

Are Human Faces and Voices Ornaments Signaling Common Underlying Cues to Mate Value?

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In our daily lives, we constantly interact with people. We maintain relationships with families and friends. We collaborate with colleagues. We seek passion with our lovers and avoid conflicts with our enemies. How we divide the world into these and many other categories of people is initially guided by our first impressions of how they look and sound. Many times we are surprised when we hear someone on the phone whom we have not yet met face-to-face; they sound different from what we imagined. There are, however, many things that we are not surprised about in such situations. People are accurate at identifying sex, health, emotions, and age by both voices and faces.^{3–12} There is good evidence that many seemingly disparate ornaments such as body and face,¹³ body and voice,^{14–16} and face and odor¹⁹ may convey either backup signals of the same underlying quality^{20,21} or convey signals of different underlying qualities that are used in conjunction to provide a more robust view of the organism's overall fitness.^{22,23} Is this also true of face and voices?

Until recently, little attention has been given to the idea that people's faces and voices might both signal the same underlying qualities related to hormone levels, and that we might use these hormonal fitness markers to provide a better picture of the signaler's overall mate value.^{20,21,24} In this paper I first argue that aspects of voices and faces *can* be used as markers of hormonal status. Second, I argue that both vocal and facial features associated with hormonal status *are* used by people to assess mate quality.

HORMONAL SIGNALS OF MATE QUALITY

Sexually dimorphic body features, or ornaments, that are enhanced by testosterone are candidate signals of male mate quality for two main rea-

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sons. First, dominant men most often have higher testosterone levels and higher reproductive success than subordinate men do.^{25,26} Second, testosterone has been implicated as a handicapping hormone (Box 1), providing not only suppressed immune function,¹⁸ but a tendency to participate in risky physical and sexual behavior.¹⁶ Given these points, we might predict that men displaying large ornaments, indicative of high testosterone, might be displaying their dominance and resistance to infectious diseases, both of which are qualities to be sought after by mates among most social species.²⁷

Ornaments that are positively related to estrogen levels are candidate signals of female mate quality because it has been demonstrated that estrogen, within the normal range, positively predicts various

measures of women's ability to become fertilized.^{28,29} Thus, men may find women with traits indicating relatively high estrogen levels to be the most attractive.

The first question addressed here is whether or not men's and women's faces and voices signal testosterone and estrogen levels, respectively. It has long been known that castrating a boy before puberty will stifle a surge of testosterone at puberty, inhibiting the male-typical pubertal drop in voice pitch¹⁷ (see Box 1). Thus, there is causal connection between testosterone at puberty and voice pitch. More recently, studies have shown correlations between adult and pubertal testosterone and low voice pitch (see Box 2 for description of vocal production).^{30–32} It is unknown whether the negative correlation between testosterone and voice pitch among adult men is a result of the causal link between pubertal testosterone and voice pitch (meaning that adult testosterone levels can be used to back-predict pubertal testosterone levels) or occurs because adult men with higher testosterone behaviorally modify their voice pitch to be lower. In addition, two studies have demonstrated, by using ratings of both real faces and average faces of men with high and low testosterone, that men with higher testosterone levels also have more masculine faces than men with lower testosterone levels do.^{33,34} Figure 1 illustrates masculinized and feminized men's and women's faces, which encompass many relevant features of the face that are thought to be altered by testosterone.³⁵

Less is known about the relationship between estrogen and women's voice pitch than is known about the relationship between testosterone

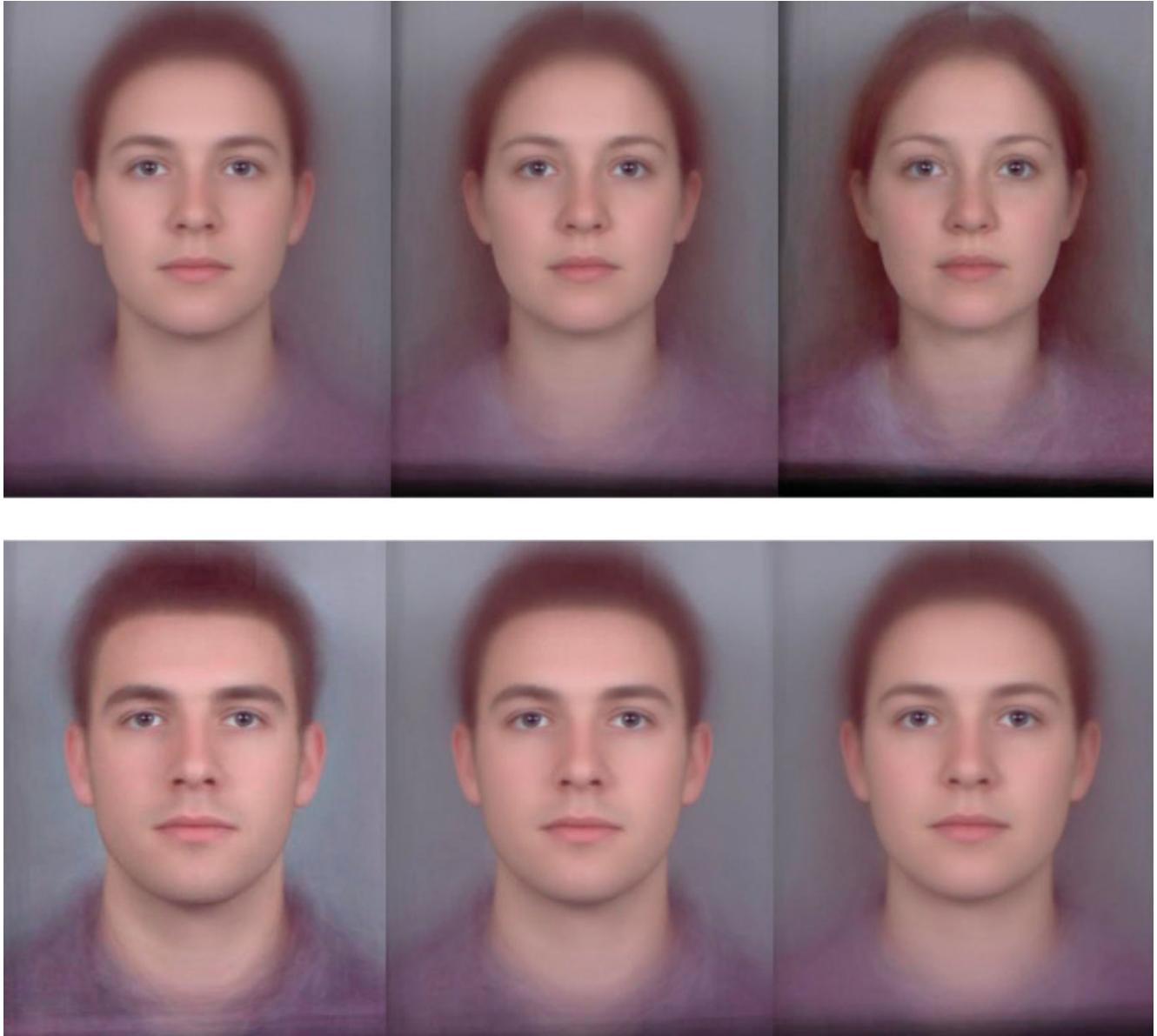


Figure 1. Masculinized (left), averaged (center), and feminized (right) female (top) and male (bottom) faces. Images were created using in-house facial transformation software⁷⁹⁻⁸² with a technique similar to that used in many studies on facial masculinity (see De Bruine³⁵ for review). Briefly, composites of digital images of 50 men's faces and 50 women's faces were demarcated with 179 landmark points. Faces were snapped into average shape by standardizing triangular tessellations among the landmark points and color (RGB) values averaged. Wavelet-based edge-detection algorithms were used to average texture information to provide the faces with more realistic skin tone. Next, each image was manipulated to $\pm 50\%$ of the shape differences between the average man and the average woman's face, resulting in masculinized, average, and feminized versions of the faces. What differs between these methods and those used elsewhere (see De Bruine³⁵ for review), is that here the transformation was applied to the same faces as those used as manipulation endpoints, creating what is technically called a "morph," and is merely a continuum between the faces. When these manipulations are applied to a separate (3rd) face, the software produces a "transform," which alters the 3rd image so that it will contain a given percentage of the differences between the two endpoint images. (Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.)

and voice pitch. Nevertheless, several researchers have hypothesized that a potential link could be a result of competition for expression between estrogen and testosterone at puberty or could occur via a behavioral path-

way whereby women with higher estrogen levels raise their voice pitch more than women with lower estrogen levels do.^{36,37} There has been one reported correlation among voice pitch, short vocal-tract length,

and high estrogen among women (Box 2).³⁸ In addition, women with feminine faces have higher estrogen levels than do women with relatively lower estrogen levels.³⁹ Furthermore, women with lower-pitched voices

Box 1. The Handicap Principal, Voice Pitch, and Testosterone.

The handicap hypothesis¹ states that males that display larger traits that are costly to produce may have higher reproductive success than do those displaying smaller traits. This can increase the size and/or frequency of

these traits in successive generations. Over a given period of time, this iterative process can lead to increases in sexual dimorphism across a population. Low voice pitch among men is thought to be one such trait because it

is costly to produce. Low voice pitch is considered costly because, without enough testosterone, men's voice pitch will never reach its maturational state.¹⁷ In addition, high testosterone is associated with health risks.¹⁸

have more masculine facial proportions than do women with higher-pitched voices.⁴⁰ Thus, as in males, female facial features and voice pitch are correlated with hormone levels.

Generalized Men's Preferences for Women's Faces

One account of facial attractiveness states that the single feature that determines facial attractiveness is how average it is relative to the population.⁴¹ This account suggests that face processing may be prototype-based.⁴² This means that your daily experience with faces is encoded. You store memories of faces relative to the prototype, or average configuration, of these faces. Recent work has revealed that we actually have many face prototypes, which are contingent on social variables such as sex.^{43,44} Average faces may be attractive because they are the closest to these internal prototypes.⁴¹ Traditional psychology states that we prefer things that we see most often via what is called "mere exposure." Thus, because average faces are familiar looking, we may prefer them to relatively distinctive faces. This view, however, has recently been qualified by the observation that our experiences with different faces can alter how much we like similar faces in subsequent viewings.⁴⁵ While there is evidence against the prototype account of averageness preferences, average faces may be attractive for other reasons. For example, people with diverse immune-system profiles (heterozygous HLA/MHC profiles) tend to have more attractive faces than do people with less diverse immune systems (homozygous HLA/MHC profiles).^{11,46} Thus, average faces may have healthier looking skin, which is indicative of the heterozygous HLA complex.^{11,46} However, healthy looking

skin coloration is also associated with male masculinity and female femininity,⁴⁷ so it is unlikely from these findings that we can state unequivocally that averageness is the critical determinant of facial attractiveness.

In response to the claim that attractiveness is merely a synonym for averageness, it has been demonstrated that not only are average faces that have been systematically manipulated away from average toward a highly attractive prototype more attractive than the grand sample's average,⁴⁸ but that visually adapting to highly attractive faces makes them appear more average but less attractive.⁴⁹ Thus, there is not a perfect one-to-one correspondence between averageness and facial attractiveness. Nevertheless, there is little disagreement that men prefer feminine women's faces to masculine women's faces.^{50,51}

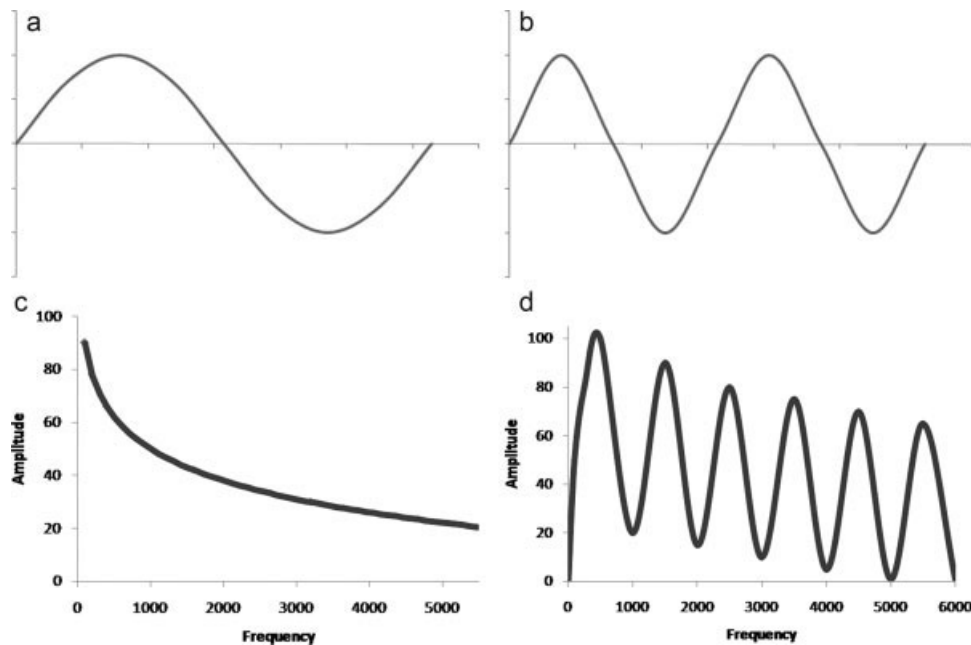
Generalized Men's Preferences for Women's Voices

To date, only two published studies have investigated men's preferences for women's voices. Collins and Missing⁵² found that, among unmanipulated voices, women's vocal attractiveness correlated with high voice pitch and shorter vocal tracts, both of which are characteristically feminine features. Indeed, when manipulated independently of vocal-tract length, lowering voice pitch increases the masculinity ratings of women's voices.⁵³ In this study Feinberg and coworkers raised and lowered the pitch of women's voices that had originated at masculine, average, and feminine pitch. This experimental design allowed participants to prefer average voices, masculine voices, or feminine voices. Feminized voices (those with raised pitch) were preferred to masculinized voices (those with lowered

pitch) at each level of starting pitch, suggesting that preferences for femininity outweigh preferences for masculinity and averageness in women's voices as well as in their faces.^{49,54} Further evidence for relationships between facial and vocal attractiveness come from Collins and Missing,⁵² who found that women with attractive faces also had attractive voices. Following up on this study, Feinberg and coworkers⁴⁰ found that women with masculine faces, as assessed by a facio-metric method following Penton-Voak and colleagues,⁷⁴ tend to have lower-pitched voices than women with feminine faces do. Feinberg and coworkers,⁴⁰ also found that in both real and averaged photographs, women with high-pitched voices had more attractive faces than did women with low-pitched voices. Thus there is a consistent view that women's faces and voices may signal estrogen levels and that men prefer both faces³⁹ and voices^{52,53} with cues indicating high estrogen levels. While there is agreement that men prefer femininity in both women's faces and voices, there is less agreement on the general preferences of women for masculinity in men's faces and voices.

Generalized Women's Preferences for Men's Faces

Multiple studies using masculinity manipulations show general female preferences for femininity,^{50,51} masculinity,³⁵ and averageness¹⁹ in men's faces. There have been attempts to reconcile these findings due to methodological differences between studies.⁵⁵ However, many studies using the same methods have produced different generalized facial masculinity preferen-



Box 2. Speech Production.²

To produce speech, first air is expelled through the lungs and passed through the vocal folds. A pressure asymmetry from below and above the vocal folds, combined with the myoelectric properties of the vocal folds themselves, causes the vocal folds to vibrate. This process is much like filling a balloon with air and letting the air out slowly through the stretched opening to produce sound. Vocal-fold vibration produces what is perceived as pitch, but is more physically deemed fundamental frequency (typically, the lowest frequency produced) and its corresponding harmonics (integer multiples of the fundamental frequency caused by pressure doubling at the anti-nodes of the standing waveform). Here, panel (a) displays a first harmonic (time is on the x axis; air pressure is on the y axis). By examining the second harmonic (b),

one can see that there are twice the amount of peaks in the same time-frame, meaning that the frequency is double, or an octave higher, than the original frequency.

The supralaryngeal vocal tract (henceforth called vocal tract for brevity) is basically a tube. Every tube has certain resonances that allow particular harmonic frequencies to pass through with unattenuated amplitude, but the amplitude of most of the harmonics is attenuated. The distance between these resonances depends on the length of a given tube. Therefore, the resonances in the vocal tract act as a filter. The most common way to understand what vocal tracts of different sizes sound like is to listen to someone who has inhaled helium gas. Because helium is lighter than air, it changes the speed at which sound

travels, producing the frequencies equivalent to those that would happen if someone were to shorten his or her vocal tract. Note that changing the size of the vocal tract does not alter pitch; also, altering pitch does not change the size of the vocal tract. Panel (c) displays a model of an amplitude-frequency spectrum from a typical voice. Here the harmonics become softer at a rate of 12 dB/octave. Panel (d) displays what the same spectrum would look like if were filtered by the vocal tract. Each peak in this plot represents a formant frequency. Each valley in the plot is a location in the spectrum where frequencies were attenuated. Typically, researchers measure only the first 3–4 formant frequencies because these measurements become unstable at higher frequencies. (Illustrations by Feinberg.)

ces,^{19,35,50,56} while one study using different methods has yielded the same general preferences.³⁵ Thus, individual differences in masculinity preference strength between populations are more likely to account for differences in masculinity preference strength between studies than are slight methodological differences among studies.

Generalized Women's Preferences for Men's Voices

Recent research demonstrates that in a natural-fertility population, men with lower-pitched voices have higher reproductive success than do men with higher-pitched voices.²⁴ Studies have found either very strong

general female preferences for masculinity in men's voices^{57–60} or no general preference for either masculinity or femininity.^{30,61} The key differences between studies that have found masculine voices attractive and those that have not are that in studies that have found these associations, specific vowel sounds were

used as vocal stimuli⁵⁷⁻⁶⁰ in order to reduce the potential influences of different accents on attractiveness. Those studies that have not found such general associations either used different speech content from each vocalizer⁶¹ or specifically asked participants to produce inconsistent vowel sounds.³⁰ Thus, it is possible that features such as accent or emotion could have overshadowed any potential relationship between voice pitch and attractiveness in these studies. Nevertheless, it has recently been demonstrated that men with attractive faces also tend to have attractive voices.⁵⁸ In this study, ratings of each man's face and voice were averaged across women. Average attractiveness ratings were correlated across the two sensory modalities.

INDIVIDUAL DIFFERENCES IN VOCAL AND FACIAL MASCULINITY PREFERENCES

Many studies demonstrate that men with high testosterone not only invest less in relationships and offspring than men with lower testosterone do,⁶²⁻⁶⁵ but that women's attributions toward men's faces suggest that this lack of potential parental investment is detectible from how masculine the face looks.⁵⁰ Furthermore, men with high testosterone and masculine faces are also reported to be less interested in children than are men with lower testosterone and more feminine faces.³⁴ Therefore, high-testosterone men may not be the optimal mate choice for all women at all times. When women are looking for strong genes for dominance and heritable immunity to infection, they may increase their preferences for masculinity, whereas when investment is more important, women might increase their femininity preferences.⁶⁶

In support of this argument, women's preferences for male facial masculinity are strongest at the most fertile (late follicular) menstrual-cycle phase^{67,68} and when women seek short-term partners.⁶⁹ The aforementioned reduction in facial masculinity preferences at nonfertile men-

strual-cycle phases appears to coincide with a spike in progesterone levels at the mid-luteal menstrual-cycle phase.⁷⁰ This spike in progesterone is also associated with increased attraction to faces with a higher-than-average resemblance to themselves,⁷¹ suggesting that progesterone is associated with pro-social, resource-acquiring behavior. Hormonal contraceptives have also been shown to disrupt⁶⁹ or reduce women's facial masculinity preferences.¹⁹ Indeed, women's preferences for masculinity in men's voices is also highest at the most fertile (late follicular) menstrual-cycle phase, when progesterone is lowest and when women are seeking short-term partners.^{59,61}

When women are looking for strong genes for dominance and heritable immunity to infection, they may increase their preferences for masculinity, whereas when investment is more important, women might increase their femininity preferences.

These findings are robust relative to alternative explanations such as increased sensitivity to masculinity over the menstrual cycle.⁷² As Feinberg and colleagues⁵⁹ found, while attraction to masculine voices was heightened at mid-cycle, dominance ratings of the same voices that were manipulated in apparent masculinity did not vary cyclically. Thus, hormone-mediated preferences for masculinity appear to be the result of an adaptive function rather than a byproduct of sensory biases, which also can change cyclically. Welling and coworkers⁵⁶ also demonstrate that menstrual-cycle shifts in preferences for facial masculinity cannot be

explained by regression to the mean (another type of sensory bias). Similarly, increased health preferences (healthy looking faces appear more masculine than do unhealthy looking faces⁴⁷) at the mid-luteal menstrual-cycle phase are evidence against a sensory bias account of menstrual-cycle shifts in face preferences because preferences can be increased at other times of the menstrual cycle than the late-follicular (fertile) menstrual-cycle phase.

An interesting phenomenon here is that women's behavior also suggests that feminine women might be better able to secure masculine men as long-term mates than masculine women can. Women with low (hourglass-shaped) waist-to-hip ratios have higher estrogen levels and stronger facial masculinity preferences, specifically when looking for long-term mates.^{73,74} From this we might predict that women with higher estrogen might not change their preferences over the menstrual cycle as much as masculine women might. Indeed, menstrual-cycle shifts in vocal masculinity preferences are weaker for women with higher average estrogen levels than for those with lower average estrogen levels.⁵⁹ Contrary to this hypothesis, Welling and colleagues⁵⁶ found that women with the highest average estrogen levels had the strongest shifts in facial masculinity preferences over the menstrual cycle. It is yet to be determined whether this discrepancy is due to testosterone signal variation, between face and voice masculinity or because information conveyed over time is encoded in voices but not photographs.

CROSS-CULTURAL STUDIES

There have been few cross-cultural studies on facial masculinity preferences. Moreover, cross-cultural work on voice preferences is yet to be reported. However, a recent study has demonstrated that among the Hadza, a hunter-gatherer group living in Tanzania, men with lower-pitched voices have higher reproductive success than do men with higher-pitched voices.²⁴ Nevertheless, when investigating consistency in masculinity preferences across cul-

tures, it is important to keep in mind that if universal preferences do not exist within a particular culture, we should not expect them to exist across cultures. Ecological factors such as mating system (monogamy, polygamy, and polyandry), parasite load, and resource availability vary worldwide. Studying the behavioral ecology of humans may shed light on variation in masculinity preferences across cultures.

For example, studies show that men's preferences for manipulated femininity in men and women's faces are consistent across many cultures, including the United Kingdom (UK), Australia, Japan, and China.^{50,51,68} However, women's preferences for facial masculinity are stronger among rural Jamaican women than among women from the UK.⁷⁵ Penton-Voak and coworkers⁷⁵ suggest that these population differences are due to the greater parasite load in the tropics than in the UK and/or because of differences in mating systems across the two populations. In the UK, men typically invest in their offspring, whereas in rural Jamaica, due to paternity uncertainty, it is more likely that men will invest in their sister's offspring than in their own.⁷⁵ Thus, while women in the UK may be trading off between men with masculine features, signaling potential good genes to producing dominant, immunocompetent offspring,⁷⁶ and feminine men who are more willing to invest in the offspring,^{62-65,77} women in rural Jamaica might more strongly prefer masculine men because investment is obtained via other means.

Thus, when accounting for individual differences in women's preferences for male facial and vocal masculinity, even though these preferences may not be absolute in nature, women's behavior mirrors a system in which both face and voice are cues to hormone levels, which signal paternal investment style, dominance, and immunocompetence.

CONCLUSION

The study of human vocal attractiveness is a new and exciting area of inquiry. Substantial advances in voice attractiveness emerge every year, and many gaps in current understanding

are being filled. The picture of voice and face attractiveness that is emerging is consistent with the idea that these perceptions tap an underlying perception of hormone levels that spans sensory modalities. Based on data showing that both men and women with attractive faces have more sexual partners,^{14,78} we can safely assume that preference for sexual dimorphism in both modalities in both sexes is potentially adaptive. As attractive as it might be to use these data to explain the ancestral origins of sexual dimorphism, we can only draw the conclusion that sexual selection maintains current levels of dimorphism because the paleontological record has not yet been examined in this light. However, it is highly likely that some mixture of male and female selection and competition played a crucial role in shaping human sexual dimorphism in our ancestral past and is currently shaping the sexual dimorphism of future generations of humans. Interdisciplinary research is encouraged to further explore this rapidly growing field.

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