Behavioural Processes 164 (2019) 25–29

Contents lists available at ScienceDirect

Behavioural Processes

journal homepage: www.elsevier.com/locate/behavproc

Positive association between facial and vocal femininity/masculinity in women but not in men

Kamila Janaina Pereira[a,*], Marco Antonio Correa Varella[a], Karel Kleisner[b], Ondřej Pavlovič[b], Jaroslava Varella Valentova[a]

[a] Department of Experimental Psychology, Institute of Psychology, University of Sao Paulo, Sao Paulo, Brazil
[b] Department of Philosophy and History of Science, Faculty of Science, Charles University, Prague, Czech Republic

ARTICLE INFO

Keywords:
Acoustic trait
Femininity
Masculinity
Multimodal perception
Sexual selection
Visual trait

ABSTRACT

Multicomponent stimuli improve information reception. In women, perceived facial and vocal femininity-masculinity (FM) are concordant; however, mixed results are found for men. Some feminine and masculine traits are related to sex hormone action and can indicate reproductive qualities. However, most of the current research about human mate choice focuses on isolated indicators, especially visual assessment of faces. We therefore examined the cross-modal concordance hypothesis by testing correlations between perceptions of FM based on facial, vocal, and behavioral stimuli. Standardized facial pictures, vocal recordings and dance videos of 38 men and 41 women, aged 18–35 years, were rated by 21 male and 43 female students, aged 18–35 years, on 100-point scale (0 = very feminine; 100 = very masculine). All participants were Brazilian students from University of Sao Paulo. In women, facial and vocal FM correlated positively, suggesting concordant information about mate quality. Such results were not found in men, indicating multiple messages, which agree with women's multifaceted preference for male FM. In both sexes, FM of dance did not correlate with voices or faces, indicating different information and distinct process of development. We thus partially supported the cross-modal concordance hypothesis.

1. Introduction

Animals communicate with intraspecific and interspecific individuals in distinct contexts, such as parental care (e.g., Redondo and Castro, 1992), predator deterrence (e.g., Zuberbühler et al., 1999), and mate choice (e.g., Lardner and Bin Lakim, 2002; Sweeney et al., 2003). Some characteristics, such as sex dimorphic traits, can cue to the producers' health, fertility, hormonal status and/or other qualities (Gallup and Frederick, 2010). Humans are sexually dimorphic in several aspects (see, Puts, 2016), such as in facial and vocal characteristics (Puts et al., 2012), and behavior (Berenbaum and Beltz, 2011). Among other factors, levels of reproductive hormones influence development of feminine and masculine traits (e.g., Feinberg, 2008), thus affecting communication. For instance, estrogen is associated with higher vocal pitch (Raj et al., 2010), facial feminine features (Law Smith et al., 2006), and maternal behavior (Law Smith et al., 2012), although see Jones et al. (2018) for no association between sex hormones and facial attractiveness in women. Testosterone is linked to lower vocal fundamental frequency (Evans et al., 2008), masculine facial characteristics (Penton-Voak and Chen, 2004), and aggressive behavior (Batrinos, 2012).

Masculine and feminine traits that coevolved with perceptual propensities of potential mates are important cues in the mate choice process. Indeed, men find more attractive sex hormone-dependent characteristics of female body and behavior, such as feminine faces (Moore et al., 2011; Perrett et al., 1998; Rhodes et al., 2003), voices (Apicella and Feinberg, 2009; Puts et al., 2011; Re et al., 2012), and dance (Röder et al, 2016). However, studies are inconsistent about women's preferences for male masculinity (e.g., DeBruine et al., 2006; Fink and Penton-Voak, 2002; Re et al., 2012; Rhodes et al., 2000; Stephen et al., 2012).

In real life context, usually the traits are not evaluated separately, but rather holistically using multimodal information that can improve information exchange. In women, perception of distinct sensory cues (e.g. faces and voices) is intercorrelated, thus, different modalities seem to carry concordant information about fertility and genetic quality (e.g., Collins and Missing, 2003; Fraccaro et al., 2010; Wheatley et al., 2014). Again, mixed results were found for intercorrelation of perception of male stimuli (Feinberg et al., 2008; Little et al., 2011; Valentova et al.,

* Corresponding author at: Department of Experimental Psychology, Institute of Psychology, University of Sao Paulo, 1721 Professor Mello Moraes Avenue, BLOCO F, SALA 35, Sao Paulo, SP, CEP 05508-030, Brazil.
E-mail addresses: kamilajpereira@gmail.com, kamilajpereira@usp.br (K.J. Pereira).

https://doi.org/10.1016/j.beproc.2019.04.010
Received 5 April 2018; Received in revised form 12 March 2019; Accepted 15 April 2019
Available online 16 April 2019
0376-6357/

2017). Despite the multimodal nature of masculinity and femininity in humans, most of the current research still focuses on isolated cues, e.g., either faces or voices (for a review, see Wells et al., 2009). Thus, more research on perceptions from multiple channels of information is needed.

Further, most research has studied facial traits, neglecting other channels of information, such as voice and odor (for further discussion, see Groyecka et al., 2017). Moreover, body movements, such as dance or gait, have been rarely studied in the mate choice context (Fink et al., 2015), despite dance behavior being an important part of courtship in many human societies. To the best of our knowledge, no study yet has tested a possible correlation between perception of faces, voices and dance movements. Finally, studies have usually analyzed samples from the USA and Europe. However, some cultural differences have been found regarding the sensory preference (e.g., Havlíček et al., 2008; Marcinkowska et al., 2014; Scott et al., 2014), thus showing the necessity of studies from different localities and cross-cultural research.

1.1. Aims

In the current study, we tested whether femininity-masculinity (FM) is concordantly perceived from faces, voices, and dance behavior in a sample of Brazilian women and men. We hypothesized that, at least in women, perceived FM of faces, voices and behavior would be intercorrelated.

2. Material and methods

Sixty women and 56 men were recruited at the University of Sao Paulo, Brazil. Those who identified themselves as bisexual and homosexual (3–6 on Kinsey scale) were excluded as they possess slightly distinct morphology and behavior (Johnson et al., 2007; Valentova et al., 2011, 2014; Wang and Kosinski, 2018). Moreover, one foreign student, and participants who did not complete the survey were also excluded. The final sample consisted of 38 men (age M = 23.55, SD = 3.28) and 41 women (age M = 24.00, SD = 5.05). Self-reports indicated that most participants were undergraduates (70.9%) and white (74.7%). Mann-Whitney U test showed no significant age difference between sexes (U = 790, p = 0.76).

2.1. Procedure

Participants were informed about general aims of the study and invited to the laboratory. Subsequently, they read and signed a consent form. The procedure was part of a larger intercultural study on human mating strategies (for other details, see Havlíček et al., 2017; Valentova et al., 2017; Varella et al., 2014), and lasted 40–60 min. The experiment consisted of a set of questionnaires, basic body measurements, standardized facial photographs, and vocal and dance recordings. Participants were asked to wear standardized white T–shirt and grey trousers in three sizes, and were given privacy to change their clothes. Makeup was removed, and hair band was provided when needed. No financial reward was given. The IRB of University of Sao Paulo (Nr. 53719416.5.0000.5561) and Charles University (Nr. 2011/7) approved the experiment.

2.2. Photographs and recordings

A standardized photographic equipment, camera distance, light, background, and clothes were used for facial photographs and video recordings. Participants were instructed to adopt a neutral facial expression for the facial pictures. Subsequently, using Photoshop software each photograph was placed on a neutral grey background (Valentova et al., 2017). For videos, participants were instructed to dance as naturally as possible under a standard simple rhythm (130 beats per minute) that was synthesized using an automatic random rhythmic generator in Max/Msp. Each video comprised 40 s, but only ten seconds of the middle part of the recordings were used for the rating session. Each video was cut and digitally edited using Videomux software, so that black and white videos with higher contrast were obtained. Finally, faces were covered (blurred) using Adobe Premiere Pro CC. Voices were recorded in a quiet room and participants were instructed to repeat the following sentence in Portuguese “Hi, my name is Pedro/Ana and I am from Belo Horizonte” – “Pedro” for all men, and “Ana” for all women (for details see, Valentova et al., 2017).

2.3. Facial, vocal, and behavior ratings

The stimuli were presented to a distinct and unrelated sample of 30 men and 58 women to assess FM on a 100-point scale ranging from 0 (very feminine) to 100 (very masculine). Participants were recruited online from students of University of Sao Paulo and were directed to Qualtrics platform (https://www.qualtrics.com). Non-heterosexuals (scoring 3–6 on Kinsey scale), one pregnant woman, and individuals older than 35 years were excluded, leaving a sample comparable to the target sample. The final sample comprised 21 men (age M = 23.86, SD = 4.62) and 43 women (age M = 24.14, SD = 4.56), composed mostly of undergraduate (57.8%) and white (71.9%) students. The sexes did not differ significantly in age (U = 470, p = 0.79).

Participants completed a basic demographic questionnaire and assessed the stimuli of both sexes in three randomized blocks (ratings of facial, vocal and behavioral stimuli). Within each block, the individual stimuli were also randomized. Thus, participants judged each stimulus in a randomized order and only once. There was a strong correlation between males’ and females’ ratings in all rated stimuli (all ρ’s ≥ 0.85, all p’s < 0.001) and the Cronbach’s alphas of FM ratings were reasonably high for facial ($\alpha = 0.78$), vocal ($\alpha = 0.83$) and behavioral ($\alpha = 0.89$) ratings.

2.4. Analyses

Shapiro-Wilks test was used to check the normality of data. Since some variables departed from normality, Spearman rank correlation was used to examine the relation between all modalities ratings. All data were analyzed via SPSS 21.0 (IBM Corp.). Data were transformed into Z-Scores to perform a figure using OriginPro 9.5 (OriginLab).

3. Results and discussion

As shown in Fig. 1, in women, we found a significant correlation between the mean perceived facial and vocal femininity-masculinity (FM) (N = 41, $\rho = 0.33$, p = 0.03). However, there was no significant correlation between behavioral FM and facial (N = 41, $\rho = 0.09$, p = 0.59) or vocal FM (N = 41, $\rho = 0.08$, p = 0.62).

In men, there was no significant correlation between facial and vocal FM (N = 38, $\rho = -0.02$, p = 0.89), behavioral and facial (N = 38, $\rho = 0.14$, p = 0.40), or behavioral and vocal FM (N = 38, $\rho = 0.02$, p = 0.93).

In women, we have replicated the positive association between perceived FM of faces and voices (Fraccaro et al., 2010; Feinberg et al., 2005; Smith et al., 2016). Although weak in its effect, the current results indicate that female facial and vocal FM can offer concordant underlying information. Rowe (1999) argues that multicomponent stimuli increase information reception. Studies suggest that women’s femininity indicates health, fertility, and parenting skills (Feinberg, 2008; Jasieńska et al., 2004; Law Smith et al., 2012). Accordingly, feminine traits are assessed as more attractive (Moore et al., 2011; Perrett et al., 1998; Valentova et al., 2017; although see Jones et al., 2018 for no association between sex hormones and perceived attractiveness in faces), and are preferred by men (Re et al., 2012). Additionally, facial and vocal attractiveness predicted the overall attractiveness ratings of women (Wells et al., 2013), and attractiveness

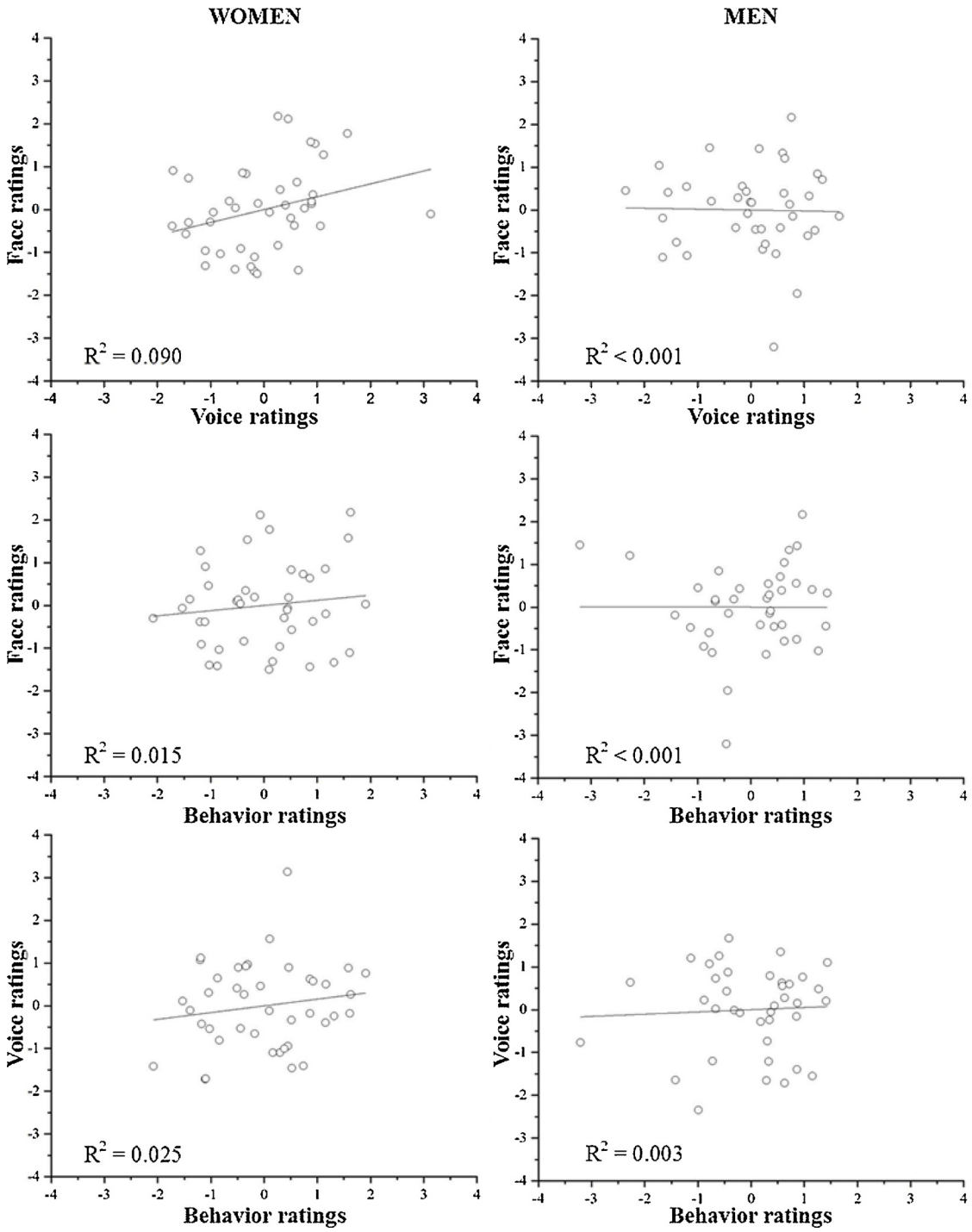

Fig. 1. Correlations of femininity-masculinity ratings between facial, vocal, and behavioral stimuli separately for male and female targets.

ratings of feminine faces increased when presented along with vocal femininity (O'Connor et al., 2013).

In men, faces and voices show no concordance and can, thus, indicate different qualities of the individual. Wells et al. (2013) showed that men's faces and voices contribute independently to attractiveness. Accordingly, Varella et al. (2014) found that women preferred men with a mosaic of masculine and feminine traits. In the same line, women's ratings of male attractiveness increased with a negative covariance between girth, and facial and vocal masculinity (Hill et al., 2013). Thus, testosterone synthesis and mechanisms of tissue response in different parts of the body and behavior may have evolved independently (Hau, 2007).

Men's non-concordant information may be adaptive and reflect women's highly flexible preferences for FM. Previous studies show that women's mate choice varies according to stage of menstrual cycle, resource and pathogen exposure, relationship status, or women's own mate quality (Brooks et al., 2010; Gildersleeve et al., 2014; Little et al., 2011; Lyons et al., 2016; Moore et al., 2013), indicating a variable preference for indirect (e.g. genetic quality) and direct (e.g. parental care) paternal investment according to the context (Gray et al., 2002; Kruger and Fitzgerald, 2011).

We found no correlation between ratings of FM of dance videos and FM rated from voices and faces, either in men or women. Thus, dance has no concordance with the other variables, and may thus convey

different messages. We can speculate that complex behavior, such as dance, which is aerobically costly, represents and develops via distinct process than facial and vocal display. Indeed, FM of behavior is emergent already during early childhood, while vocal and facial FM develops largely through exposure to sex hormone during puberty (Hines, 2011; Puts et al., 2012; Rieger et al., 2008).

In summary, we found a positive correlation between perception of women's facial and vocal FM, but that did not occur in men. Furthermore, dance was not associated with either vocal or facial FM in either men or women. The current study thus advanced the discussion concerning the use of multiple sensory modalities in the context of assessing masculinity-femininity. Differently from previous research, besides studying facial and vocal perception, we also focused on complex behavior, dancing (for further discussion, see Groyecka et al., 2017). As our study sample was relatively small and conducted on a specific population (Brazilian men and women), further studies are needed. Different populations can show distinct results in perception of faces, voices, and other sensory modalities, as shown by previous studies (e.g., Havlíček et al., 2008; Marcinkowska et al., 2014). Further, we collected samples in artificial environment, and recruited mostly university students. Future studies, thus, should investigate higher diversity of indicators, ideally in cross-cultural and more realistic mate choice settings.

Declaration of interest

The first author was supported by a PhD studentship from the Brazilian National Council for Scientific and Technological Development. However, said agency did not interfere in any aspect of research nor writing process of the report.

Acknowledgments

KJP was supported by Brazilian National Council for Scientific and Technological Development (grant number 140083/2015-4). KK and JVV were supported by Czech Science Foundation (GACR 18-10298S). OP was supported by the Grant Agency of the Charles University (GAUK 641116). We thank Professor Jerry A. Hogan for proofreading the manuscript and making comments.

References

Apicella, C.L., Feinberg, D.R., 2009. Voice pitch alters mate-choice-relevant perception in hunter–gatherers. Proc. R. Soc. B: Biol. Sci. 276, 1077. https://doi.org/10.1098/rspb.2008.1542.

Batrinos, M.L., 2012. Testosterone and aggressive behavior in man. Int. J. Endocrinol. Metab. 10, 563–568. https://doi.org/10.5812/ijem.3661.

Berenbaum, S.A., Beltz, A.M., 2011. Sexual differentiation of human behavior: effects of prenatal and pubertal organizational hormones. Front. Neuroendocrinol. 32, 183–200. https://doi.org/10.1016/j.yfrne.2011.03.001.

Brooks, R., Scott, I.M., Maklakov, A.A., Kasumovic, M.M., Clark, A.P., Penton-Voak, I.S., 2010. National income inequality predicts women's preferences for masculinized faces better than health does. Proc. R. Soc. Lond. B: Biol. Sci. 278, 810–814. https://doi.org/10.1098/rspb.2010.0964.

Collins, S.A., Missing, C., 2003. Vocal and visual attractiveness are related in women. Anim. Behav. 65, 997–1004. https://doi.org/10.1006/anbe.2003.2123.

DeBruine, L.M., Jones, B.C., Little, A.C., Boothroyd, L.G., Perrett, D.I., Penton-Voak, I.S., Cooper, P.A., Penke, L., Feinberg, D.R., Tiddeman, B.P., 2006. Correlated preferences for facial masculinity and ideal or actual partner's masculinity. Proc. R. Soc. B: Biol. Sci. 273, 1355. https://doi.org/10.1098/rspb.2005.3445. LP-1360.

Evans, S., Neave, N., Wakelin, D., Hamilton, C., 2008. The relationship between testosterone and vocal frequencies in human males. Physiol. Behav. 93, 783–788. https://doi.org/10.1016/j.physbeh.2007.11.033.

Feinberg, D.R., 2008. Are human faces and voices ornaments signaling common underlying cues to mate value? Evol. Anthropol. Issues News Rev. 17, 112–118. https://doi.org/10.1002/evan.20166.

Feinberg, D.R., Jones, B.C., DeBruine, L.M., Moore, F.R., Law Smith, M.J., Cornwell, R.E., Tiddeman, B.P., Boothroyd, L.G., Perrett, D.I., 2005. The voice and face of woman: one ornament that signals quality? Evol. Hum. Behav. 26, 398–408. https://doi.org/10.1016/j.evolhumbehav.2005.04.001.

Feinberg, D.R., DeBruine, L.M., Jones, B.C., Little, A.C., 2008. Correlated preferences for men's facial and vocal masculinity. Evol. Hum. Behav. 29, 233–241. https://doi.org/10.1016/j.evolhumbehav.2007.12.008.

Fink, B., Penton-Voak, I., 2002. Evolutionary psychology of facial attractiveness. Curr. Dir. Psychol. Sci. 11, 154–158. https://doi.org/10.1111/1467-8721.00190.

Fink, B., Weege, B., Neave, N., Pham, M.N., Shackelford, T.K., 2015. Integrating body movement into attractiveness research. Front. Psychol. 6, 220. https://doi.org/10.3389/fpsyg.2015.00220.

Fraccaro, P.J., Feinberg, D.R., DeBruine, L.M., Little, A.C., Watkins, C.D., Jones, B.C., 2010. Correlated male preferences for femininity in female faces and voices. Evol. Psychol. 8https://doi.org/10.1177/147470491000800311. 147470491000800320.

Gallup Jr., G.G., Frederick, D.A., 2010. The science of sex appeal: an evolutionary perspective. Rev. Gen. Psychol. 14, 240–250. https://doi.org/10.1037/a0020451.

Gildersleeve, K., Haselton, M.G., Fales, M.R., 2014. Do women's mate preferences change across the ovulatory cycle? A meta-analytic review. Psychol. Bull. 140, 1205–1259. https://doi.org/10.1037/a0035438.

Gray, P.B., Kahlenberg, S.M., Barrett, E.S., Lipson, S.F., Ellison, P.T., 2002. Marriage and fatherhood are associated with lower testosterone in males. Evol. Hum. Behav. 23, 193–201. https://doi.org/10.1016/S1090-5138(01)00101-5.

Groyecka, A., Pisanski, K., Sorokowska, A., Havlíček, J., Karwowski, M., Puts, D., Roberts, S.C., Sorokowski, P., 2017. Attractiveness is multimodal: beauty is also in the nose and ear of the beholder. Front. Psychol. 8, 778. https://doi.org/10.3389/fpsyg.2017.00778.

Hau, M., 2007. Regulation of male traits by testosterone: implications for the evolution of vertebrate life histories. BioEssays 29, 133–144. https://doi.org/10.1002/bies.20524.

Havlíček, J., Saxton, T.K., Roberts, S.C., Jozifkova, E., Lhota, S., Valentova, J., Flegr, J., 2008. He sees, she smells? Male and female reports of sensory reliance in mate choice and non-mate choice contexts. Pers. Individ. Differ. 45, 565–570. https://doi.org/10.1016/j.paid.2008.06.019.

Havlíček, J., Třebický, V., Valentova, J.V., Kleisner, K., Akoko, R.M., Fialová, J., Jash, R., Kočnar, T., Pereira, K.J., Štěrbová, Z., Varella, M.A.C., Vokurková, J., Vunan, E., Roberts, S.C., 2017. Men's preferences for women's breast size and shape in four cultures. Evol. Hum. Behav. 38, 217–226. https://doi.org/10.1016/j.evolhumbehav.2016.10.002.

Hill, A.K., Hunt, J., Welling, L.L.M., Cárdenas, R.A., Rotella, M.A., Wheatley, J.R., Dawood, K., Shriver, M.D., Puts, D.A., 2013. Quantifying the strength and form of sexual selection on men's traits. Evol. Hum. Behav. 34, 334–341. https://doi.org/10.1016/j.evolhumbehav.2013.05.004.

Hines, M., 2011. Prenatal endocrine influences on sexual orientation and on sexually differentiated childhood behavior. Front. Neuroendocrinol. 32, 170–182. https://doi.org/10.1016/j.yfrne.2011.02.006.

Jasieńska, G., Ziomkiewicz, A., Ellison, P.T., Lipson, S.F., Thune, I., 2004. Large breasts and narrow waists indicate high reproductive potential in women. Proc. R. Soc. Lond. Ser. B: Biol. Sci. 271, 1213. https://doi.org/10.1098/rspb.2004.2712.

Johnson, K.L., Gill, S., Reichman, V., Tassinary, L.G., 2007. Swagger, sway, and sexuality: judging sexual orientation from body motion and morphology. J. Pers. Soc. Psychol. 93, 321–334. https://doi.org/10.1037/0022-3514.93.3.321.

Jones, B.C., Hahn, A.C., Fisher, C.I., Wang, H., Kandrik, M., Lao, J., et al., 2018. No compelling evidence that more physically attractive young adult women have higher estradiol or progesterone. Psychoneuroendocrinology 98, 1–5. https://doi.org/10.1016/j.psyneuen.2018.07.026.

Kruger, D.J., Fitzgerald, C.J., 2011. Reproductive strategies and relationship preferences associated with prestigious and dominant men. Pers. Individ. Differ. 50, 365–369. https://doi.org/10.1016/j.paid.2010.10.022.

Lardner, B., Bin Lakim, M., 2002. Tree-hole frogs exploit resonance effects. Nature 420, 475. https://doi.org/10.1038/420475a.

Law Smith, M., Perrett, D., Jones, B., Cornwell, R., Moore, F., Feinberg, D., Boothroyd, L., Durrani, S., Stirrat, M., Whiten, S., Pitman, R., Hillier, S., 2006. Facial appearance is a cue to oestrogen levels in women. Proc. R. Soc. B: Biol. Sci. 273, 135–140. https://doi.org/10.1098/rspb.2005.3296.

Law Smith, M.J., Deady, D.K., Moore, F.R., Jones, B.C., Cornwell, R.E., Stirrat, M., Lawson, J.F., Feinberg, D.R., Perrett, D.I., 2012. Maternal tendencies in women are associated with estrogen levels and facial femininity. Horm. Behav. 61, 12–16. https://doi.org/10.1016/j.yhbeh.2011.09.005.

Little, A.C., Connely, J., Feinberg, D.R., Jones, B.C., Roberts, S.C., 2011. Human preference for masculinity differs according to context in faces, bodies, voices, and smell. Behav. Ecol. 22, 862–868. https://doi.org/10.1093/beheco/arr061.

Lyons, M., Marcinkowska, U., Moisey, V., Harrison, N., 2016. The effects of resource availability and relationship status on women's preference for facial masculinity in men: an eye-tracking study. Pers. Individ. Differ. 95, 25–28. https://doi.org/10.1016/j.paid.2016.02.025.

Marcinkowska, U.M., Kozlov, M.V., Cai, H., Contreras-Garduño, J., Dixson, B.J., Oana, G.A., Kaminski, G., Li, N.P., Lyons, M.T., Onyishi, I.E., Prasai, K., Pazhoohi, F., Prokop, P., Rosales Cardozo, S.L., Sydney, N., Yong, J.C., Rantala, M.J., 2014. Cross-cultural variation in men's preference for sexual dimorphism in women's faces. Biol. Lett. 10, 20130850. https://doi.org/10.1098/rsbl.2013.0850.

Moore, F.R., Law Smith, M.J., Taylor, V., Perrett, D.I., 2011. Sexual dimorphism in the female face is a cue to health and social status but not age. Pers. Individ. Differ. 50, 1068–1073. https://doi.org/10.1016/j.paid.2011.01.026.

Moore, F.R., Coetzee, V., Contreras-Garduño, J., Debruine, L.M., Kleisner, K., Krams, I., Marcinkowska, U., Nord, A., Perrett, D.I., Rantala, M.J., Schaum, N., Suzuki, T.N., 2013. Cross-cultural variation in women's preferences for cues to sex- and stress-hormones in the male face. Biol. Lett. 9, 20130050. https://doi.org/10.1098/rsbl.2013.0050.

O'Connor, J.J.M., Fraccaro, P.J., Pisanski, K., Tigue, C.C., Feinberg, D.R., 2013. Men's preferences for women's femininity in dynamic cross-modal stimuli. PLoS One 8, e69531. https://doi.org/10.1371/journal.pone.0069531.

Penton-Voak, I.S., Chen, J.Y., 2004. High salivary testosterone is linked to masculine male

facial appearance in humans. Evol. Hum. Behav. 25, 229–241. https://doi.org/10.1016/j.evolhumbehav.2004.04.003.
Perrett, D.I., Lee, K.J., Penton-Voak, I., Rowland, D., Yoshikawa, S., Burt, D.M., Henzi, S.P., Castles, D.L., Akamatsu, S., 1998. Effects of sexual dimorphism on facial attractiveness. Nature 394, 884. https://doi.org/10.1038/29772.
Puts, D.A., 2016. Human sexual selection. Curr. Opin. Psychol. 7, 28–32. https://doi.org/10.1016/j.copsyc.2015.07.011.
Puts, D.A., Barndt, J.L., Welling, L.L.M., Dawood, K., Burriss, R.P., 2011. Intrasexual competition among women: vocal femininity affects perceptions of attractiveness and flirtatiousness. Pers. Individ. Differ. 50, 111–115. https://doi.org/10.1016/j.paid.2010.09.011.
Puts, D.A., Jones, B.C., DeBruine, L.M., 2012. Sexual selection on human faces and voices. J. Sex Res. 49, 227–243. https://doi.org/10.1080/00224499.2012.658924.
Raj, A., Gupta, B., Chowdhury, A., Chadha, S., 2010. A study of voice changes in various phases of menstrual cycle and in postmenopausal women. J. Voice 24, 363–368. https://doi.org/10.1016/j.jvoice.2008.10.005.
Re, D.E., O'Connor, J.J.M., Bennett, P.J., Feinberg, D.R., 2012. Preferences for very low and very high voice pitch in humans. PLoS One 7, e32719. https://doi.org/10.1371/journal.pone.0032719.
Redondo, T., Castro, F., 1992. Signalling of nutritional need by magpie nestlings. Ethology 92, 193–204. https://doi.org/10.1111/j.1439-0310.1992.tb00959.x.
Rhodes, G., Hickford, C., Jeffery, L., 2000. Sex-typicality and attractiveness: are supermale and superfemale faces super-attractive? Br. J. Psychol. 91, 125–140. https://doi.org/10.1348/000712600161718.
Rhodes, G., Chan, J., Zebrowitz, L.A., Simmons, L.W., 2003. Does sexual dimorphism in human faces signal health? Proc. R. Soc. B: Biol. Sci. 270, S93–S95. https://doi.org/10.1098/rsbl.2003.0023.
Rieger, G., Linsenmeier, J.A.W., Gygax, L., Bailey, J.M., 2008. Sexual orientation and childhood gender nonconformity: evidence from home videos. Dev. Psychol. 44, 46–58. https://doi.org/10.1037/0012-1649.44.1.46.
Röder, S., Carbon, C.C., Shackelford, T.K., Pisanski, K., Weege, B., Fink, B., 2016. Men's visual attention to and perceptions of women's dance movements. Pers. Individ. Differ. 101, 1–3. https://doi.org/10.1016/j.paid.2016.05.025.
Rowe, C., 1999. Receiver psychology and the evolution of multicomponent signals. Anim. Behav. 58, 921–931. https://doi.org/10.1006/anbe.1999.1242.
Scott, I.M., Clark, A.P., Josephson, S.C., Boyette, A.H., Cuthill, I.C., Fried, R.L., Gibson, M.A., Hewlett, B.S., Jamieson, M., Jankowiak, W., Honey, P.L., Huang, Z., Liebert, M.A., Purzycki, B.G., Shaver, J.H., Snodgrass, J.J., Sosis, R., Sugiyama, L.S., Swami, V., Yu, D.W., Zhao, Y., Penton-Voak, I.S., 2014. Human preferences for sexually dimorphic faces may be evolutionarily novel. Proc. Natl. Acad. Sci. U. S. A. 111, 14388–14393. https://doi.org/10.1073/pnas.1409643111.
Smith, H.M.J., Dunn, A.K., Baguley, T., Stacey, P.C., 2016. Concordant cues in faces and voices: testing the backup signal hypothesis. Evol. Psychol. 14, 1–10. https://doi.org/10.1177/1474704916630317.
Stephen, I.D., Scott, I.M.L., Coetzee, V., Pound, N., Perrett, D.I., Penton-Voak, I.S., 2012. Cross-cultural effects of color, but not morphological masculinity, on perceived attractiveness of men's faces. Evol. Hum. Behav. 33, 260–267. https://doi.org/10.1016/j.evolhumbehav.2011.10.003.
Sweeney, A., Jiggins, C., Johnsen, S., 2003. Polarized light as a butterfly mating signal. Nature 423, 31–32. https://doi.org/10.1038/423031a.
Valentova, J., Rieger, G., Havlicek, J., Linsenmeier, J.A.W., Bailey, J.M., 2011. Judgments of sexual orientation and masculinity–femininity based on thin slices of behavior: a cross-cultural comparison. Arch. Sex. Behav. 40, 1145–1152. https://doi.org/10.1007/s10508-011-9818-1.
Valentova, J.V., Kleisner, K., Havlíček, J., Neustupa, J., 2014. Shape differences between the faces of homosexual and heterosexual men. Arch. Sex. Behav. 43, 353–361. https://doi.org/10.1007/s10508-013-0194-x.
Valentova, J.V., Varella, M.A.C., Havlíček, J., Kleisner, K., 2017. Positive association between vocal and facial attractiveness in women but not in men: a cross-cultural study. Behav. Process. 135, 95–100. https://doi.org/10.1016/j.beproc.2016.12.005.
Varella, M.A.C., Valentova, J.V., Pereira, K.J., Bussab, V.S.R., 2014. Promiscuity is related to masculine and feminine body traits in both men and women: evidence from Brazilian and Czech samples. Behav. Process. 109, 34–39. https://doi.org/10.1016/j.beproc.2014.07.010.
Wang, Y., Kosinski, M., 2018. Deep neural networks are more accurate than humans at detecting sexual orientation from facial images. J. Pers. Soc. Psychol. 114, 246–257. https://doi.org/10.1037/pspa0000098.
Wells, T.J., Dunn, A.K., Sergeant, M.J.T., Davies, M.N.O., 2009. Multiple signals in human mate selection: a review and framework for integrating facial and vocal signals. J. Evol. Psychol. 7, 111–139. https://doi.org/10.1556/JEP.7.2009.2.2.
Wells, T., Baguley, T., Sergeant, M., Dunn, A., 2013. Perceptions of human attractiveness comprising face and voice cues. Arch. Sex. Behav. 42, 805–811. https://doi.org/10.1007/s10508-012-0054-0.
Wheatley, J.R., Apicella, C.A., Burriss, R.P., Cárdenas, R.A., Bailey, D.H., Welling, L.L.M., Puts, D.A., 2014. Women's faces and voices are cues to reproductive potential in industrial and forager societies. Evol. Hum. Behav. 35, 264–271. https://doi.org/10.1016/j.evolhumbehav.2014.02.006.
Zuberbühler, K., Jenny, D., Bshary, R., 1999. The predator deterrence function of primate alarm calls. Ethology 105, 477–490. https://doi.org/10.1046/j.1439-0310.1999.00396.x.