness. * = Choice of feminized voices significantly greater than chance ($p < .0001$).

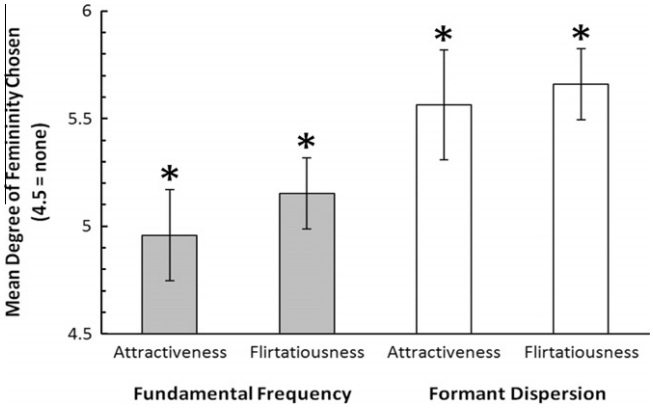

Fig. 2. Results for women. Formant dispersion had a larger overall effect than fundamental frequency, and femininity had effects on both attractiveness and flirtatiousness but more so on flirtatiousness. * = Choice of feminized voices significantly greater than chance ($p < .0001$).

$t_{43} = 4.38$, $p < .0001$; D_f: $t_{43} = 8.44$, $p < .0001$) and more flirtatious (one-sample t-test against null value of 4.5: F_0: $t_{43} = 8.01$, $p < .0001$; D_f: $t_{43} = 14.09$, $p < .0001$).

4. Discussion

4.1. Attractiveness to men

This paper replicates previous findings (Apicella & Feinberg, 2009; Feinberg et al., 2008; Jones et al., 2008, 2010) that feminized female voices are more attractive to men than are masculinized voices. Under no condition was a masculinized pitch favored, and in three of four contexts, a preference for feminized voices was statistically significant. Only for F_0 manipulations and a long-term mating context was the trend for men to prefer a more feminine voice not statistically significant.

The female voice could serve as a cue of youth and fertility (Collins & Missing, 2003). Given the comparative neoteny of women's features (Jones & Hill, 1993; McArthur & Berry, 1983) and the tendency for men to prefer younger partners (Buss, 1989), it is a reasonable hypothesis that intersexual selection maintained high, youthful-sounding voices in women. In contrast, intrasexual dominance competition may have shaped men's deeper voices more strongly than did female preferences (Hodges-Simeon et al., 2010; Puts et al., 2006, 2007; Wolff & Puts, 2010).

4.2. Mating context

This paper presents several novel results. Ours is the first study of which we are aware to explore the effects of mating context on men's preferences for women's voices. Men exhibited stronger preferences for vocal femininity in short-term than in long-term mating contexts. Moreover, F_0 and D_f individually had significantly larger effects on short-term attractiveness than they did on long-term attractiveness.

This effect of mating context is illuminating. Assuming that women compete to gain male investment (Cashdan, 1996), sexual selection should favor traits in women that attract this investment; a feminine voice might be one such trait. If so, then one might predict that feminine voices would be preferred more in long-term, committed mating contexts than in short-term, sexual ones.

One might also predict the opposite. This is because a number of considerations beyond physical attractiveness, such as personality, intelligence, parenting ability, and fidelity (Buss & Schmitt, 1993; Greitemeyer, 2007; Li, 2007; Little, Cohen, Jones, & Belsky, 2007; Regan, Levin, Sprecher, Christopher, & Cate, 2000) go into selecting a long-term mate, whereas signs of fertility (Singh, 1995; Thornhill & Gangestad, 1999) and sexual availability (Hughes et al., 2004) may be of predominant importance to men selecting short-term partners. Men's mating standards, including standards for physical attractiveness, apparently decline for short-term relationships relative to marriage (Kenrick et al., 1993). However, whereas men reported that attractiveness was of comparable or lesser importance than agreeableness and emotional stability for marriage, attractiveness was the most essential mate choice criterion for a "one-night stand" and "sexual relations" (Kenrick et al., 1993). Men may accept a less attractive woman as a short-term partner compared to a marriage partner (i.e., their *standards* are lower), but their choice of short-term partners is more dependent upon the woman's physical attractiveness (i.e., their *preference* is stronger). Otherwise put, the *relative* importance of physical attractiveness is greater in short-term contexts.

Women's voices may nevertheless have evolved to obtain male investment. In the present study, vocal femininity increased women's attractiveness as long-term mates. In addition, it is possible that feminine voices increased male investment ancestrally by enticing men to consider sexual relationships, given that such relationships can lead to long-term relationships and investment. These results thus shed new light on how men choose and women compete for mates.

4.3. Effects of F_0 and D_f

We also explored the relative effects of F_0 and D_f on attractiveness to men and threat potential to women. We accomplished this by manipulating F_0 and D_f by the same perceptual amounts (increasing and decreasing voice clips by one JND in each acoustic parameter). We found that both D_f and F_0 contributed significantly to perceptions of attractiveness and flirtatiousness, but that D_f made a larger contribution. For male listeners, short-term and long-term attractiveness were significantly more strongly related to D_f than to F_0. For female listeners, attractiveness and flirtatiousness were significantly more strongly related to D_f than to F_0.

4.4. Threat potential

The principal findings of this paper are that women perceived feminized female voices as more attractive to men and more flirtatious, and that women were more sensitive to the acoustic parameter (D_f) that more strongly affected men's preferences. These results support the prediction that women use vocal characteristics to track the threat potential of their competitors.

Women may perceive rivals with feminine voices as more threatening because men find feminine voices attractive, and mate attraction is a major avenue by which women compete for mates (Cashdan, 1996). Men may be willing to offer greater investment or abandon a current mate for an attractive woman due to her high mate value, thus threatening other women's abilities to attract and maintain relationships with desirable partners (Brewer & Archer, 2007). Rivals with more attractive faces or bodies were found to be distressing to women (Buss et al., 2000), and women rate more facially attractive women as more promiscuous, stronger threats to relationships, and less acceptable for introduction to family and friends (Brewer & Archer, 2007). Women also rate themselves as less desirable partners after viewing facial photographs of attractive women (Gutierres et al., 1999). Given that a feminine voice is attractive to men, and attractive, feminine voices may signal sexual interest and availability in women (Hughes et al., 2004), it has likely been important over human evolution for women to monitor the vocal femininity of rivals.

4.5. Limitations

Our results suggest that D_f is more salient than F_0 in perceptions of attractiveness and flirtatiousness. However, it is possible that one JND manipulations in F_0 and D_f produce differing changes in apparent masculinity/femininity. This might be true if one acoustic parameter was manipulated by a greater proportion of the natural within-sex variation (more standard deviations, SD). Bryant and Haselton (2009) reported on the SD of women's F_0 and D_f. Averaged across two menstrual cycle phases, the SDs were 22.65 and 49.65 Hz for F_0 and D_f, respectively. In the present study, stimulus voices were manipulated on average by 10.56 Hz in F_0, approximately 0.47 SD, and D_f was manipulated on average by 62.64 Hz, approximately 1.26 SD. Because our manipulations were shifted by more SD in D_f, the larger main effect of D_f may have resulted from vocal femininity being modified to a greater extent when D_f was manipulated than when F_0 was manipulated, despite both manipulations being equally audible.

4.6. Future research

Future studies should further tease apart the perceptual differences between F_0 and D_f by manipulating these acoustic variables by the same number of within-sex standard deviations. More work is also needed to clarify what messages vocal traits are sending to potential mates and competitors—that is, what do pitch, timbre, and other aspects of voices advertize? Because men prefer feminine voices, one might also expect that women vying for the attentions of men would elevate vocal femininity by raising the pitch and timbre of their voices, a possibility that invites testing.

References

Apicella, C. L., & Feinberg, D. R. (2009). Voice pitch alters mate-choice-relevant perception in hunter-gatherers. *Proceeding of the Royal Society B: Biological Sciences, 276*, 1077–1082.

Archer, J. (2009). Does sexual selection explain human sex differences in aggression? *Behavioral and Brain Sciences, 32*, 249–266.

Baken, R. J. (1987). *Clinical measurement of speech and voice*. Boston: Little, Brown, and Co.

Boothroyd, L., Jones, B. C., Burt, D. M., DeBruine, L. M., & Perrett, D. I. (2008). Facial correlates of sociosexuality. *Evolution and Human Behavior, 29*, 211–218.

Brewer, G., & Archer, J. (2007). What do people infer from facial attractiveness? *Journal of Evolutionary Psychology, 5*, 1–11.

Bryant, G. A., & Haselton, M. G. (2009). Vocal cues of ovulation in human females. *Biology Letters, 5*, 12–15.

Buss, D. M. (1989). Sex differences in human mate preferences: Evolutionary hypotheses tested in 37 cultures. *Behavioral and Brain Sciences, 12*, 1–49.

Buss, D. M., & Schmitt, D. P. (1993). Sexual strategies theory: An evolutionary perspective on human mating. *Psychological Review, 100*, 204–232.

Buss, D. M., Shackelford, T. K., Choe, J. C., Bunnk, B., & Dijkstra, P. (2000). Distress about mating rivals. *Personal Relationships, 7*, 235–243.

Cashdan, E. (1996). Women's mating strategies. *Evolutionary Anthropology, 5*, 134–143.

Collins, S. A. (2000). Men's voices and women's choices. *Animal Behaviour, 60*, 773–780.

Collins, S. A., & Missing, C. (2003). Vocal and visual attractiveness are related in women. *Animal Behaviour, 65*, 997–1004.

Evans, S., Neave, N., & Wakelin, D. (2006). Relationships between vocal characteristics and body size and shape in human males: An evolutionary explanation for a deep male voice. *Biological Psychology, 72*, 160–163.

Fairbanks, G. (1960). *Voice and articulation drillbook* (2nd ed.). New York: Harper and Row.

Fant, G. (1960). *Acoustic theory of speech production*. The Hague: Mouton.

Feinberg, D. R., DeBruine, L. M., Jones, B. C., & Perrett, D. I. (2008). The role of femininity and averageness of voice pitch in aesthetic judgments of women's voices. *Perception, 37*, 615–623.

Feinberg, D. R., Jones, B. C., Little, A. C., Burt, D. M., & Perrett, D. I. (2005). Manipulations of fundamental and formant frequencies affect the attractiveness of human male voices. *Animal Behaviour, 69*, 561–568.

Fitch, W. T. (1997). Vocal tract length and formant frequency dispersion correlate with body size in rhesus macaques. *Journal of the Acoustical Society of America, 102*, 1213–1222.

Fitch, W. T., & Giedd, J. (1999). Morphology and development of the human vocal tract: A study using magnetic resonance imaging. *Journal of the Acoustical Society America, 106*(3 Pt 1), 1511–1522.

Geary, D. C., & Flinn, M. V. (2001). Evolution of human parental behavior and the human family. *Parenting: Science and Practice, 1*, 5–61.

Greitemeyer, T. (2007). What do men and women want in a partner? Are educated partners always more desirable? *Journal of Experimental Social Psychology, 43*, 180–194.

Guegen, N. (2009). Menstrual cycle phase and female receptivity to a courtship solicitation: An evaluation in a nightclub. *Evolution and Human Behavior, 30*, 351–355.

Gutierres, S. E., Kenrick, D. T., & Partch, J. J. (1999). Beauty, dominance, and the mating game: Contrast effects in self-assessment reflect gender differences in mate selection. *Personality and Social Psychology Bulletin, 25*, 1126–1134.

Haselton, M. G., & Gangestad, S. W. (2006). Conditional expression of women's desires and men's mate guarding across the ovulatory cycle. *Hormones and Behavior, 49*, 509–518.

Hodges-Simeon, C. R., Gaulin, S. J. C., & Puts, D. A. (2010). Voice correlates of mating success in men: Examining "contests" versus "mate choice" modes of sexual selection. *Archives of Sexual Behavior*. doi:10.1007/s10508-010-9625-0.

Hughes, S. M., Dispenza, F., & Gallup, G. G. (2004). Ratings of voice attractiveness predict sexual behavior and body configuration. *Evolution and Human Behavior, 25*, 295–304.

Jones, B. C., Feinberg, D. R., DeBruine, L. M., Little, A. C., & Vukovic, J. (2008). Integrating cues of social interest and voice pitch in men's preferences for women's voices. *Biology Letters, 4*, 192–194.

Jones, B. C., Feinberg, D. R., DeBruine, L. M., Little, A. C., & Vukovic, J. (2010). A domain-specific opposite-sex bias in human preferences for manipulated voice pitch. *Animal Behaviour, 79*, 57–62.

Jones, D., & Hill, K. (1993). Criteria of facial attractiveness in five populations. *Human Nature, 4*, 271–296.

Kenrick, D., Groth, G., Trost, M., & Sadalla, E. (1993). Integrating evolutionary and social exchange perspectives on relationships: Effects of gender, self-appraisal, and involvement level on mate selection criteria. *Journal of Personality and Social Psychology, 64*, 951–969.

Kinsey, A. C., Pomeroy, W. B., & Martin, C. E. (1948). *Sexual behavior in the human male*. Philadelphia: W.B. Saunders.

Li, N. P. (2007). Mate preference necessities in long- and short-term mating: People prioritize in themselves what their mates prioritize in them. *Acta Psychologica Sinica, 39*, 528–535.

Little, A. C., Cohen, D. L., Jones, B. C., & Belsky, J. (2007). Human preferences for facial masculinity change with relationship type and environmental harshness. *Behavioral Ecology and Sociobiology, 61*, 967–973.

Marks, L. E., & Gescheider, G. A. (2002). Psychophysical scaling. In H. Pashler & J. Wixted (Eds.), *Stevens' handbook of experimental psychology* (3rd ed., Vol. 4: Methodology in experimental psychology, pp. 91–138). Hoboken, NJ: John Wiley and Sons.

McArthur, L. Z., & Berry, D. S. (1983). Impressions of baby-faced adults. *Social Cognition, 2*, 315–342.

Mikach, S. M., & Bailey, J. M. (1999). What distinguishes women with unusually high numbers of sex partners? *Evolution and Human Behavior, 20*, 141–150.

Pillsworth, E. G., & Haselton, M. G. (2006). Male sexual attractiveness predicts differential ovulatory shifts in female extra-pair attraction and male mate retention. *Evolution and Human Behavior, 27*, 247–258.

Pipitone, N. R., & Gallup, G. G. Jr., (2008). Women's voice attractiveness varies across the menstrual cycle. *Evolution and Human Behavior, 29*, 268–274.

Puts, D. A. (2005). Mating context and menstrual phase affect women's preferences for male voice pitch. *Evolution and Human Behavior, 26*, 388–397.

Puts, D. A. (2010). Beauty and the beast: Mechanisms of sexual selection in humans. *Evolution and Human Behavior, 31*, 157–175.

Puts, D. A., Gaulin, S. J. C., & Verdolini, K. (2006). Dominance and the evolution of sexual dimorphism in human voice pitch. *Evolution and Human Behavior, 27*, 283–296.

Puts, D. A., Hodges, C., Cardenas, R. A., & Gaulin, S. J. C. (2007). Men's voices as dominance signals: Vocal fundamental and formant frequencies influence dominance attributions among men. *Evolution and Human Behavior, 28*, 340–344.

Regan, P. C., Levin, L., Sprecher, S., Christopher, F. S., & Cate, R. (2000). Partner preferences: What characteristics do men and women desire in their short-term sexual and long-term romantic partners? *Journal of Psychology and Human Sexuality, 12*, 1–21.

Schmitt, D. P., & Buss, D. M. (1996). Strategic self-promotion and competitor derogation: Sex and context effects on the perceived effectiveness of mate attraction tactics. *Journal of Personality and Social Psychology, 70*, 1185–1204.

Singh, D. (1995). Female health, attractiveness and desirability for relationships: Role of breast asymmetry and waist-to-hip ratio. *Ethology and Sociobiology, 16*, 465–481.

Singh, D. (2004). Mating strategies of young women: Role of physical attractiveness. *Journal of Sex Research, 41*, 43–54.

Stevens, K. (1998). *Acoustic phonetics*. Cambridge, Massachusetts: MIT Press.

Thornhill, R., & Gangestad, S. W. (1999). Facial attractiveness. *Trends in Cognitive Sciences, 3*, 452–460.

Titze, I. R. (2000). *Principles of voice production*. Iowa City, Iowa: National Center for Voice and Speech.

Trivers, R. L. (1972). Parental investment and sexual selection. In B. Cambell (Ed.), *Sexual selection and the descent of man, 1871–1971* (pp. 136–179). London: Heinemann.

Wolff, S. E., & Puts, D. A. (2010). Vocal masculinity is a robust dominance signal in men. *Behavioral Ecology and Sociobiology, 64*, 1673–1683.