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Original Article

Facial, Olfactory, and Vocal Cues to Female Reproductive Value

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Abstract: Facial, olfactory, and vocal cues may advertise women's fertility. However, most of the evidence for this proposal has come from studies of changes in young adult women's attractiveness over the menstrual cycle. By contrast with this emphasis on changes in attractiveness over the menstrual cycle, possible changes in women's attractiveness over their lifespan have received little attention. The present study investigated men's ratings of young girls' (11-15 years old), adult women's (19-30 years old) and circum-menopausal women's (50-65 years old) facial, body odor, and vocal attractiveness and femininity. Faces and voices, but not body odors, of young girls and adult women were perceived to be significantly more attractive and feminine than those of circum-menopausal women. These data suggest that facial and vocal cues may be cues to women's reproductive value, but that body odor cues do not necessarily advertise this information.

Keywords: women, face, body odor, voice, attractiveness, femininity, reproductive value

Introduction

Some of the facial, olfactory, and vocal cues considered by men to be attractive in women may be preferred because they are associated with women's genotypic and/or phenotypic condition (Grammer, Fink, Møller, and Thornhill, 2003; Thornhill and Gangestad, 2008). These preferences may then reflect adaptations for selecting mates with high reproductive value (Fisher, 1930). Consistent with this proposal, several studies have reported positive correlations between attractive facial characteristics in women and measures of their physical health (see Gray and Boothroyd, 2012, for a recent review).

Additionally, body characteristics that are particularly important determinants of women's body attractiveness (e.g., their body mass index [Tovée and Cornelissen, 2001; Tovée, Hancock, Mahmoodi, Singleton, and Cornelissen, 2002], waist circumference and breast size [Jasińska, Ziomkiewicz, Ellison, Lipson, and Thune, 2004]) are also associated with health measures (Flegal, Kit, Orpana, and Graubard, 2013). Many researchers have suggested that fertility may be a particularly important component of women's mate value (e.g., Gangestad and Thornhill, 2008; Grammer, Fink, Jütte, Ronzal, and Thornhill, 2001, Grammer et al., 2003; Symons, 1979, 1995). However, there is considerably less evidence for correlations between physical characteristics in women and fertility.

To date, the majority of studies that have investigated possible links between women's attractiveness and measures of their fertility have tested for changes in young adult women's attractiveness over the menstrual cycle (see Haselton and Gildersleeve, 2011 for a recent review). For example, studies have found that men judge face photographs (Puts et al., 2013; Roberts et al., 2004), recordings of women's voices (Bryant and Haselton, 2009; Pipitone and Gallup, 2008; Puts et al., 2013), and body odor samples (Gildersleeve, Haselton, Larson, and Pillsworth, 2012; Havlicek, Dvorakova, Bartos, and Flegr, 2006; Kuukasjärvi et al., 2004; Roberts et al., 2011; Singh and Bronstad, 2001) obtained during the fertile (i.e., late follicular) phase of the menstrual cycle to be more attractive than those obtained during low-fertility phases. Studies of men's perceptions of the facial and vocal attractiveness of women taking hormonal contraceptives did not find any of the above reported systematic differences across the menstrual cycle (see Alvergne and Lummaa, 2009, for a review), consistent with the proposal that these findings reflect associations between fertility and attractiveness. Although it is unclear whether changes in women's attractiveness during the menstrual cycle necessarily reflect *signals* of women's fertility (see Thornhill and Gangestad, 2008 for discussion), they complement findings from other research that has linked between-subject differences in young adult women's facial and body attractiveness to between-subject differences in their fertility, as estimated from measured hormone levels (face: Law-Smith et al., 2006; body: Jasińska et al., 2004).

The majority of research that investigated the relationship between women's attractiveness and fertility has done so in samples of young adult (i.e., college-aged) women. This emphasis on young adult women may be warranted because women's fecundity is generally highest between 18 and 25 years of age, at least in Western societies (Balasch, 2010; Wood, 1989). However, it is also clear that female fecundity is not limited to this life-stage but should rather be seen as a function of age (Pawlowski and Dunbar, 1999), beginning at menarche and ending at menopause. This raises the question of whether men's judgments of women's attractiveness are sensitive to these age-related changes in fertility.

The current research explored this question by investigating whether men judge the attractiveness of faces, body odors, and voices from three different groups of women (young girls, adult women, and circum-menopausal women) to be significantly different from one another. Given the inverse J-shaped relationship between age and fecundity (Jones and Lopez, 2006), we hypothesized that face, odor, and voice stimuli collected from circum-menopausal women would be judged to be less attractive than the other groups. Since previous work demonstrated that men's preferences for putative facial, olfactory, and

vocal fertility cues are correlated across modalities suggests that men respond to fertility cues in these domains in similar ways (Collins and Missing, 2003; Feinberg et al., 2005; Fraccaro et al., 2011; Rikowski and Grammer, 1999; Röder, Fink, Feinberg, and Neave, 2013; Saxton, Burriss, Murray, Rowland, and Roberts, 2009; Thornhill and Grammer, 1999), we predicted similar patterns of results for men's judgments of women's facial, odor, and body attractiveness. In addition to investigating between-group differences in women's attractiveness, we also tested for between-group differences in men's perceptions of women's femininity. Since previous research suggests that femininity is an important determinant of women's attractiveness (Feinberg, DeBruine, Jones, and Perrett, 2008; Perrett et al., 1998), we predicted that analyses of men's ratings of women's femininity would show a similar pattern of results to our analyses of men's ratings of women's attractiveness.

Materials and Methods

Female participants

Facial photographs, body odors and voice recordings were collected from a total sample of 121 heterosexual women from three different age groups: young girls ($n = 50$; age range = 11-15 years, $M = 13.76$ years, $SD = 1.44$ years), adult women ($n = 42$; age range = 19-30 years, $M = 23.48$ years, $SD = 2.47$ years) and circum-menopausal women ($n = 29$; age range = 50-65 years, $M = 56.83$ years, $SD = 5.17$ years). Participants were recruited from the local population of Göttingen (Germany) and all reported to be native German speakers. To control for possible effects of exogenous hormones on attractiveness, only participants who reported not using any kind of hormonal contraceptive or supplements at the time of data collection were recruited. All participants received 30 euros financial compensation.

Facial photographs

A digital image of the face in front-view was taken of each woman under standardized light, from a fixed distance and with fixed focus, and against a constant black background. Images were captured using a 6.2-megapixel digital single-lens reflex camera (Canon EOS 500D) fitted with a Canon 55-200mm 1:4-5.6 lens (Canon Corporation, Tokyo, Japan) and stored in JPEG file format at a resolution of 3168 x 4752 pixels. The women were instructed to adopt neutral facial expressions and remove make-up, glasses and any other facial adornments (e.g., facial jewellery). All participants were asked to tie back their head hair with a black hair-band. In post-processing, faces were isolated from remaining other visible features (such as hair and the neck) by colouring these features black in Adobe Photoshop CS3 (Adobe Systems Inc., San Jose, USA). Finally, all digital images were scaled to a resolution of 433 x 600 pixels for presentation in the rating component of the study.

Body odor samples

White cotton T-shirts were used for body odor collection, following previous protocols (e.g., Lenchova, Roberts, and Havlicek, 2009; Rikowski and Grammer, 1999;

Singh and Bronstad, 2001). Each participant received a number coded bag containing one unworn white, 100% cotton T-shirt, a box of unscented washing powder for washing clothes and bed sheets, and a bottle of unscented body soap and hair shampoo. All T-shirts were washed with the same unscented washing powder before giving them to the participants and were then put into plastic zip bags immediately. Participants were instructed to refrain from using perfume, engaging in sexual activity, sharing their bed with another person (or their pet) for the three consecutive nights of wearing the T-shirt. They were also instructed not to eat onions, garlic or spicy foods during this period. They were further instructed to wash their bed sheets and pillow covers with the unscented washing powder before the three nights of wearing the T-shirt. Participants were told to use the unscented soap and hair shampoo for bathing or showering each evening to assure similar personal hygiene practices between participants. They were instructed to put the T-shirt back into the plastic bag each morning and take it out only before going to bed again. After three nights, participants were told to put back the T-shirt into the plastic bag, seal it and keep it in the freezer until their appointment with the experimenter. At this appointment, the bags with the T-shirts were collected and kept frozen at -20°C until the body odor ratings took place. We checked reported compliance with experimenter instructions using protocols described in previous studies (Rikowski and Grammer, 1999; Singh and Bronstad, 2001; Thornhill and Gangestad, 1999) by asking female participants after completion of the body odor sampling procedure (via a questionnaire) to report any violations of the instructions, such as the use of perfume/deodorants, cigarette smoking, usage of provided unscented soap and shampoo. ANOVA statistics revealed that none of the requested possible violations of the protocol had a significant effect on men's perceptions of female attractiveness and femininity (all $F > .84$, all $p > .05$).

Voice recordings

Voice recordings were collected with a unidirectional microphone (Rode NT1-A, with phantom power and Rode SM6 pop filter), positioned approximately 10 centimetres in front of the head of the participant, using computer software (Apple Logic Studio®; Apple Inc. Cupertino, USA) and at a sampling rate of 44.1 kHz with 16-bit amplitude. A digital interface (M-AUDIO 8x8 Audio-/MIDI-Interface Fast Track®) was used to encode the recording. Participants were requested to speak the five vowels (A [a], E [ɛ], I [i], O [o], U [u]) repeatedly and for one minute. To ensure a constant speech rate, the vowels were presented visually on a computer screen in front of them (via a video clip), one after the other, and in two seconds intervals. Participants were asked to speak each vowel when it was presented on the screen. The serial order of the visual presentation of vowels changed six times within one minute of presentation in order to avoid habituation effects. For the subsequent rating study, a sequence of approximately nine seconds of the vowels I [i], E [ɛ], O [o], U [u], A [a] (in that order), was digitally isolated from the entire stream and saved in MP3 audio format (Constant Bit Rate Mode, 128kbps).

Rating studies

Digital facial photographs, body odor samples (via T-shirts) and voice recordings were presented in three independent rating studies to a total sample of 450 male

participants (age range = 18-40 years, $M = 23.84$ years, $SD = 3.50$ years) and rated on attractiveness and femininity. All participants received 5 euros compensation for their time.

Face and voice perceptions

A panel of 150 men (age range = 18-40 years, $M = 23.68$ years, $SD = 3.25$ years) rated 24 facial photographs that were randomly selected out of the total sample, 12 of them on attractiveness and another 12 on femininity. Attractiveness and femininity were rated in separate blocks of trials and trial order was fully randomized. Another 150 men (age range = 18-40 years, $M = 23.20$ years, $SD = 2.97$ years) judged each a subset of 24 voice recordings on attractiveness and femininity using the same procedure. Medialab 2008 software (Empirisoft Inc., New York, USA) was used for face and voice presentation and ratings were made on a 5-point scale (1 = not at all attractive/feminine to 5 = very attractive/feminine). For the assessments of voice recordings participants listened to the samples using circum-aural earphones (Superlux HD681F). All voice recordings were set to constant amplitude, and participants were instructed to judge the voices spontaneously as the samples were played only once before they were prompted to make a decision.

Body odor perceptions

A panel of 150 men (age range = 18-40 years, $M = 24.65$ years, $SD = 4.04$ years) was recruited to judge the smell of 12 T-Shirts, randomly selected from the total sample, for attractiveness and femininity. The T-shirt rating took place in separate sessions, over a time period of three weeks. At each session, 12 T-Shirts were defrosted three hours before the rating and put into 5 litre glass jars with clamp lids, numbered from 1 to 12 and judged by 10 participants. They were told to pick one jar after the other (the order differing between participants), shake it, open it and smell it without touching the T-Shirt, then rate the smell of the T-Shirt for attractiveness and femininity on a 5-point scale (1 = not at all attractive/feminine to 5 = very attractive/feminine). Participants provided their ratings using paper questionnaires that were placed next to each jar.

Results

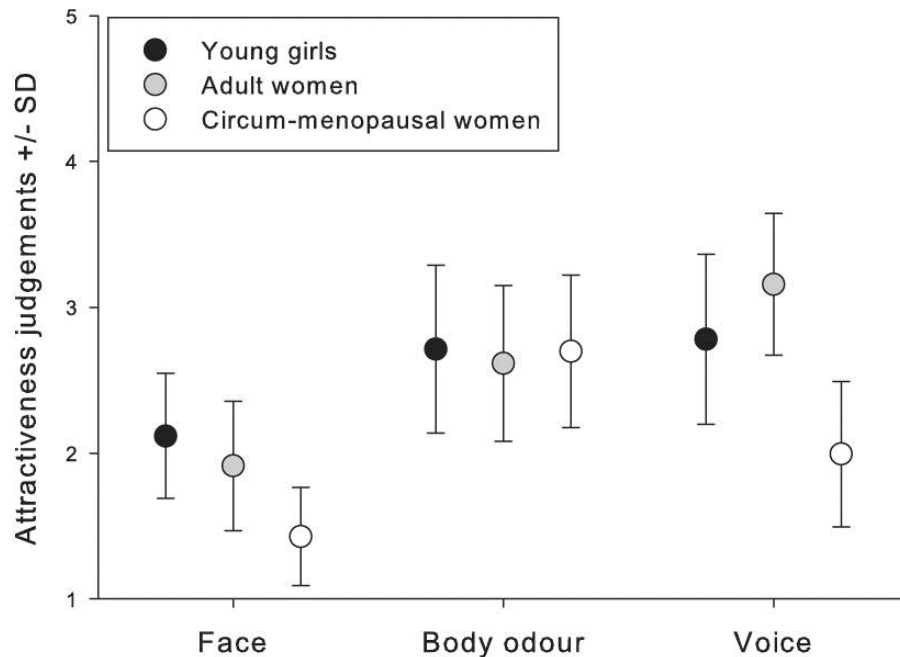
A one-sample Kolmogorov-Smirnov test indicated that the mean values of men's attractiveness and femininity ratings for women's faces, body odors and voices within each age group did not show a significant deviation from the normal distribution (all $Z < 1.12$, all $p > .17$).

To test for differences between mean values of men's judgements of women's facial, olfactory and vocal attractiveness and femininity, a series of analyses of variance (ANOVA) was conducted. Separate analyses were carried out for each combination of rating type (attractiveness or femininity) and characteristic (face, body odor, or voice). Mean ratings were the dependent variable and *age group* (young girls, adult women, circum-menopausal women) was the factor.

Analyses showed a significant effect of *age group* for ratings of both facial attractiveness ($F = 25.58$, $p < .001$; $\eta^2 = 0.30$) and vocal attractiveness ($F = 41.34$, $p < .001$; $\eta^2 = 0.41$), but not for ratings of body odor attractiveness ($F = 0.39$, $p = .68$; $\eta^2 =$

.007; Figure 1). For facial attractiveness, young girls received the highest attractiveness ratings ($M = 2.12$, $SD = 0.43$), followed by that of adult women ($M = 1.91$, $SD = 0.44$), and circum-menopausal women ($M = 1.43$, $SD = 0.34$). Both, young girls and adult women were judged to be significantly more attractive than circum-menopausal women (both $p < .001$), whereas the difference in attractiveness ratings between young girls and adult women was not quite significant ($p = .06$). For vocal attractiveness, adult women received higher attractiveness ratings than did young girls and circum-menopausal women (adult women: $M = 3.16$, $SD = 0.49$; young girls: $M = 2.78$, $SD = 0.58$; circum-menopausal women: $M = 1.99$, $SD = 0.50$), and attractiveness ratings for each of the three groups differed significantly from one another (all $p < .01$).

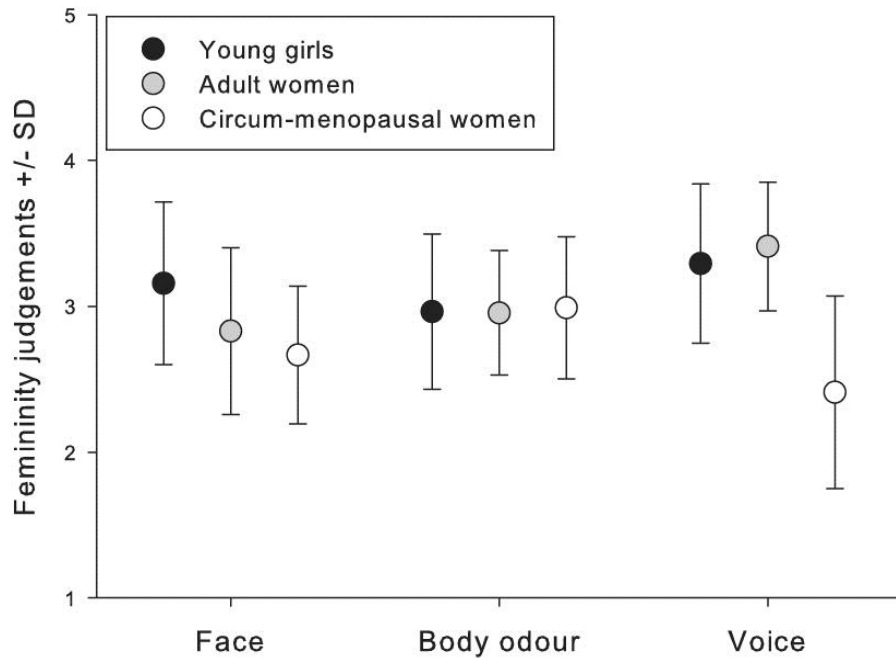
Figure 1. Men's attractiveness judgements of young girls, adult women's and circum-menopausal women's faces, body odors and voices.



Pairwise comparisons of body odor attractiveness ratings between the age groups did not show any significant difference (all $p = .99$).

The ANOVAs for femininity ratings also showed a main effect of *age group* for ratings of women's faces ($F = 8.49$, $p < .001$; $\eta^2 = 0.13$) and voices ($F = 33.12$, $p < .001$; $\eta^2 = 0.36$), but not for ratings of body odors ($F = 0.05$, $p = .96$; $\eta^2 = 0.0008$; Figure 2). Faces of young girls received higher femininity ratings than those of adult women and circum-menopausal women (young girls: $M = 3.16$, $SD = 0.56$; adult women: $M = 2.83$, $SD = 0.57$; circum-menopausal women: $M = 2.67$, $SD = 0.47$).

Figure 2. Men's femininity judgements of young girls, adult women's and circum-menopausal women's faces, body odors and voices.



Pairwise comparisons showed that femininity ratings of young girls' faces were significantly higher than those of adult ($p < .05$) and circum-menopausal women's faces ($p < .001$), but that adult women and circum-menopausal women did not differ in rated femininity ($p = .63$). Analyses also showed that vocal femininity ratings of adult women were higher than those of young girls and circum-menopausal women (adult women: $M = 3.41$, $SD = 0.44$; young girls: $M = 3.29$, $SD = 0.55$; circum-menopausal women: $M = 2.41$, $SD = 0.66$). Pairwise comparisons showed that femininity ratings of circum-menopausal women's voices were significantly lower than those of young girls' or adult women's voices (both $p < .001$), but no significant difference between femininity ratings of young girls' and adult women's voices ($p = .91$). Pairwise comparisons of body odor femininity ratings between the age groups did not show any significant difference (all $p > .05$).

Female age was positively correlated with vocal attractiveness in the group of young girls ($r = .49$, $p < .001$) and negatively correlated with vocal attractiveness in the group of adult women ($r = -.39$, $p < .05$). The correlation between age and vocal attractiveness in the group of circum-menopausal women was not significant, however ($r = .08$, $p = .69$). Although female age was also positively correlated with facial attractiveness in the group of young girls ($r = .31$, $p < .05$), it did not predict facial attractiveness in the groups of adult ($r = .04$, $p = .81$) or circum-menopausal ($r = -.30$, $p = .12$) women. Female age did not correlate with body odor attractiveness in any of the three groups (all absolute $r < .24$, all $p > .10$).

Discussion

The aim of the present study was to investigate the significance of women's faces, body odors and voices as cues to age-related differences in female reproductive value. We studied men's perceptions of the attractiveness and femininity of these features in three groups of women: young girls, adult women, and circum-menopausal women. Our results show that men judged the attractiveness and femininity of young girls and adult women to be significantly higher than that of circum-menopausal women. However, we did not detect significant differences in attractiveness and femininity assessments of body odor among the three groups of women. Thus, our results suggest that both women's faces and voices provide cues to women's reproductive value, but also indicate that body odor may not necessarily provide similar information about women's age-linked fertility. Moreover, there were differences in regard to men's attractiveness and femininity perception of women's faces and voices, particularly for the group of young girls and adult women. Young girls' faces were judged to be more attractive and feminine than those of adult women while adult women's voices were judged to be more attractive and feminine than those of young girls. These latter results suggest that men's perceptions of women's vocal and facial attractiveness may be more closely tied to femininity than youth, *per se* (see also, e.g., Feinberg et al., 2008). Indeed, among the group of young girls, age was positively correlated with both facial and vocal attractiveness, suggesting more mature girls may be judged as more attractive.

Studies of the role of facial, olfactory and vocal cues in human mate preferences and choice have suggested that certain features in women are particularly attractive to men because they signal aspects of women's phenotypic and genotypic condition (Grammer et al., 2003; Thornhill and Gangestad, 2008). Health and youth are considered to be the predominant qualities men employ in their assessment of female attractiveness and femininity because of their link with fertility and reproductive value (Grammer et al., 2003; Wood, 1989). Most evidence for this proposal has come from studies of young adult women (typically college-age students), although the hypothesis receives additional support from the medical literature on age-related changes in female endocrinology and the associated decline of fecundity (e.g., Jones and Lopez, 2006). Evolutionary psychologists have suggested that men are sensitive to even subtle hormone-related changes in female facial, olfactory or vocal characteristics (e.g., those occurring across the menstrual cycle), and there is accumulating evidence that this is indeed the case (see Haselton and Gildersleeve, 2011 for a recent review). A typical finding is that men judge women's faces, voices, and also body odor collected during the fertile phase of the menstrual cycle higher on attractiveness than those obtained during low-fertility phases (but see Mitro, Gordon, Olsson, and Lundström, 2012 for people's ability to discriminate age based on body odor).

Our data expand on these studies of men's sensitivity to female menstrual cycle related changes in facial appearance, body odor and voice quality by investigating men's attractiveness and femininity assessments of women from three age groups that cover a larger age range than was the case in previous studies. Considering a women's life span, it is obvious that, although female fecundity declines with age, it is not limited to a certain period in early adulthood (Pawlowski and Dunbar, 1999). Nonetheless, we hypothesized

that the pattern of differences in men's perception of the attractiveness of facial, vocal, and olfactory cues in different groups of women (young girls, adult women, and circum-menopausal women) would be similar to that reported in studies comparing fertile and non-fertile phases of the menstrual cycle, such that circum-menopausal women would be judged to be less attractive and feminine than the other groups. This hypothesis was supported by our data for attractiveness and femininity judgements of female faces and voices, but not for the assessment of body odor. While this latter null result clearly does not imply that body odor conveys no information about women's reproductive value, it does seem to contrast with Mitro et al. (2012), who reported that humans are sensitive to age-related intensity of body odor and that this relates to pleasantness ratings. Fundamental differences in the design of our and Mitro et al.'s studies may explain this discrepancy, however. For example, Mitro et al. (2012) collected 'supra-donor' stimuli by combining body odor samples from same-sex and same-age group individuals, in order to control for the potential effects mediated by individual body odor, while our study presented individual samples of body odor to men and considered mean ratings in the statistical analysis. In addition, Mitro et al. (2012) found that participants' ability to extract age-related cues from body odor depends on the sex of the donor, such that participants' discrimination performance was higher for male body odor than for female body odor whilst pleasantness ratings were higher for female body odor than for male body odor. Except for the difference in pleasantness ratings of middle-age (45-55 years) and old-age women's (75-95 years) body odor (the former being rated as more pleasant), no other significant differences were detected with female donors. The difficulty in detecting age-related differences, especially in *female* body odor, may explain our finding of no significant differences in attractiveness and femininity rating among the three age groups.

Although some studies of women's vocal and facial attractiveness have found that women's voices and faces may be more attractive around ovulation than during other phases of the menstrual cycle (Bryant and Haselton, 2009; Roberts et al., 2004), other studies have not observed this pattern of results (e.g., Bleske-Rechek et al., 2011; Fischer et al., 2011). Our data showing that circum-menopausal women's voice and faces are perceived to be less attractive than those of women with greater reproductive potential, together with other recent work linking vocal and facial attractiveness to measured hormone levels in adult women (Puts et al., 2013), present converging evidence for the proposal that women's facial and vocal attractiveness are cues to their reproductive potential, even if evidence from studies exploring the effects of fertility over the menstrual cycle may be equivocal.

An interesting result of this present study is that men's attractiveness and femininity assessments of young girl's faces were highest whereas with voices adult women received the highest ratings. There is probably more than one way to interpret this finding and in lack of additional attributes and/or hormonal data from our female participants we can only speculate on the actual cause that has created it. We did not ask male judges to explicitly rate *sexual attractiveness* of the women when presenting their faces, body odor and voices. Thus, the highest ratings of facial attractiveness and femininity of young girls may be explained by a general aesthetic assessment, which is likely influenced, but not necessarily caused, by the mating context. We hypothesize that this result could be an expression of the

fundamental selection pressure operating on male assessments of female quality, resulting in preferences for features that signal youth rather than a true preference for young girls' faces. On the contrary, women's voices may be a more accurate cue to female fecundity than faces, given that men's judgements of adult women's vocal attractiveness in particular were highest. With reference to age-related hormonal effects (particularly around puberty and menopause) upon female faces and voices, it seems sensible to conclude that the strength of these actions favour voice over facial attractiveness when it comes to the assessment of female fecundity.

In summary, our data show that female facial and vocal attractiveness (but not body odor) serve as age cues and suggest that men are sensitive to these cues when assessing women's attractiveness and femininity. In considering women of three age groups, i.e., young girls, adult women, and circum-menopausal women, we found a significant effect of age group on men's assessments of female facial and vocal femininity, which was primarily driven by less positive ratings for circum-menopausal women. Furthermore, our data suggest a general preference for female youth, which finds differential expression in terms of attractiveness and femininity assessments of women's faces and voices. In considering the strong link between age and fertility in women, we propose that facial and vocal cues may serve as cues to female reproductive value and that voice quality may particularly advertise fecundity. Future studies should employ hormonal data and render men's assessments of female features more precisely (e.g., by comparing attractiveness judgments in mating and prosocial contexts) in order to disentangle mate preferences from other forms of evaluation. Such studies could also more carefully consider the possible effects of the type of relationship for which men judged female attractiveness (e.g., long-term versus short-term, platonic versus sexual) and the possible role that cosmetic procedures may have in influencing perceptions of women's reproductive value, particularly when assessing the attractiveness of older women.

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