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Faking it: deliberately altered voice pitch and vocal attractiveness

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Previous research has shown that men prefer higher-pitched women's voices and women prefer lower-pitched men's voices. However, both men and women can modulate their voice pitch, which can affect others' perceptions of the voice. Here we tested whether deliberate pitch changes affect speakers' vocal attractiveness. Our results suggest that deliberately exaggerating sex-typical voice pitch (i.e. lowering pitch in men and raising pitch in women) does not necessarily increase vocal attractiveness but that exaggerating sex-atypical voice pitch (i.e. raising pitch in men and lowering pitch in women) may decrease vocal attractiveness. By contrast with these findings for attractiveness, listeners interpreted lowered-pitch voices as sounding more dominant than habitually pitched voices in same-sex voices, which may aid in avoiding the costs associated with intrasexual competition. These findings suggest that the way humans perceive deliberate manipulations of voice pitch can mitigate the potential costs of using an alterable cue to assess attractiveness, and that functional honesty may only evolve in domains where such honesty would be favourable to perceivers.

Fundamental frequency is tied to the rate of vibration of the vocal folds (see Titze 1994 for an overview of vocal production). Here we refer to the perception of fundamental frequency and/or the resulting harmonic spectrum as 'pitch'. Previous research has demonstrated that, in general, men prefer relatively high-pitched women's voices (Collins & Missing 2003; Feinberg et al. 2008b; Jones et al. 2008, 2010; Borkowska & Pawlowski 2011; Puts et al. 2011). Men's attractiveness ratings of women's voices are positively correlated with women's voice pitch (Collins & Missing 2003; Feinberg et al. 2008b), and men prefer women's voices manipulated to have higher voice pitch to voices manipulated to have lower voice pitch (Feinberg et al. 2008b; Apicella & Feinberg 2009; Jones et al. 2010; O'Connor et al. 2011; Puts et al. 2011). Conversely, women prefer lower-pitched men's voices (Collins 2000; Feinberg et al. 2005; Hodges-Simeon et al. 2010). Women's attractiveness judgments of men's voices are negatively associated with men's voice pitch (Collins 2000), and women prefer experimentally manipulated lower-pitched voices to higher-pitched voices (Feinberg et al. 2005; Puts 2005; Vukovic et al. 2008, 2010a, 2011; Hodges-Simeon et al. 2010; Jones et al. 2010; O'Connor et al. 2011, 2012).

Preferences for exaggerated sex-typical traits may reflect preferences for high-quality mates (Thornhill & Gangestad 1999; Feinberg 2008). Masculine characteristics are positively related to indices of long-term health (Rhodes et al. 2003; Thornhill & Gangestad 2006; Gangestad et al. 2010) and physical strength (Fink et al. 2007), and may advertise the robustness of an individual's immune system (Moore et al. 2011; Rantala et al. 2012). Moreover, among men, exaggerated sex-typical (i.e. masculine) vocal and facial characteristics have positive effects on perceptions of dominance (Perrett et al. 1998; Feinberg et al. 2006; Puts et al. 2006, 2007, 2012; Jones et al. 2010; Watkins et al. 2010). Since vocal and facial masculinity are positively correlated among men (Saxton et al. 2006, 2009) and may share a common hormonal basis (Harries et al. 1997; Dabbs & Mallinger 1999; Verdonck et al. 1999; Penton-Voak & Chen 2004; Roney et al. 2006; Evans et al. 2008), women's preferences for lower-pitched men's voices may reflect a preference for cues to long-term health and/or dominance (e.g. Puts et al. 2012).

Among women, voice pitch is negatively associated with health risk factors (Vukovic et al. 2010a). Women's voice pitch is also positively related to oestrogen levels (Abitbol et al. 1999), which, within the normal range, are positively related to healthy reproductive development (Alonso & Rosenfield 2002). Between individuals, ratings of women's vocal attractiveness are positively correlated with voice pitch (Collins & Missing 2003; Feinberg et al. 2008b) and attractive body configurations (Collins & Missing 2003;

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Hughes et al. 2004; Vukovic et al. 2010a). For example, women's voice pitch is negatively related to overall body mass and body mass index (Vukovic et al. 2010a). In addition, women's vocal attractiveness is negatively related to waist-to-hip ratio (Hughes et al. 2004), a trait that is positively associated with oestrogen levels (Jasienska et al. 2004) and many other indices of reproductive health (Singh 2002).

Although habitual pitch (i.e. natural speaking pitch) is a reliable indicator of sex hormone levels (Abitbol et al. 1999; Dabbs & Mallinger 1999), voice pitch is clearly not a fixed trait. Indeed, examples of within-individual variation in voice pitch are ubiquitous. During singing, the deliberate manipulation of laryngeal muscles modulates voice pitch to produce specific musical tones (Titze 1994). Voice pitch also changes according to social context. Indeed, context-dependent vocal changes are widespread among the animal kingdom and have been observed in anurans (Wagner 1989a, b, 1992; Bee & Perrill 1996; Given 1999; Bee et al. 1999, 2000; Bee & Bowling 2002; Lardner & bin Lakim 2002; Owen & Gordon 2005), bovids (Frey et al. 2008), cervids (Reby et al. 2005), canids (Yin 2002), phascolarctids (i.e. koalas, Charlton et al. 2011), passerine birds (Leavesley & Magrath 2005; Goodale & Kotagama 2006) and primates (Seyfarth et al. 1980; Snowdon et al. 1983; Zuberbühler 2000; reviewed in: Tomasello & Zuberbühler 2002; Seyfarth & Cheney 2003). Among humans, speakers tend to raise their voice pitch when speaking to an infant (Fernald & Kuhl 1987; Trainor & Desjardins 2002), match their pitch to conversation partners who are higher in social status (Gregory & Webster 1996), and speak in a lower- or higher-pitched voice when speaking to a less dominant or more dominant listener, respectively (Puts et al. 2006). Similarly, red deer stags, *Cervus elaphus*, lower the formant frequencies of their roars by extending their vocal tracts to competitors that sound larger (Reby et al. 2005). Importantly, human speakers have been found to change their voice pitch when viewing unattractive or attractive listeners (Hughes et al. 2010; Fraccaro et al. 2011). Fraccaro et al. (2011) asked women to leave voicemail messages conveying romantic interest to two men differing in sexually dimorphic face shape, and found that women spoke with a relatively higher-pitched voice to the type of face they preferred. By contrast, Hughes et al. (2010) had men and women leave voicemail messages about a psychology survey to attractive and unattractive individuals, and found that both men and women spoke in a relatively lower-pitched voice to the attractive individuals. These seemingly opposing results point to the potentially important influence of social context on vocal modulations (i.e. in a professional context: Hughes et al. 2010; in a mating context: Fraccaro et al. 2011). This research on human vocal modulations in response to social cues complements similar work on vocal modulations in cervids and bovids. Fallow deer, *Dama dama*, red deer, goitered gazelles, *Gazella subgutturosa*, and Mongolian gazelles, *Procrapra gutturosa*, lower their laryngeal position to produce low vocal tract resonance frequencies in response to intruders and during the rut season (Fitch & Reby 2001; McElligott et al. 2006; Frey et al. 2008, 2011). The similarity in frequency profiles of vocalizations across languages and species has been suggested to constitute evidence for a 'frequency code' common to many animals (see Ohala 1983, 1984).

Although research has demonstrated that individuals modulate their voice pitch in mate choice (Anolli & Ciceri 2002; Fraccaro et al. 2011) and dominance-related contexts (Puts et al. 2006), and that computer-manipulated voice pitch affects attractiveness (e.g. Feinberg et al. 2005, 2008a, b), it is not known whether deliberate modulations of voice pitch in the absence of social context is sufficient to affect attractiveness or dominance judgments in both sexes. Investigating this issue is potentially important, however; if deliberately manipulating voice pitch causes individuals to appear more attractive, it would cast doubt on the extent to which voice pitch is likely to be an honest cue of mate quality. By contrast, because voice pitch can carry information about the emotional state of a speaker (Fairbanks & Pronovost 1939; Williams & Stevens 1972; Razak et al. 2003), listeners may be inclined to interpret voice pitches associated with dominance as genuine to avoid conflict with aggressive individuals and/or harm from them. Here, we investigated whether deliberate alterations of voice pitch altered attractiveness (experiment 1) or dominance (experiment 2) judgments when compared to a speaker's habitual voice pitch.

EXPERIMENT 1

First, we tested whether deliberately altered voice pitch influences ratings of vocal attractiveness compared to the modal pitch of speakers. Participants made two-alternative forced-choice judgments of attractiveness for a speaker's habitual voice pitch, and his or her raised or lowered voice pitch. We hypothesized that, if voice pitch is an honest cue of mate quality, voice pitch alterations would not increase the attractiveness of speakers.

Methods

Protocols were approved by the McMaster Research Ethics Board.

Stimuli

We recorded the voices of four women (mean ± SE age = 19.25 ± 0.23 years) and four men (mean ± SE age = 18.25 ± 0.23 years) speaking the West-Central Canadian English vowel sounds 'eh' as in bet, 'ee' as in see, 'ah' as in father, 'oh' as in note and 'oo' as in boot. Each participant was instructed to speak the vowels in three different ways: naturally (i.e. in their habitual pitch), with a raised voice pitch and with a lowered voice pitch (see Fig. 1). Participants were instructed not to enter the falsetto and pulse registers (i.e. registers above and below the normal speaking range, respectively), and to speak the vowels one after another. The number of voices used in our study is similar to those used in previous studies assessing preferences for raised and lowered voice pitch (e.g. Feinberg et al. 2006; Fraccaro et al. 2010; Jones et al. 2010; Vukovic et al. 2011). Recordings were made using a stand-mounted (via vibrational dampener) Sennheiser MKH70 microphone in an anechoic chamber (WhisperRoom SE 2000 Series) using Adobe OnLocation recording software, in mono, at a sampling rate of 48 kHz with 16-bit amplitude quantization. This resulted in 24 voice recordings, each of which consisted of all five vowel sounds (each of our eight participants spoke once in habitual pitch, once in raised pitch and once in lowered pitch; see Tables 1, 2). Voice pitch was measured using the autocorrelation function in Praat (Boersma & Weenink 2012). We used a frequency range of 60–100 Hz for male voices and 100–600 Hz for female voices (following Feinberg et al. 2005; Vukovic et al. 2010a, b). All raised-pitched voices were higher than habitually pitched voices, and all lowered-pitch voices were lower than habitually pitched voices. Both the raised- and lowered-pitched voices fell within the normal pitch range for human adults (Childers & Wu 1991). Amplitudes were scaled to a constant presentation level using the root mean squared method in Praat (Boersma & Weenink 2012). A related-samples Wilcoxon signed-ranks test revealed that the magnitude of the unsigned mean of voice pitch change did not significantly differ between raising and lowering from habitual pitch in women ($Z = 0.365$, $N = 4$, $P = 0.715$) but was marginally significant in men ($Z = 1.826$, $N = 4$, $P = 0.068$), suggesting that men raised their voice pitch more than they lowered it. Change in duration of recording from habitual pitch did not differ between raised and lowered voices (related-samples Wilcoxon signed-ranks test: men: $Z = 0.365$, $N = 4$, $P = 0.715$; women: $Z = 1.105$, $N = 4$, $P = 0.269$). Since formant

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