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Menstrual cycle, trait estrogen level, and masculinity preferences in the human voice

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Abstract

Men with low testosterone (feminine men) invest in relationships and offspring more than men with high testosterone (masculine men). Women's attraction to testosterone dependent traits (e.g. masculine face shape) is enhanced during the late-follicular, fertile phase of the menstrual cycle. Attractive, feminine women have stronger preferences for masculine men as possible long-term partners than less attractive, masculine women. We manipulated 2 testosterone related vocal traits (voice pitch and apparent vocal-tract length) in voices to test if women prefer masculinized men's voices to feminized men's voices; masculinity preferences are enhanced at the fertile (late-follicular) menstrual cycle phase; the amount that masculinity preferences shift cyclically relates to average estrone-3-glucuronide concentration (the primary urinary metabolite of estrone, E3G). We found women displayed general masculinity preferences for men's voices; masculinity preferences were greater in the fertile (late-follicular) phase of the cycle than the non-fertile (early-follicular and luteal) phase; and this effect was most pronounced for women with low average E3G concentration. As feminine women (i.e. those with high average E3G levels) are most able to obtain investment even from masculine men, these women may not need to change their mating preference or strategy during the menstrual cycle as much as masculine women.

Keywords: Vocal; Voice; Attractiveness; Masculinity; Dominance; Pitch; Vocal-tract; Estrogen

Introduction

Masculine traits in men indicate long-term health (Rhodes et al., 2003), higher reproductive success (Mueller and Mazur, 1997, 1998; Pawlowski et al., 2000), but reduced commitment to relationships and offspring (Burnham et al., 2003; Gray, 2003; Gray et al., 2002, 2004). By contrast, feminine traits in men indicate a higher probability of relationship commitment and paternal investment (Burnham et al., 2003; Gray, 2003; Gray et al., 2002, 2004). Women exhibit stronger facial masculinity preferences during the most fertile phase of the menstrual cycle (late-follicular phase) than at other times (Johnston et al., 2001; Penton-Voak and Perrett, 2000; Penton-Voak et al., 1999). Menstrual cycle shifts in facial masculinity preferences have been observed when women evaluated men's faces for short-term relationships (Penton-Voak et al., 1999) and when relationship context was not specified (Johnston et al., 2001; Penton-Voak and Perrett, 2000; Penton-Voak et al., 1999).

Masculinity in men's face shape is preferred by women more for short-term than long-term relationships (Johnston et al., 2001; Little et al., 2002; Penton-Voak et al., 1999, 2003). Preferences for male facial masculinity are influenced by the attractiveness and femininity of the female judges (Little et al., 2001; Penton-Voak et al., 2003). While relatively unattractive and masculine women demonstrated stronger preferences for masculine males as short-term

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partners than as long-term partners, the effect of relationship context on masculinity preferences was weaker for attractive, feminine women (Little et al., 2001; Penton-Voak et al., 2003). This effect of own condition on women's masculinity preferences is thought to occur because more attractive, feminine women may be better able to obtain investment from masculine men during long-term relationships (Clark, 2004; Gangestad and Simpson, 2000; Little et al., 2001; Penton-Voak et al., 2003). Given that attractive and feminine women have more stable masculinity preferences across relationship contexts than unattractive and masculine women, attractive and feminine women should show less variation in their preferences for masculine males during the menstrual cycle than unattractive and masculine women. Fundamental frequency (an acoustic measure of voice pitch) in men is negatively related to testosterone throughout pubertal development (Butler et al., 1989; Harries et al., 1997, 1998) and during adulthood (Dabbs and Mallinger, 1999). Collins (2000) and Feinberg et al. (2005) found that low fundamental frequency and large apparent vocal-tract length (indicated by narrow spacing of formant frequencies) independently predicted perceived masculinity. Fundamental frequency correlated negatively with attractiveness (Collins, 2000) and correlated with perceived dominance (Tusing and Dillard, 2000) of men's voices. Enhancing masculine characteristics in voices (lowering fundamental frequency and increasing apparent vocal-tract length) using Praat audio software (Boersma and Weenink, 2001) also increased women's attributions of masculinity and attractiveness to male voices (Feinberg et al., 2005). Moreover, male vocal attractiveness is highly related to masculinity (Collins, 2000; Feinberg et al., 2005) and men with attractive voices have more mating success than men with unattractive voices (Hughes et al., 2004).

Testosterone enhances somatic tissue development (Notelovitz, 2002). Thus, vocal-tract length and testosterone are positively related (Fitch and Giedd, 1999). As vocal-tract length increases, formant dispersion decreases, closely spaced formants are associated with large body size in rhesus macaques (*Macaca mulatta*, Fitch, 1997), dogs (*Canis familiaris*, Riede and Fitch, 1999), and humans (*Homo sapiens*, Collins and Missing, 2003; Fitch and Giedd, 1999; Gonzalez, 2004). Other estimates of vocal-tract length predict body size in red deer (*Cervus elaphus*, Reby and McComb, 2003). Feinberg et al. (2005), Smith et al. (2005), and Fitch (1994) found that increasing apparent vocal-tract length in human voices increased perceived height. It is relevant here that Pawlowski et al. (2000) found that taller men had higher reproductive success.

Using voices manipulated in formant (vocal-tract length) and fundamental frequencies, we tested if women's preferences for masculine male and female voices were affected by menstrual cycle. In light of Feinberg et al. (2005) and Collins (2000), we predicted that masculinized men's voices would be preferred to feminized men's voices. Next we predicted that masculinity preferences for men's voices would be stronger when conception risk is high (late-follicular phase) than when conception risk is low (early-follicular and luteal phases). This would parallel findings for facial masculinity.

Gangestad et al. (2004) found that women's preferences for dominant behavioral displays in video clips (including voices perceived as dominant) are strongest during the late-follicular phase of the menstrual cycle. Gangestad et al. (2004) did not test for variation in women's preferences for dominant voices. Also, Gangestad et al. (2004) did not determine whether their observed cyclic shift in attraction to dominance in men was due to a change in sensitivity to dominance across the menstrual cycle (see Macrae et al., 2002), or a change in attraction to dominance across the menstrual cycle. We sought to address the above by asking women to assess attractiveness and dominance of voices across the menstrual cycle and determining if sensitivity and/or attraction to dominance change cyclically.

Penton-Voak et al. (2003) found that waist-to-hip ratio negatively predicted women's preferences for masculinity in men's faces. Waist-to-hip ratio is negatively related to estrogen level (Jasienska et al., 2004). Therefore, we can predict that between women, average levels of estrogen metabolites would positively correlate with women's masculinity preferences in men's voices.

As feminine and attractive women showed the least variation when evaluating attractiveness of masculinized faces in long-term and short-term contexts (Little et al., 2001; Penton-Voak et al., 2003), we predicted that women with high average (trait) estrogen (an index of femininity and reproductive health in women, Jasienska et al., 2004; Moran et al., 1999; Zaadastra et al., 1993) would have relatively stable preferences for masculinity across the menstrual cycle. By contrast, we predicted that women with low average estrogen would show the most marked masculinity preference change across the cycle.

We tested for menstrual cycle shifts in both men and women's voices. If cyclic shifts are linked to mate-choice then such shifts would be present for men's but not women's voices. If may be however that menstrual cycle shifts have no costs, in which case, they could occur for both sexes of voices.

Materials and methods

Voice recordings

Four men's and 4 women's voices were recorded, speaking monopthong vowels "eh", "ee", "ah", "oh", and "oo" with an Audio-Technica AT4041 cardioid condenser microphone in a quiet room from a distance of approximately 20 cm. The voices were encoded directly onto computer hard disk in mono at 44.1 kHz sampling rate and 16-bit quantization using Sonic Foundry's Sound Forge 6.0. The voices, when manipulated, spanned the normal