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Voices of Africa: acoustic predictors of human male vocal attractiveness

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Robust evidence shows that voice quality affects various social interactions, including mate preferences. Previous research found that male voices perceived as attractive are characterized by low voice pitch, lower or sexually typical formants and relatively high breathiness. These features tend to be seen as markers of an individual's quality as a potential mate. Although there are considerable differences between languages in vocal parameters that could influence the perceived attractiveness, the above-mentioned findings rely on research based mainly on participants from European or North American countries. In our study, we therefore tested the main acoustic predictors of vocal attractiveness using two male samples from Cameroon and Namibia. Standardized vocal recordings were then assessed for vocal attractiveness by a panel of female raters from the Czech Republic. Our results show that in the Cameroonian voices, fundamental frequency was strongly negatively associated with perceived vocal attractiveness. In the Namibian sample, however, it was not the fundamental frequency but lower mean formants and harmonics-to-noise ratio that were negatively associated with vocal attractiveness. This pattern may be partly attributed to differences in morphological characteristics such as the body mass index, indicating variation across individual populations.

The quality of male voice considerably contributes to the impression of physical attractiveness. The most extensively studied perceptual characteristic is voice pitch and its acoustic correlate, the fundamental frequency (F0). Women stereotypically perceive male voices with low F0 as more attractive (Bruckert, Liénard, Lacroix, Kreutzer, & Leboucher, 2006; Hodges-Simeon, Gaulin, & Puts, 2010; Skrinda et al., 2014) and these preferences seem to emerge during puberty (Saxton, Caryl, & Roberts, 2006). Preference for a low voice pitch is further supported by studies manipulating F0. More specifically, an experimental lowering of the F0 of men's voices by computer software increases the attractiveness ratings of male voices (Feinberg, Jones, Little, Burt, & Perrett, 2005; Feinberg et al., 2006; Jones, Feinberg, DeBruine, Little, & Vukovic, 2010; Riding, Lonsdale, & Brown, 2006). There may, however, be limits beyond which manipulation to a lower F0 is no longer perceived as more attractive. Re, O'Connor, Bennett, and Feinberg (2012) reported a limit for male voices manipulated to less than 96 Hz (see Saxton, Mackey, McCarty, & Neave, 2015, for similar findings). On the other hand, some studies observed a decrease in attractiveness ratings of male voices manipulated to a higher pitch but, interestingly, no increase in attractiveness when voices were manipulated to lower pitch (Xu, Lee, Wu, Liu, & Birkholz, 2013). Similar results were reported for deliberate changes in the voice pitch. Recordings of men who deliberately increased their voice pitch were perceived as less attractive, but there was no significant change to attractiveness ratings when they spoke with a lowered pitch (Fraccaro et al., 2013). These results indicate that it may be difficult to deliberately manipulate male voice pitch under a lower physiological threshold without sacrificing some other acoustical qualities linked to mate quality. Voice pitch is related to the length, tension and cross-sectional area of the vocal folds (Titze, 2011), which potentially makes it a reliable cue of individual's quality such as body size. Low mean F0 is positively associated with perceived body size (Rendall, Vokey, & Nemeth, 2007; von Kriegstein, Warren,

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Ives, Patterson, & Griffiths, 2006). However, F0 is a weak predictor of actual body size within the sexes (Pisanski, Fraccaro, Tigue, O'Connor, & Feinberg, 2014; but see Cartei, Bond, & Reby, 2014). A similar association was found for physical strength (Hodges-Simeon, Gurven, Puts, & Gaulin, 2014; but see also Sell et al., 2010). Moreover, F0 is negatively associated with testosterone levels (Dabbs & Mallinger, 1999; Evans, Neave, Wakelin, & Hamilton, 2008; Puts, Apicella, & Cárdenas, 2012), although the strength of the association tended to be rather low and, in some studies, even nonsignificant (Bruckert et al., 2006; Harries, Walker, Williams, Hawkins, & Hughes, 1997). Lower mean F0 is also related to some reproductive variables, such as lower age at the first sexual intercourse, number of sexual partners and reproductive success (Apicella, Feinberg, & Marlowe, 2007; Hughes, Dispenza, & Gallup, 2004).

Voice quality can be further characterized by its formant structure. According to the source-filter theory of voice production (Fant, 1960), formants (amplified bandwidths in the voice spectrum) reflect resonant properties of the vocal tract. Although a dynamic change of formant structure is essential to speech production, and various languages and dialects can differ in their mean formant values for perceptually similar phonemes, mean formant values can also vary, and rather substantially, depending on the age and/or sex of the speaker (Johnson, 2005). Formant structure is also implicated in the formation of individual's voice timbre (i.e. voice colour) impression and contributes to individual vocal recognition (Xu, Homae, Hashimoto, & Hagiwara, 2013). In most studies, formants tend to be aggregated into a single variable such as formant dispersion (D_f; Fitch & Giedd, 1999), mean formant position (P_f; Puts et al., 2012), or other variables (for a review, see Pisanski, Fraccaro, Tigue, O'Connor, Röder et al., 2014). Studies employing experimental manipulation found that male voices manipulated to lower and more closely spaced formants are perceived as more attractive primarily when formant manipulation is accompanied by concordant manipulation to lower pitch (Feinberg et al., 2005, 2006, 2011; Pisanski & Rendall, 2011; Pisanski, Mishra, & Rendall, 2012; Xu, Lee et al., 2013). Formant structure, either on its own (Rendall et al., 2007) or jointly with voice pitch, can be used as a reliable predictor of body size and thus serve as a cue to the quality of the potential partner (Pisanski, Fraccaro, Tigue, O'Connor, & Feinberg, 2014).

Finally, vocal production can also be characterized by tonal quality, which is perceptually manifested as breathiness (ranging from breathy to tense vocal quality). Higher breathiness is caused primarily by insufficient glottal closure, leading to a more turbulent airflow over the vocal folds, which in turn causes higher noise levels in the vocal signal. It has been hypothesized that higher breathiness might simulate arousal in women (Henton & Bladon, 1985), although the acoustic signal of utterances deliberately expressing 'eroticism' in voice contains a higher proportion of rated breathiness in both men and women (Guzman, Correa, Muñoz, & Mayerhoff, 2013). The most salient acoustic proxy for breathiness is lower harmonics-to-noise ratio (HNR), which represents the ratio between periodic and aperiodic sound (Hillenbrand & Houde, 1996; de Krom, 1995). Existing studies indicate that vocal breathiness is positively related to perceived vocal attractiveness (Fraccaro et al., 2013; Xu, Lee et al., 2013), although this might be restricted only to female voices (Babel, McGuire, & King, 2014).

All of the vocal characteristics reviewed above seem to be sexually dimorphic. Compared to women, men have on average a lower voice pitch, more closely spaced formants and lower breathiness (Bachorowski & Owren, 1999; Klatt & Klatt, 1990; Peterson & Barney, 1952). Studies of gender attribution based on vocal stimuli show that the most influential factor is voice pitch, followed by formants and breathiness (Van Borsel, Janssens, & De Bodt, 2009). Differences in F0 and formants arise mainly during puberty, perhaps as a consequence of variation in the production of androgens (Harries et al., 1997). Pubertal changes in men include a secondary descent of the larynx, which is larger than expected given sex differences in body height (Fitch & Giedd, 1999). Based on this evidence, it has been suggested that preferences for a low F0 and perhaps also low formants and HNR have been shaped by sexual selection because they may provide cues to an individual's hormonal status (Dabbs & Mallinger, 1999; Evans et al., 2008), body size and/or body composition (Pisanski et al., 2012, 2016), and perhaps also dominance (Puts, 2016).

As mentioned above, however, the vast majority of existing studies are based on vocal stimuli from European and North American countries (for notable exceptions see Apicella & Feinberg, 2009; Puts et al., 2012; Sell et al., 2010). This limits the generalizability of these findings because individual languages show considerable variation in the use of individual vocal parameters (such as formants structure), which may influence the relative contribution of these parameters to the perception of vocal attractiveness. Moreover, individual populations also vary in ecological factors such as resource scarcity or parasite load. Given that various vocal parameters might be sensitive to different environmental stressors, this may also affect their relative significance in the perception of attractiveness. To address these issues, we used vocal recordings collected from men from two African countries, Cameroon and Namibia.

METHODS

Stimuli

We used male vocal recordings from two African countries: Cameroon ($N = 45$; mean age = 21.9 years; SD = 2.29) and Namibia ($N = 48$; mean age = 23 years; SD = 3.59). Each recording consisted of a short English sentence: 'My name is David and I am from Buea', in Cameroon, and 'My name is Simon and I am from Keetmanshoop', in Namibia. English is the official language in both countries. Recordings (in wave format) were taken in a quiet room with SONY PCM D50 recorder equipped by a windscreen. Body height was measured by anthropometer Tristom P226, and body weight was measured by a digital personal weight scale. The two samples of males did not differ significantly in age, but they did differ in body size measures such as height, weight and body mass (body mass index, BMI). A total of 21 out of 48 participants from Namibia had BMIs less than 18.5 (underweight classification threshold, World Health Organization, 1995) compared to just one underweight participant in the Cameroonian sample. Descriptive statistics of physical measures and ages of participants for both samples and independent samples *t* tests to assess intersample differences in physical measures and age are summarized in Table 1.

Table 1
Descriptive statistics of physical measures and age of Cameroonian and Namibian participants

	N	Mean±SD (range)			
		Height (cm)	Weight (kg)	Body mass index (BMI)	Age (years)
Cameroon	45	173.4±6.8 (161–188)	69.5±8.9 (54.8–91.5)	23.1±2.4 (17–31)	21.9±2.3 (18–30)
Namibia	48	168.8±6.6 (154–183)	56.2±10.9 (40–89)	19.7±3.4 (15–30)	23±3.6 (18–30)
t_{91}		3.26	6.47	5.66	1.86
P		<0.002	<0.001	<0.001	<0.07