Cues for facial attractiveness and preference of sexual dimorphism: A comparison across five cultures

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Abstract

It has been hypothesised that the strength of association between sex typicality and attractiveness follows an adaptive pattern across cultures. Such pattern allows for adjustment of individual preferences for facial cues associated with direct (parenting) and indirect (biological quality) benefits from mating with a potential mate according to environmental conditions. To test this hypothesis, we examined associations among intra-culturally perceived sex typicality, attractiveness, measured skin lightness, measured averageness, and sexual dimorphism of shape from facial images, while controlling for age, body mass, and facial width, in five distinct cultures with different environmental and socioeconomic conditions (Cameroon, N of facial stimuli = 200, 100 women; Colombia, N = 138, 66 women; Czechia, N = 100, 50 women; Iran, N = 87, 43 women; and Turkey, N = 185, 93 women). Our results suggest that measured sexual shape dimorphism and averageness are not significantly associated with neither perceived sex typicality nor attractiveness across the cultures. In all samples of female faces, however, perceived sex typicality was positively related to facial attractiveness. Women found perceived sex typicality in men as more attractive only in the Czech environment, with its relatively abundant resources, and in Colombia, which is a highly socioeconomically heterogeneous and competitive culture. Lighter skin raised the ratings of both attractiveness and sex typicality only in Cameroonian women. Darker men were perceived significantly more sex-typical but not more attractive in Cameroonian, Colombian, and Iranian samples. Altogether, our results highlight the need to control for which measure of sexual dimorphism is used (perceived or measured) and make a detailed description of the local environment. It is the perceived, rather than measured, sexual dimorphism that is associated with perceived attractiveness, and wealth distribution, rather than public, health that seems to affect masculinity preferences.

Keywords: Face, Attractiveness, Sexual Dimorphism, Averageness, Geometric Morphometrics, Environment

1. Introduction

According to the signalling theory, human traits which are perceived as attractive are honest cues of genetic fitness. They indicate the level of an individual's adaptation to the local conditions (Gangestad & Scheyd, 2005; Thornhill & Gangestad, 1999). Preferential cooperation and mating with individuals who have attractive traits should, therefore, improve one's reproductive success, and attraction to such traits in potential mates may be an adaptation (Gangestad & Scheyd, 2005; Little, 2014). Beside acoustic and olfactory cues, visual characteristics strongly influence the perception of human attractiveness (Groyecka et al., 2017). Accordingly, many studies investigated the perception of facial and bodily attractiveness and identified facial attractiveness as the most important constituent of human physical attractiveness (Currie & Little, 2009; Peters et al., 2007).

Attractive facial features serve as cues to biological quality and fitness (Kościński, 2007, 2008), in particular healthiness and viability (Henderson et al., 2016; Rhodes et al., 2003), proper hormone-based development of secondary sexual characteristics, and high fertility (Law Smith et al., 2006; Rantala et al., 2012; Whitehouse et al., 2015). They also provide specific facial cues to psychological characteristics important in partnership and childbearing, such as faithfulness (Boothroyd et al., 2008) and willingness to cooperate (Stirrat & Perrett, 2010).

The perception of facial attractiveness is a quick, effortless, and intuitive process (Willis & Todorov, 2006). Despite some interindividual variation in the perception of facial attractiveness (Bronstad & Russell, 2007; Germine et al., 2015; Hönekopp, 2006; Kramer et al., 2018), people from similar cultural backgrounds perceive facial attractiveness similarly (Kowner & Ogawa, 1995; Langlois et al., 2000; Little & Hancock, 2002; Strzalko & Kaszycka, 1992).

While there is also evidence showing some cross-cultural agreement in attractiveness ratings (Burke et al., 2013; Coetzee et al., 2014; Langlois et al., 2000), a growing number of studies report mixed results concerning agreement between distant and mutually unfamiliar cultures (Apicella et al., 2007; Coetzee et al., 2014; Jones and Hill 1993; Sorokowski et al., 2013a; Zebrowitz et al., 2012). Cross-cultural disagreement in attractiveness perception among distant cultures seems to contradict the assumption that attractive facial traits serve as cues to biological quality. A plausible evolutionary-based explanation is that across cultures, preferred traits vary because different characteristics are optimal for survival and reproduction in different environments (DeBruine et al., 2010a; Lee & Zietsch, 2011; Little et al., 2007). Below, we summarise existing evidence regarding the association between biological quality, facial traits, and perceived attractiveness across cultures.

1.1. Age

Youthfulness is associated with higher fertility in both men (Hassan & Killick, 2003) and women (Dunson et al., 2002) and is perceived as attractive across various cultures (Buss, 1989; Maestripieri

et al., 2014; McLellan & McKelvie, 1993). Middle-aged men, on the other hand, are perceived as more attractive than middle-aged women because in men, older age is associated with higher social status and more resources without a substantial decrease in fertility (Maestripieri et al., 2014).

1.2. Averageness

Previous investigations have shown that composite facial stimuli (Langlois et al., 1994; Rhodes et al., 1999; Rhodes & Tremewan, 1996; Rhodes et al., 2001a), averaged individual faces, and natural faces with more average facial configuration are perceived as more attractive and healthier across cultures (Apicella et al., 2007; Deffenbacher et al., 1998; Komori et al., 2009; Rhodes et al., 2001a).

Facial averageness is considered a cue for health, developmental stability (Thornhill and Møller, 1997), and MHC-heterozygosity (Lie et al., 2008; Rhodes et al., 1999). Though Rhodes et al. (2001b) found a positive association between perceived facial health and facial averageness, there is only weak evidence that facial averageness mirrors actual health (Cai et al., 2019; Jones, 2018; Rhodes et al., 2001b; Zebrowitz & Rhodes, 2004).

1.3. Skin colouration

Facial skin colouration has been shown to affect perceived attractiveness, youthfulness, and healthiness across cultures (Coetzee et al., 2014; Matts et al., 2007; Re et al., 2011; Tan et al., 2017; Tan et al., 2018).

Skin luminance is a sexually dimorphic trait. Women have, on average, lighter complexion than men of the same ethnic background (de Rigal et al., 2010; Jablonski & Chaplin, 2000; van den Berghe & Frost, 1986). According to van den Berghe and Frost (1986), lighter skin reflects women's youthfulness, which is perceived as a supposed cue of residual reproductive capacity. In most cultures studied so far, lighter-skinned women are perceived as more attractive than darker-skinned women (Aoki, 2002; Badaruddoza, 2007; Carrito et al., 2016; Dixon et al., 2010; van den Berghe & Frost, 1986; Wagatsuma, 1967) but data for some dark-skinned cultures are less conclusive (Dixon et al., 2017b; Sorokowski et al., 2013b).

Cross-cultural comparisons show that for African raters, skin colouration variance is very important for ethnical typicality and attractiveness rating but less important for ratings made by Europeans (Coetzee et al., 2014; Kleisner et al., 2017; Strom et al., 2012).

1.4. Measured and perceived sex dimorphism

During ontogeny, morphological facial traits of men and women gradually diverge due to the action of sex steroids (Marečková et al., 2011; Whitehouse et al., 2015). As a result, adult faces acquire sex-typical features (Hausman, 1999; Mooradian et al., 1987; Worthman, 1995).

It has been suggested that relative facial width, usually calculated as the ratio of bizygomatic width to upper facial height (fWHR) (Třebický et al., 2015) is a sexually dimorphic trait (Weston et al., 2007). In men, relatively wider faces, i.e. faces with higher fWHR, may be a cue to higher baseline testosterone levels (Lefevre et al., 2013), commonly associated with higher propensity to aggression (Archer, 2006). In accordance with these findings, it has been demonstrated that men with relatively wider faces are more aggressive (Carré & McCormick, 2008) and more successful in direct physical confrontations (Stirrat et al., 2012; Třebický et al., 2015). Although several recent studies question fWHR as a sexually dimorphic trait (Lefevre et al., 2012; Özener, 2012), higher fWHR may be associated with higher male sexual dimorphism in some populations (Geniole et al., 2015).

Higher perceived facial femininity and measured female facial sexual dimorphism is associated with higher perceived attractiveness in non-manipulated female faces (Foo et al., 2017b; Scott et al., 2010; cf. Muñoz-Reyes et al., 2015), composite female facial stimuli, and even in manipulated female faces (Mogilski & Welling, 2017; Perrett et al., 1998; Perrett et al., 1994; Rhodes, 2006; Rhodes et al., 2000; Smith et al., 2009). Attractive and feminine women were shown to have relatively higher oestrogen levels (Durante & Li, 2009; Law Smith et al., 2006; Probst et al., 2016). Higher oestrogen levels have been linked to female fertility (Lipson and Ellison, 1996) and preference for feminine facial traits could thus amount to preference for fertility cues. Preference for femininity in female faces has been found across cultures, although it is less strong in harsher environments with worse health indices (De Barra et al., 2013; Marcinkowska et al., 2014; Penton-Voak et al., 2004).

With respect to men's facial masculinity, the evidence is mixed. Some studies report preference for more feminine features in men's faces (Perrett et al., 1998; Rhodes et al., 2000), some show preferences for more masculine features (Foo et al., 2017b; Johnston et al., 2001; Peters et al., 2008; Skrandina et al., 2014), while several other studies found preference for neither masculinity nor femininity (Mogilski & Welling, 2017; Penton-Voak & Chen, 2004; Scott et al., 2010; Stephen et al., 2012). Although it has been suggested that methodological differences are at least in part responsible for such mixed results (Rennels et al., 2008; Rhodes, 2006), differences in environmental conditions may better explain the preference for sexually dimorphic facial features in both intercultural (Brooks et al., 2011; DeBruine et al., 2010a; DeBruine et al., 2011) and interpersonal context (Little et al., 2007).

Masculine men have been considered to be more immunocompetent (Foo et al., 2017a; Rantala et al., 2012; cf. Nowak et al., 2018) and healthier compared to their less masculine peers (Rhodes et al., 2003; Thornhill & Gangestad, 2006; see also Moore et al., 2011; Rantala et al., 2012). Accordingly, in harsher environments with limited access to medical care where poor health is a crucial risk for survival, women tend to prefer more masculine male faces (DeBruine et al., 2010a;

DeBruine et al., 2011; Penton-Voak et al., 2004) and male faces with apparent cues to higher testosterone levels (Moore et al., 2013). By preferring more masculine men, women in a harsher environment are thus increasing chances of getting a healthy mate who would sire more immunocompetent offspring.

Formidability and resource holding potential, i.e. an individual's willingness to engage in conflict over resources stemming from his/her ability to obtain or withdraw resources from a rival (see Třebický et al., 2019) are also cued by masculinity (Boothroyd et al., 2007; Carre & McCormick, 2008; Stirrat & Perrett, 2010; Swaddle & Reiersen, 2002; Třebický et al., 2015). A woman living in an environment with higher income inequality may prefer masculine men because they are more likely to obtain more resources for their families (Brooks et al., 2011; Little et al., 2013). Greater income inequality is also associated with crime and public violence (Daly & Wilson, 2001; Rufrancos et al., 2013). Preference for masculine men seems adaptive because a formidable and dominant partner could protect his mate against violence (Ryder et al., 2016).

Studies on Colombian population, however, show that fear of domestic violence predicts masculinity preferences negatively (Borras-Guevara et al., 2017a, 2017b). Masculinity is also connected with risks of testosterone-associated antisocial behaviours (van Bokhoven et al., 2006), higher divorce probability (Booth et al., 1993; Mazur & Michalek, 1998), and low partner fidelity (Penton-Voak & Chen, 2004; Polo et al., 2019), and may thus ultimately negatively affect mating success. Scott et al. (2014) proposed a hypothesis according to which masculine men are preferred only in modern, urban populations with sufficient and easily accessible resources. Recently, this hypothesis found support in results reported by Marcinkowska et al. (2019).

1.5. The current study

Although some evidence suggests that similar facial characteristics, such as averageness, youthfulness, and women's femininity are preferred across cultures (Buss, 1989; Coetzee et al., 2014; Rhodes et al., 2001a), cross-cultural differences in preferred characteristics have also been reported (Han et al., 2018; Sorokowski et al., 2013a). To explore the relationship between facial attractiveness, sexual dimorphism, measured facial averageness, skin lightness, age, body mass index, and fWHR in five cultures (Cameroon, Colombia, Czechia, Iran, and Turkey), we conducted a series of path analyses. The cultures differ in the net income, its distribution, level of violence, and public health (see Table 1), which all may affect the preferences. We use two measures of facial sexual dimorphism: (I) perceived sexual dimorphism (hereinafter called 'perceived masculinity' and 'perceived femininity') and (II) measured sexual dimorphism of facial shape calculated from landmark-based geometric morphometrics.

Evaluation of faces from another population may cause people to perform worse in trait attribution (Anzures et al., 2013). In the current study, the faces were therefore judged by raters from their own culture. Moreover, to avoid confounding effects of stimuli manipulation on trait attribution (DeBruine et al., 2010b; Rennels et al., 2008 see also Kleisner et al., 2019), we used only non-manipulated facial stimuli.

It has been demonstrated that the level of correlation between measured sexual dimorphism and perceived facial sexual dimorphism is only moderate (Mitteroecker et al., 2015). It has also been shown that perceived sexual dimorphism is affected by skin lightness and across cultures, women have lighter-coloured skin than men (van den Berghe & Frost, 1986; Carrito & Semin, 2019). We expect that perceived and measured sexual dimorphism are positively correlated. Across cultures, however, perceived sexual dimorphism and attractiveness may also be affected by other cues, such as averageness and skin lightness.

For instance, it has been found that people of sub-Saharan African origin are more sensitive to facial skin colouration and lightness variability as a cue for both facial attractiveness (Kleisner et al., 2017) and ethnic typicality (Strom et al., 2012). We therefore predict that Cameroonian participants are likely to strongly consider skin lightness when rating attractiveness and sex typicality.

People of European and Asian origin also use skin colouration as a cue to attractiveness (Han et al., 2018), healthiness (Henderson et al., 2017; Tan et al., 2018), and sexual dimorphism (Carrito & Semin, 2019). Accordingly, we predict that darker men (lower skin lightness) would be perceived as more masculine across cultures and lighter women as more feminine.

We predict that perceived sexual dimorphism (femininity) of female faces is associated with higher attractiveness across all the five cultures studied here (Cameroon, Colombia, Czech, Iran, and Turkey). Nevertheless, given that previous cross-cultural evidence has shown that men prefer less feminine women in harsher environments (Marcinkowska et al., 2014), we also predict that femininity preference would be weaker in Cameroon, where both the life expectancy and net income are lower than in the other four cultures (see Table 1).

Concerning the association between men's perceived sexual dimorphism (masculinity) and attractiveness, we predict that if masculinity serves as a cue to immunocompetence (Folstad & Karter, 1992), men perceived as masculine should be perceived as attractive in Cameroon, where health is the highest concern (DeBruine et al., 2010a). Additionally, more masculine men who may be capable of obtaining resources due to their physical strength (Fink et al., 2007) are preferred in socioeconomically heterogeneous and relatively competitive societies (Brooks et al., 2011). Men perceived as masculine should thus be perceived as most attractive in Colombia, because income inequality and homicide rate are the highest there (see Table 1).

On the other hand, it has also been suggested that masculine men may be preferred in modern urbanised environments (Scott et al., 2014). We evaluate this alternative hypothesis by testing the association of masculinity and attractiveness in Czech male stimuli, because in the Czech Republic the net income and life expectancy are higher and income inequality lower than in the other four cultures (see Table 1).

Table 1.

Demographic and economic measures in the five studied cultures

Culture	Homicide rate (per 100,000 inhabitants, per year, UNODC, 2019)	Life expectancy at birth - men/women (World Health Organization, 2017)	Healthy life expectancy - both sexes (World Health Organization, 2017)	Gross National Income per capita in Purchasing Power Parity [USD](World Bank, 2019a)	Gini index (Income inequality measure, World Bank, 2019b)
Cameroon	1.40 (in 2017 ¹)	56.7/59.4	51.1	3700 (in 2018 ¹)	46,60 (in 2014 ¹)
Colombia	24.90 (in 2017 ¹)	71.5/78.8	67.1	14490 (in 2018 ¹)	49,7 (in 2017 ¹)
Czechia	0.60 (in 2017 ¹)	76.2/82.1	69.3	37580 (in 2018 ¹)	25,90 (in 2015 ¹)
Iran	2.47 (in 2014 ¹)	74.6/76.9	65.4	21050 (in 2017 ¹)	40,00 (in 2016 ¹)
Turkey	4.31 (in 2012 ¹)	73.3/79.4	66.0	27470 (in 2018 ¹)	41,90 (in 2016 ¹)

¹ Latest available data

2. Materials and methods

All procedures followed ethical standards of the relevant committee on human experimentation and the Helsinki Declaration. This study was approved by the Institutional Review Board of Charles University, Faculty of Science. The photographed individuals and the raters were informed about the purpose of the data collection. Photographed persons signed informed consent. Raters consented by clicking 'I agree' in the questionnaire.

For a detailed description of stimuli acquisition, measurements, ratings, and analyses, see additional data at https://osf.io/va8pg/?view_only=021e11321855463f82fc64e6ceb5716a and within it, 'Supplementary material.pdf'. In subsequent text, all sections, tables, and images referenced as being in Supplementary materials are located in that file.

2.1. Facial photos acquisition

In total, we collected 710 standardised frontal facial photographs (357 men and 352 women) from five cultures (Cameroon, Colombia, Czechia, Iran, and Turkey). The data for age, height, and body weight were gathered for the participants from Cameroon, Colombia, Czechia, and Turkey, while only data for age were collected from photographed Iranian individuals. The number of stimuli per culture and sex and samples' descriptives are summarised in Table S1 in Supplementary Materials. The Cameroonian stimuli were collected in two separate runs (2013 and 2016) and these two sets were also rated separately. In order to achieve a higher statistical power, however, the two Cameroonian

samples were combined. Analyses on the separate samples are available in Table S3 and Figure S4 in Supplementary Materials.

The photographs were taken in full colour with a digital camera, using external light sources and white or grey homogenous background. Lighting conditions were not standardised across the samples, but they were uniform within each sample (each country). All participants were asked to remove their glasses, facial jewellery, cosmetics, adopt a neutral facial expression, and look directly into the camera. All women in the Iranian set wore a hijab that covered hair, ears, and part of their cheeks.

Photographs were straightened and adjusted to set the eyes horizontally at the same height and leave approximately the same length of neck visible. They were subsequently cropped and sized to resolution $\sim 500 \times 700$ px; see sections S1.1 and S1.2 in the Supplementary materials for further details of photo acquisition and rating sessions.

2.2. Rating sessions

Ratings of facial attributes were collected online using Qualtrics survey platform (www.qualtrics.com) mostly via raters' own electronic devices. The Cameroonian stimuli (targets) from 2013 and 2016 were rated in separate runs and attractiveness (but not masculinity/femininity) of Cameroonian stimuli from 2013 was rated using off-line original purpose-made 'ImageRater' program. All raters except for the Colombian ones assessed the stimuli (targets) on verbally anchored seven-point Likert scales (1 represented not at all attractive/masculine/feminine and 7 very much attractive/masculine/feminine face). In Colombia, the scale was continuous and ranged from 1 to 10 with equivalent endpoints. Raters from each country assessed only targets from their country. All participants used as stimuli were unfamiliar to raters. Attractiveness was rated only by raters of the opposite sex except for Turkey, where both male and female facial stimuli were rated by raters of both sexes. Perceived masculinity and femininity in Cameroonian, Colombian, and Turkish culture were rated by people of both sexes, while in Czechia and Iran, perceived masculinity and femininity was rated by only by persons of the opposite sex.

2.3. Facial measures

2.3.1. Skin Lightness

In the Cameroonian, Colombian, Iranian, and Turkish targets, we measured skin lightness from facial photographs using ImageJ software (Schneider et al., 2012) with the plugin Color Transformer 2. In the Czech sample, facial skin lightness was measured *in vivo* with a spectrophotometer (Ocean Optics Flame-S, 200–850nm, with optical resolution 2nm). All measurements were taken made on three

patches on target faces (forehead, left and right cheek) and expressed in CIELab colour space (Hunter, 1958).

2.3.2. Relative facial width

We measured bizygomatic facial width and upper facial height from the glabella to the border of the upper lip from the facial photographs of the stimuli persons (Třebický et al., 2015). Then we calculated the fWHR as facial width divided by facial height.

2.3.3. Facial shape analysis

We employed geometric morphometrics to measure the level of sexual dimorphism (i.e. sexual shape dimorphism of faces) and averageness of faces. We manually landmarked all facial photographs with 72 landmarks on each face in the environment of tpsDig2 software, ver. 2.31 (Rohlf, 2015). We adapted the definitions of standard landmarks previously used by Kleisner et al. (2019). From a total of 72 landmarks, 36 were treated as semilandmarks. Procrustes superimposition of all landmark (and semilandmark) configurations was done with 'gpagen()' function in the R package Geomorph (Adams & Otárola-Castillo, 2013). Semilandmark positions were optimised based on minimising the Procrustes distances between corresponding points. For more detailed description of facial shape analysis, see Section S.1.3.4 of Supplementary materials.

We computed facial averageness as each face's distance from the average facial configuration of its bearer's sex and culture (e.g. averageness of Turkish male targets). The higher the value, the less average the facial configuration.

We computed the level of sexual shape dimorphism by projecting each facial configuration on the vector connecting male and female averages. Position along this axis defined by sex-specific averages is expressed as a single value which provides information about an individual's degree of sexual shape dimorphism. This was done separately for each culture. Higher negative values indicate more female-like facial shape, whereas higher positive values indicate a more male-like facial morphology.

Note that all Iranian women in our set wore the hijab. To compute the averageness of Iranian women and the sexual dimorphism of Iranian men and women, we therefore used the facial configuration of 49 innermost landmarks (compared to 72 landmarks in the rest of the targets groups).

2.4. Statistical analysis

All analyses were conducted using R software for statistical computing (version 3.6.0; R Core Team, 2019). All the datasets and R script are available in electronic supplementary material at https://osf.io/va8pg/?view_only=021e11321855463f82fc64e6ceb5716a.

To assess interrater agreement regarding an assessed attribute, we ran the two-way mixed average score Intraclass correlations (3,k) for the Cameroonian, Czech, and Iranian datasets where raters saw all the targets. Raters in Colombia and Turkey saw only a subsample of the respective targets, which is why for these two cultures, we ran one-way random, average score Intraclass correlations (1,k), i.e. applied a method that was more suitable for these subsamples (see Shrout & Fleiss, 1979). We computed Intraclass correlations using the 'ICC()' function of the 'psych' package for R software (Revelle, 2018). For subsequent analyses, we calculated mean perceived attractiveness and perceived sexual dimorphism ratings.

Pearson's correlation coefficients were used to investigate bivariate associations between variables. P-values in Pearson's correlations were adjusted for multiple comparisons with Benjamini-Hochberg correction procedure. Pearson's correlations and descriptive statistics (mean, SD, and range) for all variables are presented in Tables S2–S4 in the Supplementary materials. We also created a heatmap with clustering based on Pearson correlations to visualise associations between all variables ordered by culture and sex of the stimuli. This was implemented using the 'col_fun()' function of the circlize package (Gu et al., 2014) and the 'Heatmap()' function of the ComplexHeatmap package (Gu et al., 2016) in R software, and subsequently edited in Inkscape version 0.92.4 (see Fig.1).

To explore relationships between age, skin lightness, fWHR, BMI, averageness, measured and perceived sexual dimorphism, and rated attractiveness, we ran path analyses with 'sem()' function from the lavaan package for R (Rosseel, 2012). We conducted a separate path analysis for each stimuli sex/culture combination (e.g. Iranian female stimuli). Rated sex typicality and attractiveness were dependent variables (Fig. 1). The directionality of mutual interdependence between attractiveness and masculinity/femininity was not decided and we treated it as a correlation. For a detailed description of the model development, see Section S.1.4 in the Supplementary materials. Because the number of observations per estimated parameter was relatively low, robust p-values were obtained using a permutation test with 10,000 runs, where the full model was estimated on a randomised dataset.

3. Results

3.1. Correlational analyses

Descriptive values and Pearson's correlations for all variables are reported in Table S2 of the Supplementary materials. For correlation heatmaps with correlation coefficients and p-values after Benjamini-Hochberg correction, see Figure 1.

In women, we found a significant positive correlation between perceived attractiveness and perceived femininity in all five cultures: Cameroonian ($r(98)=0.77$, $p<0.001$); Colombian ($r(64)=0.84$, $p<0.001$), Czech ($r(48) = 0.87$, $p<0.001$), Iranian ($r(41) = 0.93$, $p<0.001$), and Turkish ($r(92) = 0.89$, $p<0.001$). Furthermore, in the sample of Cameroonian women, both rated attractiveness and perceived femininity positively correlated with skin lightness ($r(98)=0.31$, $p=0.014$; and $r(98)=0.36$, $p=0.004$, respectively).

In men, perceived masculinity and attractiveness were significantly correlated only in the samples of Colombian and Czech male faces ($r(70) = 0.44$, $p=0.004$; $r(48) = 0.48$, $p=0.013$, respectively). In samples of Cameroonian, Iranian, and Turkish male faces, perceived masculinity was significantly negatively correlated with facial skin lightness ($r(98)=-0.38$, $p=0.001$; $r(42)=-0.63$, $p<0.001$; $r(89)=0.32$, $p=0.009$, respectively), darker men were therefore perceived more masculine.

Measured averageness was significantly correlated with perceived attractiveness in Iranian men ($r(42)=-0.41$, $p=0.028$), with perceived femininity ($r(48)=-0.44$, $p=0.011$) and attractiveness ($r(48)=-0.52$, $p=0.002$) in Czech women, and perceived femininity ($r(92)=-0.29$, $p=0.03$) and attractiveness ($r(92)=-0.34$, $p=0.007$) in Turkish women. Accordingly, more average faces (i.e. 'averageness' values closer to zero) were perceived as more sex-typical/attractive.

Finally, measured sexual dimorphism was significantly correlated with perceived masculinity in Cameroonian men ($r(98)=0.33$, $p=0.005$; men with more male-like facial shape were perceived as more masculine), with perceived femininity in Colombian women ($r(64)=-0.33$, $p=0.045$; women with more female-like facial shape were perceived as more feminine), with perceived femininity ($r(41)=-0.45$, $p=0.016$) and attractiveness ($r(41)=-0.43$, $p=0.022$) in Iranian women (i.e. more female-like facial shapes were perceived as both more attractive and feminine in Iranian women), and perceived masculinity of Turkish men ($r(89)=0.44$, $p<0.001$, i.e. more male-like shape were perceived as more masculine).

Cameroonian women

Age	BMI	L	FWHR	SShD	AVRG	Fem	Atr	
	0.239	-0.085	-0.071	0.154	0.017	-0.320	-0.213	Age
0.067		-0.054	0.244	0.197	0.075	-0.108	-0.101	BMI
0.592	0.691		-0.137	0.020	-0.009	0.357	0.306	L
0.641	0.067	0.369		0.288	-0.045	0.062	-0.102	FWHR
0.293	0.152	0.902	0.020		-0.102	-0.063	-0.189	SShD
0.902	0.641	0.927	0.732	0.490		-0.134	-0.171	AVRG
0.011	0.490	0.004	0.660	0.660	0.369		0.775	Fem
0.115	0.490	0.014	0.490	0.166	0.228	0.000		Atr

Cameroonian men

Age	BMI	L	FWHR	SShD	AVRG	Masc	Atr	
	0.143	-0.138	-0.083	0.081	-0.035	0.353	-0.183	Age
0.370		-0.074	0.244	0.141	0.011	0.267	0.076	BMI
0.370	0.621		-0.147	-0.079	0.016	-0.380	-0.005	L
0.621	0.061	0.370		0.425	-0.212	0.033	-0.080	FWHR
0.621	0.370	0.621	0.000		-0.242	0.333	-0.008	SShD
0.866	0.964	0.964	0.121	0.061		0.064	-0.116	AVRG
0.003	0.040	0.001	0.866	0.005	0.669		-0.087	Masc
0.211	0.621	0.964	0.621	0.964	0.497	0.621		Atr

Colombian women

Age	BMI	L	FWHR	SShD	AVRG	Fem	Atr	
	0.155	0.096	0.023	-0.070	-0.068	-0.167	-0.138	Age
0.439		-0.074	0.324	0.175	0.179	-0.343	-0.324	BMI
0.651	0.751		-0.145	-0.164	0.019	0.106	-0.003	L
0.982	0.045	0.460		0.244	-0.002	-0.114	-0.153	FWHR
0.751	0.439	0.439	0.195		-0.171	-0.332	-0.276	SShD
0.751	0.439	0.982	0.990	0.439		0.011	-0.039	AVRG
0.439	0.045	0.619	0.593	0.045	0.990		0.844	Fem
0.473	0.045	0.990	0.439	0.117	0.918	0.000		Atr

Colombian men

Age	BMI	L	FWHR	SShD	AVRG	Masc	Atr	
	0.047	0.021	-0.200	-0.090	-0.094	0.177	-0.039	Age
0.882		0.104	0.224	0.307	-0.067	0.233	-0.012	BMI
0.956	0.666		0.139	0.172	0.077	-0.178	-0.160	L
0.371	0.275	0.487		0.302	0.100	-0.015	-0.094	FWHR
0.666	0.094	0.419	0.094		0.163	0.278	0.013	SShD
0.666	0.770	0.727	0.666	0.420		0.005	-0.151	AVRG
0.419	0.271	0.419	0.956	0.127	0.967		0.435	Masc
0.910	0.956	0.420	0.666	0.956	0.443	0.004		Atr

Czech women

Age	BMI	L	FWHR	SShD	AVRG	Fem	Atr	
	0.016	-0.034	-0.280	0.048	-0.080	-0.219	-0.209	Age
0.915		-0.254	0.265	-0.391	0.094	-0.198	-0.314	BMI
0.845	0.211		-0.139	0.148	-0.157	0.132	0.221	L
0.196	0.197	0.493		0.165	0.081	0.157	0.075	FWHR
0.830	0.035	0.472	0.457		0.039	0.267	0.296	SShD
0.704	0.686	0.457	0.704	0.845		-0.443	-0.518	AVRG
0.296	0.335	0.506	0.457	0.197	0.012		0.868	Fem
0.313	0.148	0.296	0.704	0.172	0.002	0.000		Atr

Czech men

Age	BMI	L	FWHR	SShD	AVRG	Masc	Atr	
	0.300	-0.169	-0.042	-0.105	0.196	0.428	-0.094	Age
0.323		-0.135	0.250	-0.184	-0.023	0.263	-0.053	BMI
0.519	0.646		-0.047	0.102	0.203	-0.203	-0.066	L
0.829	0.376	0.829		0.155	0.098	-0.070	-0.202	FWHR
0.723	0.497	0.723	0.567		-0.008	-0.179	-0.076	SShD
0.484	0.907	0.484	0.723	0.958		0.130	-0.263	AVRG
0.027	0.364	0.484	0.790	0.497	0.646		0.478	Masc
0.723	0.829	0.790	0.484	0.790	0.364	0.013		Atr

Iranian women

Age	L	FWHR	SShD	AVRG_49	Fem	Atr	
	0.061	0.456	0.002	-0.255	0.073	0.152	Age
0.773		0.052	0.142	-0.125	0.152	0.180	L
0.016	0.776		0.105	-0.063	0.239	0.207	FWHR
0.990	0.585	0.662		0.105	-0.454	-0.428	SShD
0.383	0.638	0.773	0.662		-0.225	-0.232	AVRG_49
0.773	0.579	0.383	0.016	0.383		0.934	Fem
0.579	0.522	0.426	0.022	0.383	0.000		Atr

Iranian men

Age	L	FWHR	SShD	AVRG_72	Masc	Atr	
	-0.245	-0.047	0.094	0.023	0.446	0.037	Age
0.327		-0.072	-0.275	0.033	-0.625	-0.032	L
0.924	0.924		0.567	0.005	0.054	0.124	FWHR
0.924	0.248	0.001		0.091	0.319	0.053	SShD
0.927	0.924	0.976	0.924		-0.220	-0.412	AVRG_72
0.017	0.000	0.924	0.146	0.364		0.217	Masc
0.924	0.924	0.886	0.924	0.029	0.364		Atr

Turkish women

Age	BMI	L	FWHR	SShD	AVRG	Fem	Atr	
	0.093	-0.083	-0.250	0.009	0.048	0.130	0.032	Age
0.643		0.086	0.207	0.395	0.026	-0.164	-0.203	BMI
0.643	0.643		-0.127	-0.224	-0.050	-0.015	0.029	L
0.073	0.158	0.453		0.435	0.145	-0.039	-0.082	FWHR
0.932	0.001	0.123	0.000		0.071	-0.140	-0.087	SShD
0.822	0.865	0.822	0.419	0.701		-0.286	-0.337	AVRG
0.453	0.325	0.919	0.865	0.419	0.031		0.892	Fem
0.865	0.158	0.865	0.643	0.643	0.007	0.000		Atr

Turkish men

Age	BMI	L	FWHR	SShD	AVRG	Masc	Atr	
	0.206	-0.345	0.159	0.257	0.113	0.357	0.080	Age
0.118		-0.147	0.377	0.361	0.177	0.153	-0.220	BMI
0.004	0.255		-0.026	-0.281	-0.111	-0.316	0.047	L
0.230	0.002	0.869		0.495	0.089	0.086	-0.036	FWHR
0.043	0.003	0.025	0.000		0.201	0.440	-0.010	SShD
0.411	0.175	0.411	0.534	0.121		0.018	-0.245	AVRG
0.003	0.244	0.009	0.534	0.000	0.895		0.190	Masc
0.547	0.092	0.765	0.822	0.928	0.054	0.144		Atr

Colour scale

Pearson's correlations
P-values (after BH-correction)

Figure 1. The diagram of Pearson's correlations ordered by culture and sex of the stimuli.

BMI = body mass index; L = measured skin lightness; fWHR = facial width to height ratio; SShD = measured sexual dimorphism; AVRG = measured facial averageness; AVRG_49/72 = measured facial averageness based on 49/72 landmarks (only Iranians); Fem = perceived femininity; Masc = perceived masculinity; Atr = perceived attractiveness. BH-correction = Benjamini-Hochberg correction

3.2. Path analyses

3.2.1. Female faces

Significant paths among variables mostly replicated the significant correlations reported above. In all women samples, there were significant positive residual correlations between perceived femininity and attractiveness ($r=0.75$ for Cameroonian, 0.82 for Colombian, 0.80 for Czech, 0.91 for Iranian, and 0.89 for Turkish women, $p<0.001$ in all cases).

Only in Cameroonian women, there was a significant positive association between facial skin lightness and both perceived femininity and attractiveness ($\beta=0.35$, $p=0.001$; $\beta=0.29$, $p=0.004$, respectively). Concerning associations between measured facial shape and perceived traits, we found a significant negative association between measured sexual dimorphism and perceived femininity only in the Colombian and Iranian female sample ($\beta=-0.30$, $p=0.019$; $\beta=-0.50$, $p=0.001$, respectively), while in the Iranian female sample measured sexual dimorphism was significantly associated with perceived attractiveness ($\beta=-0.47$, $p=0.002$). In Colombia, partial regression between measured sexual dimorphism and attractiveness ($\beta=-0.25$, $p=0.051$) was close to the formal significance level. In Colombia and Iran, women with more female-like facial shape were therefore perceived as significantly more feminine and in Iran, they were also perceived as more attractive. In the Czech female sample, measured facial averageness was significantly negatively associated with both perceived femininity and attractiveness (i.e. more average faces were perceived as more feminine and attractive, $\beta=-0.47$, $p=0.001$; $\beta=-0.53$, $p<0.001$, respectively). The same was held of the Turkish female sample ($\beta=-0.30$, $p=0.002$ for association between measured averageness and perceived femininity; $\beta=-0.34$, $p<0.001$ between measured averageness and attractiveness).

Perceived facial attractiveness and perceived femininity in a female sample were also related to other variables: Only in Colombia, women with higher BMI were perceived as significantly less feminine ($\beta=-0.28$, $p=0.026$) and less attractive ($\beta=-0.25$, $p=0.041$). Age was significantly negatively associated only with perceived femininity in the Cameroonian female sample ($\beta=-0.26$, $p=0.017$). No other associations between age and perceived traits were statistically significant in the female samples.

Concerning associations among predictors, in Cameroonian ($\beta=0.28$, $p=0.005$), Colombian ($\beta=0.33$, $p=0.010$), and Turkish women ($\beta=0.23$, $p=0.029$), fWHR was significantly positively associated with BMI. In Czechia, this partial regression was close to the formal level of significance ($\beta=0.27$, $p=0.060$). Only in Cameroon ($\beta=0.27$, $p=0.008$), Czechia ($\beta=0.33$, $p=0.025$), and Turkey ($\beta=0.39$, $p<0.001$), wider-faced women exhibited more male-like measured sexual dimorphism. Age was significantly positively associated with BMI ($\beta=0.24$, $p=0.025$) only in Cameroonian women and with fWHR in Iranian ($\beta=0.46$, $p=0.002$) and Turkish women ($\beta=-0.27$, $p=0.007$).

3.2.2. Male faces

Perceived masculinity of Colombian and Czech male faces was significantly positively correlated with their perceived attractiveness ($r=0.46$, $p<0.001$, and $r=0.62$, $p<0.001$; respectively). In the other cultures studied, the association between attractiveness and perceived sexual dimorphism was not statistically significant ($r=-0.07$, $p=0.574$; $r=0.16$, $p=0.533$; and $r=0.19$, $p=0.137$ for Cameroonian, Iranian, and Turkish male faces, respectively). Facial skin lightness was significantly negatively associated with perceived masculinity only in Cameroonian ($\beta=-0.33$, $p=0.001$), Colombian ($\beta=-0.24$, $p=0.041$), and Iranian ($\beta=-0.50$, $p=0.001$) male samples.

Concerning measured facial sexual dimorphism and averageness, the following significant relationships were observed: In the Cameroonian ($\beta=0.36$, $p<0.001$), Colombian ($\beta=0.30$, $p=0.014$), and Turkish sample ($\beta=0.45$, $p<0.001$), men with a higher value of sexual dimorphism (more male-like facial configurations) were perceived as more masculine. In the Iranian ($\beta=-0.42$, $p=0.007$) and Turkish sample ($\beta=-0.23$, $p=0.024$), facial configurations closer to average were perceived as more attractive.

BMI was significantly positively associated with fWHR in Cameroonian ($\beta=0.26$, $p=0.009$), Colombian ($\beta=0.23$, $p=0.048$), Czech ($\beta=0.29$, $p=0.041$), and Turkish ($\beta=0.36$, $p<0.001$) men. Relatively heavier men therefore had relatively wider faces. fWHR significantly predicted measured averageness ($\beta=-0.24$, $p=0.019$) and measured sexual dimorphism ($\beta=0.39$, $p<0.001$) in Cameroonian men. fWHR was significantly positively related to measured sex typicality in Iranian ($\beta=0.57$, $p<0.001$) and Turkish men ($\beta=0.40$, $p<0.001$). In Cameroon, Iran, and Turkey, wider faces therefore had a more male-like shape.

Significant ($p < 0.05$) associations and associations close to formal significance level (between $p = 0.1$ and $p = 0.05$) are reported in Figure 2.

Culture

Sex (stimuli)

Figure 2. A visualisation of path analyses among rated facial attributes and facial measures ordered by the sex of the stimuli (left: women; right: men) and culture. Arrows represent the direction of association. Association between perceived sexual dimorphism and attractiveness was treated as a correlation (i.e. the direction was not specified). Numbers next to the paths indicate the estimate of regression or correlation coefficient in a corresponding model with standardised variables. Black colour denotes a positive coefficient, red colour a negative one (+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$). CAM = Cameroon, COL = Colombia, CZ = Czechia, IR = Iran, TUR = Turkey. SShD = Measured Sexual (Shape) Dimorphism.

4. Discussion

In this study, we investigated associations between facial measures, perceived sex-typicality, and attractiveness of men and women in five distant cultures, namely Cameroon, Colombia, Czechia, Iran, and Turkey. The prediction that preferred traits would be rather culturally invariant (Langois et al., 2000) was not supported in our study, the only exception being that in all the five cultures, attractiveness and perceived femininity were positively related. Unlike feminine women, men perceived as more masculine were rated as significantly more attractive only in two (Czech and Colombian) of the five cultures. These results converge with previous evidence to the effect that perceived female femininity is preferred across cultures (Little et al., 2011). The observed cross-cultural variation of the relationship between perceived masculinity and attractiveness suggests that perceived masculinity is not universally preferred (Rhodes, 2006), possibly due to the negative psychological traits associated with masculinity (Boothroyd et al., 2008). Also, as discussed below, environmental differences may adaptively affect preferences of facial characteristics and lead to cross-cultural divergence (DeBruine et al., 2010a).

Further, we investigated whether measured sexual shape dimorphism and averageness affect perceived sexual dimorphism and attractiveness consistently across the five cultures. Previous studies revealed only a moderate association between perceived and measured sexual dimorphism (Koehler et al., 2004; Komori et al., 2011; Mitteroecker et al., 2015). In the current study, neither perceived femininity nor perceived masculinity were consistently associated with measured sexual dimorphism. Only in the samples of Colombian and Iranian women, faces with more female-typical measured sexual dimorphism were perceived as significantly more feminine. In Cameroon, Colombia, and Turkey, male-like sexually dimorphic facial shapes were rated as more masculine. While other attributes, such as skin colouration (Caritto et al., 2016), contrast between facial features and skin (Stephen & McKeegan, 2010), or facial hair (Clarkson et al., 2020; Dixson et al., 2017a) were beyond the scope of this study, they may affect perception of sexual dimorphism and attractiveness.

The fWHR was positively associated with measured sexual dimorphism in Cameroonian and Turkish faces of both sexes and in Czech female and Iranian male faces. Such positive association implies that individuals with more male-like facial configurations (both men and women) had relatively wider faces. Our results thus add to the results of previous research which showed that at least in some cultures, fWHR partially overlaps with measured sexual dimorphism (see Lefevre et al., 2013; Weston et al., 2007; cf. Özener, 2012). Except for the sample of Czech women, fWHR was significantly positively associated with body mass index (BMI) in all cultures in our study for which BMI was available.

Measured averageness of facial shape was positively associated with perceived attractiveness only in Czech and Turkish women and Iranian and Turkish men. More average Czech and Turkish women were also perceived as more feminine. On the other hand, raters in most cultures in our study did not perceive more average faces as more sexually dimorphic and/or attractive. Measured facial averageness might, therefore, not affect the perception of facial characteristics and, moreover, it is possible that average faces are not universally preferred (see Foo et al., 2017b).

We predicted that skin lightness, which was associated with perceived sexual dimorphism and healthiness in previous research (Carrito & Semin, 2019; Stephen & Perrett, 2016), should be related to perceived attractiveness and sexual dimorphism (darker men being more masculine) in all the five cultures. The results do not support this prediction. In Cameroonian, Colombian, and Iranian men, faces with darker skin were perceived as more masculine. In Czech and Turkish culture, however, facial skin lightness was not associated with perceived masculinity of male targets. And moreover, we found no significant association between skin lightness and perceived male facial attractiveness in any of the studied cultures.

Regarding women, skin lightness was significantly associated with perceived characteristics only in the Cameroonian female sample. Raters found Cameroonian women with lighter complexion as both more feminine and more attractive. This is in line with previous studies which identified facial skin colouration as a more important cue for the perception of facial attributes in African than in non-African populations (Coetzee et al., 2014; Kleisner et al., 2017; Strom et al., 2012).

Further possible explanation for Cameroonian preferences of skin colouration is based on a previously explored association between skin colouration and general health (Henderson et al., 2016, 2017). Life expectancy and healthy life expectancy in Cameroon is less than 60 years and gross national income in purchasing power parity per capita is only 3700 USD/year, which is the least of the five surveyed cultures (World Bank, 2019b; World Health Organization, 2017; see Table 1). Based on these proxies, we can assume that Cameroonians live in conditions where public healthcare is the

poorest among the five cultures we studied. In such an environment, people might pay more attention to minor cues to health status, such as skin lightness (Henderson et al., 2017).

4.1. Differences in preference for perceived male sex-typicality

Previous research suggests cross-cultural environmentally driven differences in preferences of male facial sexual dimorphism (masculinity). Current studies (Borras-Guevara et al., 2019; Marcinkowska et al., 2019), however, use artificially manipulated stimuli and mostly do not address the possible differences between measured and perceived sexual dimorphism (Mitteroecker et al., 2015). In this study, we used natural stimuli and two measures of sexual dimorphism (measured and perceived). In none of the cultures included in the study was measured sexual dimorphism associated with perceived attractiveness. Perceived masculinity was, on the other hand, associated with perceived attractiveness in Colombia and the Czech Republic, two rather modern and urbanised countries. The Czech and Colombian culture are, however, markedly different in the level of income inequality and violence rate (Czech environment is less violent and less socially stratified; see Table 1), that is, in two factors which according to earlier studies do have an impact on masculinity preferences (Brooks et al., 2011; Little et al., 2013).

In recent past, homicide rate, illegal drug production, guerrilla groups' activities, and kidnapping reportedly decreased in Colombia (Cotte Poveda, 2012; Mejía, 2016; Valenzuela, 2018). But the experience of past violence keeps affecting Colombian public life (O'Bryen, 2018) and Colombian society still suffers from high homicide rate (24.9 intentional homicides per 100,000 inhabitants per annum in 2017; UNODC, 2019, see also OECD, 2017). In comparison, intentional homicide rate in none of the other four surveyed cultures exceeds 5 intentional homicides per 100,000 inhabitants per annum (UNODC, 2019; see Table 1). According to previous studies, women who feel more vulnerable to criminal victimisation prefer more masculine men (Ryder et al., 2016; Snyder et al., 2011). In Colombia, fear of criminal victimisation resulting from commonly occurring public violence may strengthen women's preference for male masculine traits. Importantly, however, the distribution of both income and violence is unequal in Colombia (see <http://www.ideaspaz.org/especiales/data-fip/homicidios/#5/3.404/-70.422>). In some regions, public violence is rare and unexpected, while elsewhere, hundreds of violent crimes take place each year. The positive relationship we observed in our data between perceived attractiveness and men's perceived masculinity may therefore reflect the fear of public violence in our Colombian sample and the associated need for a protective male partner, but our sample may not be representative of the Colombian culture as a whole.

In two studies, Borrás-Guevara et al. (2017a, 2017b) found a negative association between women masculinity preference in manipulated male faces and their fear of domestic violence. Raters in these studies represented various social strata of Colombian society. Because our targets and raters were for the most part university students from Bogota, they may represent a relatively affluent social group, which seems to prefer protective masculine partners and is not afraid of domestic violence. A combination of these results highlights the need for a complex approach in future studies whose aim would be acquisition of truly representative results in cultures with substantial within-culture differences. Moreover, it would be important to investigate whether there exists a positive association between the public violence and domestic violence.

Czechia has a low crime and violence rate (less than one murder per 100,000 inhabitants per annum; see Table 1; UNODC, 2019) and the GINI coefficient of income inequality is the lowest among the five cultures in question (25.9; World Bank, 2019a; see also OECD, 2019). Moreover, both life expectancy and healthy life expectancy are higher than in the other studied cultures (World Health Organisation, 2017). According to Marcinkowska et al. (2019), women prefer masculine men, possessors of good genes, in environments with good public health and economic conditions. The risk of low parental investment and antisocial behaviour in masculine partners may be relatively unimportant for raising a child in the resource-abundant Czech environment and this is why it probably does not play such a role in women's choice of partners.

The preferences of women in the Middle Eastern countries (Iran and Turkey) in our sample were predicted neither by measured nor by the perceived sexual dimorphism. In Middle Eastern countries, the tradition of arranged marriages is widespread as is women's subordinate social role and strong interpersonal bonds (Cindoglu et al., 2011; Friedland et al., 2016). These cultural practices may explain the lack of preference for masculine traits. Parents and other relatives, who negotiate and arrange a marriage, may not perceive masculinity as highly important for their choice.

In contemporary Turkey, on the other hand, there is a large difference in social values and mating strategies between rural and urban areas as well as between the relatively westernised and industrialised west and the agricultural east (Cindoglu et al., 2011; Ilkkaracan, 1998). In western Turkey, young people have more freedom in spousal choice. Young men and women can choose their spouse on their own or either accept or reject a prospective spouse proposed by their relatives in a manner of arranged marriage (Hart, 2007). Single young men and women thus have a relatively large amount of freedom to choose a partner based on their preferences, including perceived attractiveness. Sexual selection in these circumstances may therefore be influenced by facial cues to underlying biological quality. Our Turkish participants resided mostly in Istanbul, a modernised city in western Turkey, which is why we can assume that the absence of consistent preference concerning male sex typicality, which we found, is not a consequence of prevalence of forced marriages.

An Iranian study (Honarvar et al., 2016) performed in Shiraz, regional capital of the Fars Province (population over 1.5 million), revealed that half of young participants do engage in premarital sex and one-quarter of participants reported having premarital sex with multiple partners. In Teheran, young women do not always identify with traditional practices (marriage arrangement, *mahr*) and prefer to find a partner on their own (Atari & Jamali, 2016b). When allowed to express their partnership preferences, women from Teheran consider attractiveness as one of the dimensions important for mate choice (Atari & Jamali, 2016a).

Although Iranian and Turkish women might choose their partners freely, those in our sample did not find masculine males (measured or perceived) significantly more attractive. They preferred men with more average facial shape. Iranian and Turkish women in our samples seem to prefer averageness, a supposed facial cue to healthiness, developmental stability (Thornhill & Gangestad, 1993), and human male heterozygosity (Lie et al., 2008) over sexual dimorphism, a proposed cue to immunocompetence and formidability. This association should be studied in more detail in future studies because it implies that for unknown reasons, heterozygosity and developmental stability could be more important than immunocompetence and formidability.

4.2. Study limitations

Although we aimed at keeping the methodology of photo acquisition standardised both within and across cultures, we did not manage to maintain all photo acquisition parameters identical throughout (e.g. camera sensor size or camera-to-subject distance), nor we were able to secure identical lighting conditions in all cultures. Moreover, the questionnaire for Colombian raters differed in the rating scale (in Colombia, raters used a continuous scale consisting of 10 points, while elsewhere, they responded using 7-point Likert scales). On the other hand, we analysed all the data within-culture rather than aggregating them across cultures. There is therefore no strong reason to suspect that scale variability affected our results.

Electronic devices used by raters may have caused some differences in ratings due to for instance differences in screen quality (Třebický et al., 2018). Future studies should therefore either control for the type of electronic device used or conduct rating sessions under controlled laboratory conditions.

On the individual level, preference for sexual dimorphism in men's faces may have been influenced by current fertility and hormonal regulation (see Jones et al., 2019 and citations therein) or relationship status of female raters (Little et al., 2007; Little et al., 2002). Unfortunately, we did not collect these data about participating women.

Although we measured and controlled for facial cues (age, BMI, fWHR) and described environmental conditions that may be relevant to mate choice, we certainly did not address all possible confounding variables. Future studies should account for cross-cultural differences in characteristics people value in potential mates, local beliefs, customs, and prevailing type of spousal choice. A detailed description of such local circumstances seems a plausible route for future studies, although it is not a common approach in current studies.

5. Conclusions

Most current studies on the association between facial attractiveness and sexual dimorphism use a combination of manipulated stimuli and forced-choice paradigm which dichotomises participants' decision-making. Moreover, it has been shown that in studies that use manipulated stimuli, the preferred degree of facial sexual dimorphism may depend on the stimuli-manipulation technique (DeBruine et al., 2010b; Rennels et al., 2008).

Our results, which are based on non-manipulated facial photographs, do not unequivocally support with respect of preference of sexual dimorphism either the hypothesis of 'environmental harshness' or the 'urban environment' explanation. Perceived femininity was preferred in all cultures included in our study (cf. Marcinkowska et al., 2014). Perceived masculinity was preferred only in the Czech and Colombian sample. Although both of these cultures are urbanised, they differ in some environmental aspects (Colombian environment may be regarded as generally harsher due to higher income inequality and higher violence rate). In the Cameroonian culture, however, whose members inhabit a harsher environment than Colombians, perceived masculinity was not regarded as attractive. Since Cameroonian culture is more rural than either Czech or Colombian culture, this seems to lend support to a hypothesis according to which masculinity should be preferred in urban environments, i.e. not in harsher or rural ones (Scott et al., 2014). The masculinity preference in Colombia could be, like in the Czech Republic, due to of urbanisation and not environmental harshness. On the other hand, our raters belonging to urbanised Iranian and Turkish societies did not prefer perceived facial masculinity in men. It is thus possible that a simple 'harshness versus urbanisation' distinction is too simplified and does not address all factors which may lead to a preference of certain facial traits such as perceived sexual dimorphism.

Our study brings further evidence for culture-specific perception of desirable mates based on natural facial stimuli, but the results fit expectations stemming from existing theoretical frameworks only in part. We therefore suggest that data-driven observational (and not only experimental) research is needed to achieve a more comprehensive image of social reality.

Data availability

Original data and other supplementary materials to this article are available online at https://osf.io/va8pg/?view_only=021e11321855463f82fc64e6ceb5716a.

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