

Original Article

# Hand attractiveness—its determinants and associations with facial attractiveness

Krzysztof Kościński

Department of Human Population Ecology, Institute of Anthropology, Faculty of Biology, Adam Mickiewicz University, Umultowska 89, 61-614 Poznań, Poland

Although attractiveness of the human hand seems to be of some importance in the social and mating context, it has attracted little scientific interest thus far. Here, we investigated physical determinants of hand attractiveness and its associations with facial appeal. Photographs of faces and the dorsal and ventral side of hands of young women and men were measured and assessed for attractiveness and several other features. Typicality and femininity of shape, perceived fattiness and skin healthiness, the appearance of nail vicinity, and grooming influenced hand attractiveness in men and women. Hand and facial attractiveness were correlated with each other for each sex. This relationship was mediated by shape typicality and fattiness in men and by grooming and, possibly, fattiness in women. Results are discussed from an evolutionary psychology perspective with special reference to biological signaling and mate selection. *Key words*: attractiveness, face, hand, mate choice. [*Behav Ecol* 23:334–342 (2012)]

## INTRODUCTION

Although much scientific interest has been directed to date at the attractiveness of the human face, body size and its proportions, voice, and smell (see reviews: Gangestad and Scheyd 2005; Weeden and Sabini 2005; Rhodes 2006; Havlicek and Roberts 2009; Wells et al. 2009), the attractiveness of hands has received little attention thus far. This is surprising in that hand appearance seems to be of some importance in social relations, including mating. Questionnaire data indicate that attractiveness of hands matters in a potential partner, even if not as much as for the face and body (Saino et al. 2006; Montoya 2007; Kościński 2011). Worldwide hand beautification, mainly by women, with rings, bracelets, henna, nail varnishing and decorating, and more recently hand skin rejuvenating with esthetic medicine and cosmetic surgery as well as employing hand understudies in the film industry also stress the importance of hand appearance (Eto 1999; Morris 2004; Saino et al. 2006; Jakubietz et al. 2008). This importance may be relatively large in moderate climates where hands, after the face, are the second most visible body parts (Jakubietz et al. 2005). Recently, a region specific to hand processing has been identified in the visual cortex, becoming the second region of the cortex (after that for the face) dedicated to a body part (Bracci et al. 2010). The human hand is anatomically distinguished from that of other primates by having a fully opposable thumb and relatively big thumb and index finger, adaptive features that evolved in the human ancestors so as to facilitate many actions, including throwing, clubbing and, later, more precise hand actions (Young 2003). Because some of the morphological variants that impact on the efficiency of these actions also influence hand appearance, one might expect that the human ancestors

evolved adaptive psychological preferences for hands of a specific appearance in potential mates and collaborators.

Thus far, only 1 predictor of hand attractiveness has been established, namely long fingers, although reasons for this preference are not clear (Manning 2002, 2008; Saino et al. 2006; Dane 2009; Kościński 2011). The second to fourth digit length ratio (2D:4D), a putative measure of the prenatal androgen-to-estrogen ratio (Lutchmaya et al. 2004), is however not associated with hand attractiveness (Saino et al. 2006; Voracek and Pavlovic 2007; Dane 2009; Kościński 2011). In a recent study on digitally manipulated hand images, Kościński (2011) found typicality and femininity of shape, finger length, and skin smoothness to be positively associated with hand attractiveness in each sex for both dorsal and ventral views. In the present study, we sought determinants of hand attractiveness and focused on those features of the hand that are established predictors of facial and bodily attractiveness and which are known or probable cues to one's genetic quality, physical health, fertility, and young age. These features include geometrical typicality or averageness (i.e., proximity to average phenotype for a population), femininity/masculinity (i.e., prominence of sex-typical features), fattiness, and skin condition (Gangestad and Scheyd 2005; Weeden and Sabini 2005; Rhodes 2006; Samson et al. 2010). We also included in the study nail length and decorations because grooming is a further determinant of attractiveness (Cash et al. 1989; Mulhern et al. 2003), as well as finger straightness and arrangement, as these are potential predictors of hand attractiveness (Vámos et al. 1990).

Our second focus pertains to the possible association between attractiveness of hand and face. It was repeatedly, though not unexceptionally, reported that attractiveness of various traits are correlated with one another: face and body in women (Rhodes et al. 2005; Peters et al. 2007; Saxton et al. 2009; Thornhill and Grammer 1999) and men (Hönekopp et al. 2007; Fink et al. 2010; but see also Rhodes et al. 2005), face and voice in women (Zuckerman et al. 1995; Collins and Missing 2003) and men (Saxton et al. 2006), face and smell in women (Rikowski and Grammer 1999; Thornhill and Gangestad 1999; Thornhill et al. 2003) and men (Rikowski and Grammer

Address correspondence to Dr Krzysztof Kosinski. E-mail: koscinski@amu.edu.pl.

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1999; Thornhill and Gangestad 1999), and face and hand in each sex (Dane 2009). A correlation between attractiveness of 2 features suggests a common factor underlying them, and in non-human animals, the factor is usually biological quality of an individual (Candolin 2003). In humans, such correlations are commonly interpreted in terms of biological quality operating through the level of sex hormones (androgens in men and estrogens in women), even though they may also be produced by inter-individual variation in lifestyle and grooming (Peters et al. 2007). For example, from among 10 of the above-mentioned studies reporting a correlation between attractiveness of face and body, voice, or smell in women, only Collins and Missing (2003) stated that facial makeup was removed before photographing and none controlled for facial fattiness, which must surely be a reflection of lifestyle to some extent. This suggests that grooming and lifestyle could have confounded the results of these studies.

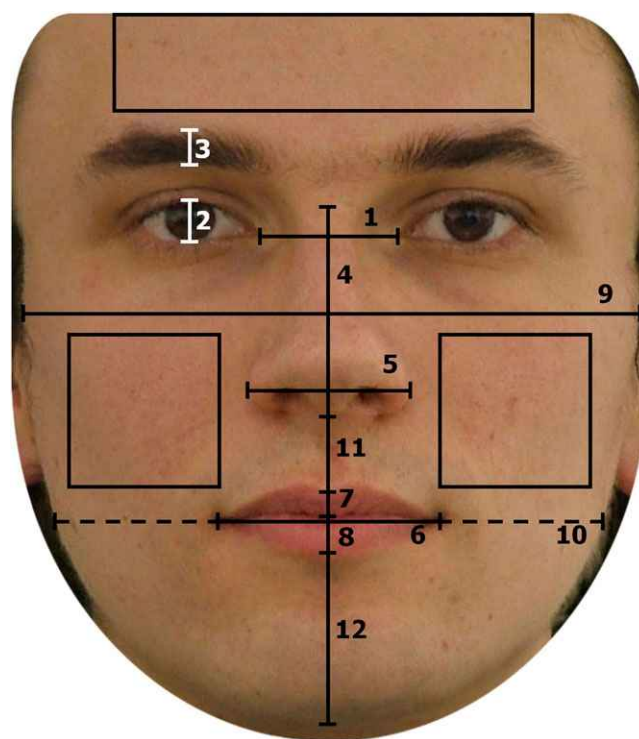
Few studies have thus far investigated the associations between hand attractiveness and the attractiveness of other physical features. Dane (2009) reported a positive relationship between attractiveness of the hand and the face in both sexes. Manning (2002) found that more attractive hands are possessed by slight men and women, tall men, and young women compared with their heavier, shorter, and older counterparts. These correlations mirror preferences for young women, tall men, and relatively slim individuals (Gangestad and Scheyd 2005; Weeden and Sabini 2005), and thereby suggest that observers can decipher cues to these traits located on the hand. Fink et al. (2011) observed a relationship between attractiveness of the face and the upper limbs (including hands) in women. Low values of 2D:4D digit ratio in men (presumably indicating high level of prenatal androgens) are associated with facial attractiveness (Ferdenzi et al. 2011, but see Neave et al. 2003), physical strength, and attractive personality and behavior (Roney and Maestripieri 2004; Fink et al. 2006, 2007; Bogaert et al. 2009). In the present study, we investigated the relationship between attractiveness of hand and face in both sexes and inquired into causes of those relationships. We reasoned that mediation of hand-face attractiveness correlation by structural qualities (e.g., averageness, sex-typicality) would indicate biological quality as the factor responsible for the correlation. On the other hand, if the mediator was to be degree of fattiness or makeup, the correlation could be due rather to lifestyle and grooming.

## MATERIALS AND METHODS

### Stimuli

Photographs of hands of 130 women (aged 18.9–25.6 years,  $M = 20.8$ ) and 126 men (aged 18.3–26.6 years,  $M = 21.5$ ) and faces of 191 women (aged 18.3–25.6 years,  $M = 20.7$ ) and 158 men (aged 18.3–26.6 years,  $M = 21.3$ ) were taken with a digital camera (Panasonic DMC-FZ18, 8.1MPx); subjects were illuminated with fluorescent light with no flash. Photos of both hand and face were available for 119 women (aged 18.9–25.6 years,  $M = 20.8$ ) and 121 men (aged 18.3–26.6 years,  $M = 21.5$ ). Measurements and assessments of traits other than attractiveness (see below) were made for all photos. Due to posers' objections and random incidents, hand attractiveness was not assessed for 1 woman and 1 man and facial attractiveness not assessed for 41 women and 23 men. In consequence, ratings of both hand and facial attractiveness were available for 94 women (aged 18.9–25.6 years,  $M = 20.7$ ) and 107 men (aged 18.5–26.6 years,  $M = 21.5$ ). All posers were Caucasian and students of universities in Poznań (Poland).

Color photos of dorsal and ventral sides of both hands were taken from a distance of 1 m. Participants placed their hands



**Figure 1**

Presentation of face for attractiveness evaluation and measurements taken from facial images (see the text for measurement details). The 3 rectangles indicate the regions presented for skin healthiness assessments.

on a green sheet attached to the wall, the dorsal or ventral side of the hand flush with the wall, fingers straightened and in natural arrangement, and wrist extended. Hand images were then digitally rotated so as to make them visually vertical. Frontal photos of faces were taken from a distance of 3 m. Posers displayed a neutral expression with a direct gaze, shut mouth, their glasses removed, and hair swept off their faces. A white mask was then applied to each photograph so as to hide all elements around the face (Figure 1). Because Bogaert et al. (2009) found that male attractiveness correlated with 2D:4D only in the right hand and other studies have also found stronger correlations for 2D:4D in the right hand (Manning et al. 1998; Lutchmaya et al. 2004), we confined our analysis (measurements and assessments) to the right hand.

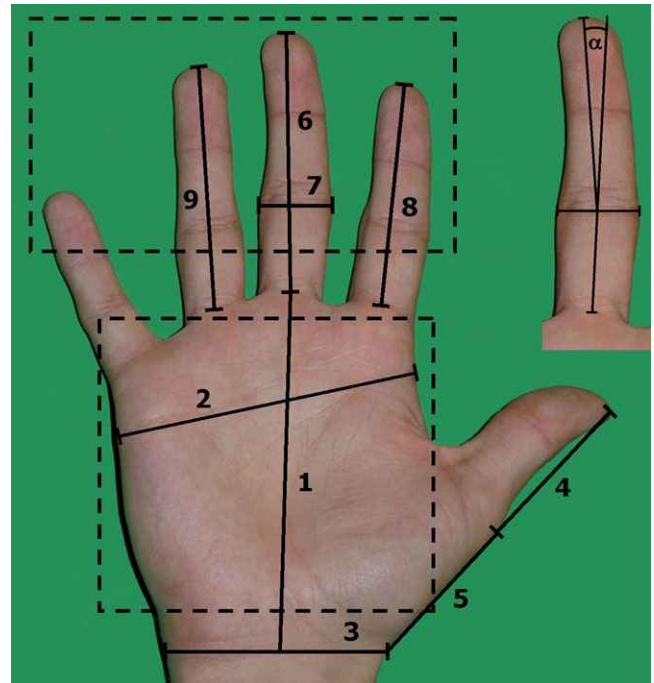
The age of each sitter was noted. Data on handedness were not gathered; however, the magnitude of directional asymmetry on hand and differences in hand measurements between right-handed and left-handed individuals are less than 1 mm (Wagner 1988; Buffa et al. 2007), and so handedness was unlikely to have substantially confounded our results.

### Evaluations

86 females and 95 males rated hand attractiveness and another 116 females and 98 males rated facial attractiveness. They were Caucasian who were students at universities in Poznań (Poland) and aged 17–47 years ( $M = 22.0$ , standard deviation [ $SD$ ] = 4.5). The procedure of attractiveness assessment was the same for hands and faces, excepting that the hand raters viewed the dorsal and ventral side alternately (subsequent images of palm and dorsum derived from different individuals). Evaluations were made on Internet pages designed specifically for this purpose. Each participant was informed that

he/she may rate as many images as they wanted and could cease participation at any time. After the sex and age was supplied, the first image to be rated appeared on the screen (all images were scaled to 400-pixel width). Each participant was asked to rate the attractiveness of the stimulus (hand or face) on a scale from 1 to 7, where 1 indicated the lowest attractiveness, 7—the highest attractiveness, and 4—moderate attractiveness. After the participant had rated the image, an image with another stimulus was displayed (in the case of faces, raters could skip a face if they could recognize the owner). Only hands and faces of opposite-sex individuals were presented, in random order, to the raters. The number of hand images (dorsal and ventral surfaces together) assessed by each rater varied from 11 to 150 ( $M = 30.5$ ). Each hand image (backs and palms taken separately) was assessed by 5–27 ( $M = 10.9$ ) judges. The number of faces rated by each judge ranged from 10 to 136 ( $M = 41.1$ ). Each face was assessed by 7–85 ( $M = 30.8$ ) judges. To ascertain whether a judge's preferences were related to the number of stimuli he/she assessed, we ran an analysis of variance with preferences for 7 facial features (see below) as repeated variable, sex as fixed variable, and the number of assessed faces as covariate. We also ran an analysis of variance with preferences for 10 hand features (see below) and hand side (ventral/dorsal) as repeated variables, sex as fixed variable, and the number of assessed hands as covariate. The number of assessed stimuli showed no significant main effect or interaction in any analysis (all  $P$ s  $> 0.1$ ), so this is not confounded in the results we report below.

Another 5 individuals (20–29 years old, including 1 man) evaluated some of the other features of hands and faces (the stimuli were displayed on a computer monitor). The healthiness of hand skin and facial skin were assessed on a 5-point scale on an image of the dorsum of the hand with all fingers masked and 3 cuttings from the forehead and cheek regions (see Figures 1 and 2 for further information on the cuttings used for assessments of hands and faces). We selected these parts because they contain minimal information on the hand or face shape (Jones et al. 2004; Roberts et al. 2005; Matts et al. 2007). Mouth positivity was rated on a scale from 1 (“distinct discontent to sadness or anger”) to 5 (“distinct content”) on the basis of a cutting containing the lip region. The raters also viewed the eye region cuttings from female faces and evaluated the presence of mascara, eye shadow, and eyeliner (each trait was coded as: 0—none, 1—weak, and 2—strong). Finally, raters viewed cuttings from the dorsum of female hands containing nails of all fingers (see Figure 2) and assessed the presence of varnish, colored varnish, and decorating patterns on a no/yes scale and also the length of the nails using a 4-point visual reference provided by the author. Another 4 individuals (29–38 years old, including 2 men) viewed faces and, separately, hand dorsal and judged whether the image suggested a normal amount of body fat (coded as 1), slimness (0), plumpness (2), or substantial plumpness (3). They then rated the intensity of lip color (0—pale, 1—moderate, and 2—bright) and the presence of lip gloss (no/yes) from cuttings from the lip region of female faces (because it proved difficult to determine the presence of lipstick, lip color was assessed instead). These raters also viewed the nail cuttings to make a single evaluation of the appearance of nails' and their vicinity as being normal (2), bad (1), or very bad (0). Subsequent debriefing revealed that decidedly the most frequent reason for below-normal judgments was reddened and/or cracked skin near to nails (and sometimes the disproportionality of the nails). Finally, 2 people (including 1 man) assessed the length of beard (from 0 to 4) and mustache (from 0 to 3) on male faces and the degree of hairiness on hand dorsa (from 0 to 3) in both sexes.



**Figure 2**

Presentation of hand for attractiveness evaluation and measurements taken from hand images (see the text for measurement details). The rectangles indicate the regions of hand dorsum presented for nail evaluations (the upper rectangle) and skin healthiness assessments (the lower rectangle). On the right side is given the method for determining finger crookedness.

### Measurements

Hand and facial measurements were taken in order to establish averageness and femininity of hands and faces and indices of finger arrangement. All hand measurements were taken on the ventral side. A special software developed by the author served to determine distances between manually placed landmarks and compute the required proportions and indices. The location of all landmarks was determined by the author.

The length of each finger was taken from its tip to the midpoint of the basal crease (Manning et al. 1998). The length of the palm was measured from the midpoint of the distal transverse wrist crease to the basal crease of the middle finger (Garrett 1971). The wrist width was taken at the level of the wrist crease. The hand width was taken as the distance between the points where proximal and distal transverse flexure creases reach the hand contour (see Bayer and Gray 1933). The width of the middle finger was taken at the level of proximal interphalangeal creases. The length of thumb was measured from its tip to the metacarpophalangeal eminence. The distance from the latter point to the wrist approximated to the length of the first metacarpal (Figure 2).

Ten proportions were calculated from the abovementioned measurements, 5 of them proving sexually dimorphic (Table 1): female hands possessed more slender palms and digits and a higher 2D:4D ratio (cf. Jakubietz RG et al. 2005). Within-sex standard values of each proportion were then computed for each individual hand. The values of the sexually dimorphic proportions were added up yielding the femininity index for each hand (all dimorphic features were found to be larger in women). Moreover, absolute values of those z-scores were determined for all 10 proportions; then, they were added up and multiplied by  $-1$  so as to arrive at the averageness index for each hand. We also established 3 indices related



**Table 1**  
**Measured hand and face features and their sexual dimorphism**

	Means ( <i>SD</i> )		<i>t</i>	<i>P</i>	
	Males	Females			
Hand (126 males and 129 females)					
Palm index [1]/[2]	1.24 (0.072)	1.28 (0.064)	4.21	0.000	F
Wrist index [3]/[2]	0.73 (0.038)	0.74 (0.040)	0.76	0.451	
Thumb index [4]/[5]	1.11 (0.184)	1.09 (0.140)	−0.72	0.474	
Digit slenderness [6]/[7]	3.82 (0.258)	4.06 (0.297)	6.92	0.000	F
2D:4D [8]/[9]	0.96 (0.031)	0.98 (0.037)	4.05	0.000	F
1D:3D [4]/[6]	0.71 (0.068)	0.71 (0.060)	−0.22	0.826	
Thumb length/palm length [4]/[1]	0.50 (0.048)	0.50 (0.040)	0.69	0.491	
Middle finger length/palm length [6]/[1]	0.70 (0.043)	0.71 (0.046)	1.37	0.173	
Thumb length/palm width [4]/[2]	0.62 (0.060)	0.64 (0.054)	3.24	0.001	F
Middle finger length/palm width [6]/[2]	0.87 (0.059)	0.90 (0.059)	4.71	0.000	F
Thumb inclination α[4]	54.07 (10.589)	54.51 (8.249)	0.37	0.710	
Finger crookedness	3.79 (2.552)	4.27 (2.368)	1.56	0.121	
Finger span	1.15 (0.140)	1.20 (0.133)	2.95	0.003	
Face (158 males and 190 females)					
Interocular distance [1]	0.51 (0.028)	0.51 (0.028)	1.72	0.087	
Eye height [2]	0.15 (0.019)	0.17 (0.019)	7.19	0.000	F
Brow thickness [3]	0.14 (0.022)	0.11 (0.022)	−14.83	0.000	
Nose length [4]	0.81 (0.060)	0.81 (0.062)	−1.21	0.228	
Nose width [5]	0.58 (0.043)	0.55 (0.041)	−6.08	0.000	F
Mouth width [6]	0.80 (0.058)	0.79 (0.056)	−1.10	0.271	
Upper lip thickness [7]	0.09 (0.023)	0.09 (0.020)	0.54	0.592	
Lower lip thickness [8]	0.14 (0.028)	0.15 (0.025)	1.63	0.103	
Lips thickness [7] + [8]	0.23 (0.044)	0.23 (0.037)	1.36	0.176	
Bizygomatic width [9]	2.22 (0.103)	2.21 (0.093)	−0.96	0.340	
Jaw width [10]	1.98 (0.127)	1.91 (0.118)	−5.28	0.000	F
Nose–mouth distance [11]	0.27 (0.037)	0.24 (0.033)	−8.22	0.000	F
Chin height [12]	0.60 (0.076)	0.53 (0.060)	−9.56	0.000	F
Facial height [4] + [7] + [8] + [11] + [12]	1.91 (0.132)	1.81 (0.100)	−8.24	0.000	F
Mouth location [11]/[12]	0.48 (0.056)	0.48 (0.054)	0.29	0.773	
Upper lip/lower lip [7]/[8]	0.61 (0.160)	0.60 (0.135)	−0.70	0.487	
Mouth width/jaw width [6]/[10]	0.41 (0.032)	0.42 (0.029)	3.36	0.001	F
Nose width/mouth width [5]/[6]	0.72 (0.055)	0.69 (0.049)	−5.29	0.000	F

The numbers in square brackets refer to the measurement numbers in Figures 1 and 2. The letter “F” indicates features taken to calculate hand or facial femininity index.

to joints rather than bones: the inclination of thumb, the span of fingers (the distance between tips of index and small finger divided by hand width), and the finger crookedness (the degree to which the middle finger is crooked, see Figure 2 for details). The middle finger was chosen to determine finger crookedness because it is the only finger, which is normally straight (Jakubietz RG et al. 2005).

Facial measurements were based on 26 landmarks (Figure 1). The landmarks have been located according to anthropometric standards (Farkas 1994); however, because of the difficulty in locating jaw angles on a photo, we determined instead points on the face contour at the level of the mouth slit (Jones et al. 2001; Penton-Voak et al. 2001; Baudouin and Tiberghien 2004). Outer eye corners were obscured by lashes in many photos making their precise location difficult to establish; the landmarks were thus not used in the present study. Fourteen segments that correspond to popularly perceptible facial traits (Figure 1, Table 1) and also used in many previous studies on facial attractiveness (e.g., Cunningham 1986; Baudouin and Tiberghien 2004) were measured. Lengths of these segments were divided by the interpupillary distance to correct them for overall size of the face (Jones et al. 2001; Baudouin and Tiberghien 2004). Furthermore, we calculated 4 quotient indices, which have been previously reported to impact on facial attractiveness (Chang and Chou 2009; see Table 1 for details). Values of bilateral traits were averaged in pairs. From 18 facial features in total, 9 proved to be sexually dimorphic (Table 1). One of

them, brow thickness, is a feature under substantial cosmetic control; it was therefore omitted in the calculation of facial femininity and averageness because these indices were intended to reflect natural facial shape. The femininity and averageness of faces were calculated analogously as they were for hands, that is, the sum of *z*-scores of sexually dimorphic traits yielded the femininity index (*z*-scores of variables larger in men than women were multiplied by −1), and the sum of absolute values of *z*-scores of all variables was multiplied by −1 to obtain the averageness index.

### Initial calculations

All assessments were averaged across the raters yielding single estimates of attractiveness and other rated features for each hand and face. The consistency of assessments of almost all features was good (Cronbach’s alpha = 0.80–0.97) but acceptable only for healthiness of hand skin (Cronbach’s alpha = 0.68). To reduce the number of variables, mascara, eye shadow, and eyeliner were added together, producing a variable further referred to as eye makeup. For the same reason, values indicating the presence of varnish and the presence of colored varnish were added together, producing a measure of varnish prominence.

To assess reliability of landmark location, 10 male and 10 female hands and faces were randomly selected, and the author placed the landmarks once again several months after initial

placement. Test–retest correlation coefficients for 10 hand proportions varied 0.91–0.99 (median = 0.96) in females and 0.93–1.00 (median = 0.97) in men, whereas reliabilities for 18 facial proportions varied 0.89–0.99 (median = 0.98) in females and 0.89–1.00 (median = 0.98) in men. Thus, the location of the landmarks was proved to be reliable.

Hand and facial attractiveness and femininity were normally distributed ( $K-S\ d_s < 0.06$ ,  $P_s > 0.2$ ). Averageness of hand and face reached normality after log transformation. The distribution of many other assessed features was not normal, and so, Spearman's rank correlation coefficient was applied to test pairwise relationships. Because visual inspection of normality plots revealed that the departures from normality were not strong, we were justified in using multiple linear regression analysis to determine the unique contributions of hand and facial features to attractiveness ratings (Hays 1963). Finger crookedness of 1 woman that was recorded as 14.9° was regarded as an outlier by the Grubbs' test ( $G = 4.25$ ,  $P = 0.008$ ); the woman was therefore excluded from further analysis. All analyses were conducted using Statistica StatSoft 8.0.

## RESULTS

### Determinants of hand and facial attractiveness

Bivariate analysis revealed many significant correlations between attractiveness of face and dorsal and ventral sides of the hand and measured and assessed features of the face or hand, respectively (Table 2). The 2D:4D digit ratio did not correlate with attractiveness of the hand dorsum or palm in any sex (all  $|r_s| < 0.16$ ,  $P_s > 0.05$ ). The age of the sitters was not related to hand or face attractiveness in any sex, excepting for a positive correlation with attractiveness of hand dorsum in men ( $r = 0.21$ ,  $P = 0.02$ ).

A model of analysis of variance with facial attractiveness as dependent variable, sex as fixed variable, and age and 7 facial features as covariates proved significant,  $F_{9,274} = 8.27$ ,  $P < 0.001$ . A model of analysis of variance with hand attractiveness (ventral/dorsal) as repeated variable, sex as fixed variable, and age and 10 hand features as covariates also proved significant,  $F_{12,240} = 4.04$ ,  $P < 0.001$  for ventral view and  $F_{12,240} = 8.09$ ,  $P < 0.001$  for dorsal view. We then performed 6 (2 sexes  $\times$  3 dependent variables) backward stepwise multiple regression analyses with attractiveness of face, dorsal or ventral side of hand as dependent variables and measured and assessed features of face or hand, respectively, and the sitter's age as independent variables.

The attractiveness of male hands in ventral view was predicted by averageness ( $\beta = 0.31$ ,  $P < 0.001$ ), femininity ( $\beta = 0.20$ ,  $P = 0.015$ ), appearance of nail vicinity ( $\beta = 0.18$ ,  $P = 0.033$ ), and age ( $\beta = 0.19$ ,  $P = 0.024$ ), overall  $F_{4,120} = 7.31$ ,  $P < 0.001$ ,  $R^2 = 19.6\%$ . In dorsal view, the attractiveness was predicted by appearance of nail vicinity ( $\beta = 0.39$ ,  $P < 0.001$ ), perceived fattiness ( $\beta = -0.24$ ,  $P = 0.002$ ), and age ( $\beta = 0.19$ ,  $P = 0.015$ ), overall  $F_{3,121} = 14.88$ ,  $P < 0.001$ ,  $R^2 = 27.0\%$ . The attractiveness of female hands in ventral view was predicted only by femininity ( $\beta = 0.25$ ,  $P = 0.004$ ), overall  $F_{1,126} = 8.41$ ,  $P = 0.004$ ,  $R^2 = 6.3\%$ . In dorsal view, however, it was predicted by femininity ( $\beta = 0.37$ ,  $P < 0.001$ ), perceived skin healthiness ( $\beta = 0.18$ ,  $P = 0.015$ ), appearance of nail vicinity ( $\beta = 0.29$ ,  $P < 0.001$ ), and varnish prominence ( $\beta = 0.21$ ,  $P = 0.006$ ), overall  $F_{4,123} = 16.05$ ,  $P < 0.001$ ,  $R^2 = 34.3\%$ .

Male facial attractiveness was predicted by averageness ( $\beta = 0.21$ ,  $P = 0.005$ ), femininity ( $\beta = 0.19$ ,  $P = 0.011$ ), perceived skin healthiness ( $\beta = 0.33$ ,  $P < 0.001$ ), fattiness ( $\beta = -0.22$ ,  $P = 0.003$ ), and mustache length ( $\beta = 0.30$ ,  $P < 0.001$ ), overall  $F_{5,129} = 12.67$ ,  $P < 0.001$ ,  $R^2 = 32.9\%$ . The predictors of female facial attractiveness appeared to be averageness ( $\beta = 0.14$ ,  $P =$

Table 2

Spearman's coefficient correlations between hand and facial attractiveness and features of hand and face, respectively, in men and women (hand, 125 males and 128 females and face, 135 males and 149 females)

	Males		Females	
	<i>r</i>	<i>P</i>	<i>r</i>	<i>P</i>
Hand attractiveness in ventral view				
Averageness	0.37	0.000*	0.14	0.126
Femininity	0.18	0.039*	0.29	0.001*
Skin healthiness	-0.12	0.192	0.07	0.423
Fattiness	-0.13	0.162	-0.17	0.051
Hairiness	0.05	0.554	-0.07	0.424
Nail vicinity	0.12	0.167*	0.07	0.444
Nail length	-0.01	0.946	-0.13	0.152
Varnish prominence			0.04	0.678
Thumb inclination	-0.11	0.217	-0.01	0.877
Finger span	0.12	0.168	0.06	0.493
Finger crookedness	-0.15	0.089	0.02	0.849
Hand attractiveness in dorsal view				
Averageness	0.17	0.064	-0.12	0.184
Femininity	0.09	0.310	0.44	0.000*
Skin healthiness	-0.03	0.743	0.16	0.074*
Fattiness	-0.24	0.007*	-0.27	0.002
Hairiness	0.17	0.065	-0.01	0.928
Nail vicinity	0.39	0.000*	0.28	0.001*
Nail length	0.19	0.032	0.12	0.178
Varnish prominence			0.24	0.006*
Thumb inclination	-0.06	0.489	-0.02	0.802
Finger span	0.19	0.030	-0.09	0.323
Finger crookedness	-0.08	0.405	-0.05	0.550
Facial attractiveness				
Averageness	0.17	0.049*	0.17	0.044*
Femininity	0.23	0.008*	0.23	0.005
Skin healthiness	0.28	0.001*	0.24	0.003*
Fattiness	-0.31	0.000*	-0.15	0.061*
Mouth positivity	0.06	0.500	0.18	0.026*
Lip color	-0.02	0.856	-0.04	0.592
Lip gloss			0.20	0.017*
Eye makeup			0.47	0.000*
Brow thickness	0.05	0.556	-0.19	0.018
Beard length	0.19	0.030		
Mustache length	0.34	0.000*		

\* Indicates significant effects in backward stepwise regression analysis (see text for numerical values).

0.035), skin healthiness ( $\beta = 0.21$ ,  $P = 0.002$ ), fattiness ( $\beta = -0.17$ ,  $P = 0.012$ ), mouth positivity ( $\beta = 0.21$ ,  $P = 0.002$ ), eye makeup ( $\beta = 0.43$ ,  $P < 0.001$ ), and lip gloss ( $\beta = 0.20$ ,  $P = 0.001$ ), overall  $F_{6,142} = 15.29$ ,  $P < 0.001$ ,  $R^2 = 39.2\%$ . Standard multiple regression analyses produced qualitatively the same results, excepting that the effect of perceived fattiness on the attractiveness of male hands in dorsal view was only marginally significant ( $\beta = -0.17$ ,  $P = 0.054$ ).

### Hand–face associations

Facial attractiveness showed correlation with hand attractiveness in both views in both sexes: males, ventral side,  $r = 0.32$ ,  $P = 0.001$  and dorsal side,  $r = 0.38$ ,  $P < 0.001$  and females, ventral side,  $r = 0.21$ ,  $P = 0.045$  and dorsal side,  $r = 0.28$ ,  $P = 0.006$ . In men, there were also significant correlations between hand and face in terms of averageness ( $r = 0.23$ ,  $P = 0.010$ ) and perceived fattiness ( $r = 0.38$ ,  $P < 0.001$ ) but not femininity and rated skin healthiness ( $|r_s| < 0.1$ ,  $P_s > 0.3$ ). In women, averageness, femininity, and rated skin healthiness were not correlated between hand and face

( $|r_s| < 0.1$ ,  $P_s > 0.3$ ); there were however relationships between perceived fattiness of hand and face ( $r = 0.23$ ,  $P = 0.014$ ) and between varnish prominence and eye makeup ( $r = 0.23$ ,  $P = 0.011$ ).

Combining these results with the abovementioned determinants for hand and face attractiveness, one can identify the factors responsible for the relationship between hand attractiveness and face attractiveness. These are averageness and fattiness in men and grooming, and, perhaps, fattiness in women. The mediation of fattiness in the hand–face attractiveness association in women is uncertain because the impact of fattiness on hand attractiveness in women was significant only in bivariate analysis, not in multiple regression. Structural equation modeling leads to the same conclusions (see Supplementary Data).

## DISCUSSION

### Results summary

Facial attractiveness was shown to be dependent on geometrical averageness and femininity, perceived skin healthiness, perceived fattiness, mouth positivity in both sexes, use of facial beauty products in women, and facial hair in men, concurring with the results from previous studies (Von Fauss 1988; Cash et al. 1989; Mulhern et al. 2003; Jones et al. 2004; Rhodes 2006; Kościński 2007; Matts et al. 2007; Neave and Shields 2008; Coetzee et al. 2009; DeBruine et al. 2010). Determinants of hand attractiveness were to a large degree analogous to those of facial attractiveness. Averageness increased attractiveness of the ventral side in both sexes and possibly the dorsal side in men, femininity enhanced attractiveness of the dorsal (only in women) and ventral side (at least in women), perceived skin healthiness being beneficial to hand attractiveness but only for the dorsal view in women, perceived fattiness was detrimental for attractiveness for the dorsal view at least in men, and grooming (specifically, varnish prominence) able to predict attractiveness of hand dorsa in women. In addition, attractiveness of the dorsal side was positively related to appearance of the nail vicinity (in both sexes). These findings closely approximate those obtained for digitally manipulated hand images, indicating that averageness, femininity, and skin smoothness increase hand attractiveness (Kościński 2011). Variation of non-geometrical hand features, skin quality, fattiness, and the appearance of nail vicinity occurs predominantly on the dorsal side, and so these features usually predicted attractiveness of the hand dorsum only. In contrast, geometrical features, such as averageness and femininity, predicted attractiveness mainly in the ventral view where non-geometrical characteristics were less conspicuous. Hand and facial attractiveness were correlated with each other for each sex. This relationship was mediated by shape typicality and fattiness in men and by grooming and, possibly, fattiness in women.

### Averageness

Averageness of morphological structures is regarded as a sign of developmental stability and good genes (Koeslag 1990; Thornhill and Møller 1997; Lie et al. 2008). The development of individuals of low genetic quality (e.g., mutation-loaded) is relatively more labile and may lead to atypical proportions of a structure. The presently observed relationship between hand averageness and facial averageness in men suggests that both reflect an individual-level developmental stability and possibly also good genes (see Thornhill and Grammer 1999; Little et al. 2008). The female preference for male hand of average shape may thus be an evolutionary adaptation for

choosing a partner with good genes (Gangestad and Scheyd 2005; Rhodes 2006). In females, however, hand averageness was not related to facial averageness, so averageness of each body part carries a different message (if any). Both men and women may prefer averageness in opposite-sex hands because hand disproportionality may impair its function (Young 2003) and because hand averageness is a reliable cue to physical health, as some diseases, for example, acromegaly, distort hand proportions (Anton 1972). The preference for hands of average shape may also be a case of a general preference for exemplars typical for their category, which is an effect of the manner in which the neural system functions (Reber et al. 2004; Halberstadt 2006).

The contention that the averageness of hand shape is a reliable cue to developmental stability and genetic quality in men only may seem unexpected, but it nonetheless accords with theoretical and some of empirical research. As theories of sexual selection predict, in the context of mate choice, good genes and cues to good genes are more important in males than females (Geary et al. 2004). Lie et al. (2008) found that major histocompatibility complex genes heterozygosity, a component of genetic quality and determinant of efficient immune functioning, correlated with facial averageness in males only. Rhodes et al. (2005) obtained that facial and bodily averageness were associated with mating success in men only, although female facial attractiveness and femininity were related to their mating success. Finally, Gangestad et al. (1994) and Thornhill and Gangestad (1994) reported that body symmetry, that is, another sign of developmental stability and genetic quality, correlated with facial attractiveness only in male individuals.

### Femininity

The prominence of sexual features is dependent on the level of sexual hormones, where a high ratio of androgens to estrogens results in a masculine phenotype, whereas a low ratio has a feminizing effect (Singh 1993; Feinberg 2008). High androgen-to-estrogen ratio in men and its low values in women are believed to signal good biological quality (Singh 1993; Gangestad and Scheyd 2005; Feinberg 2008). In the present study, however, hand femininity was not associated with facial femininity in any sex, which challenges the claim about a common hormonal basis for the dimorphism of both body parts. It has also been suggested that prenatal levels of sex hormones determine future 2D:4D finger ratio (Lutchmaya et al. 2004) and facial shape (Schaefer et al. 2005); in the current study, however, no significant correlations between 2D:4D and facial femininity and sexually dimorphic features were found in any sex (all  $|r_s| < 0.12$ ,  $P_s > 0.18$ ).

A hand with feminine (i.e., slender) shape may be a signal of not only biological quality but also socioeconomic status. People descending from families of high socioeconomic status have a slender body (Sundquist and Johansson 1998; Meyer and Selmer 1999) and thus may also have more slender hands. However, we were unable to test this hypothesis due to a lack of data on the height and weight of the sitters. In popular opinion, slender hands with long fingers are perceived as shapely and gallant (Jakubietz RG et al. 2005), destined for playing instruments rather than hard physical work (Wagner 1988; Manning 2008). The mechanization of work in contemporary societies has shifted emphasis from power handling to precision handling, the latter being better performed by the typical female than male hand (Morris 2004) which may be another reason of the observed preference for femininity in each sex. The preference, however, is certainly not a result of perceptual bias (the manner in which the neural system functions) as this would lead to a preference for

masculinized rather than feminized male hands (Enquist and Arak 1993).

### Skin healthiness

Healthy skin appearance influenced hand attractiveness only in women, which concurs with the fact that skin appearance is generally more important in women than men (Samson et al. 2010). Because some serious diseases, for example, scleroderma, substantially change the appearance of hand skin (Jakubietz MG et al. 2005), its healthy look may be a reliable cue to an individual's good health. In contrast, owing to perceptual bias, the skin of a totally healthy individual may be perceived as unhealthy and unattractive if it possesses features that resemble the symptoms of a disease (Zebrowitz et al. 2003). Persistent manual labor renders the hand skin coarse (Sanders et al. 1995); thus, it is possible that female hands with coarse skin are perceived as unattractive because they signal low socioeconomic status. Skin appearance of the hand is the feature, which changes most with age (Jakubietz et al. 2008) and therefore impacts on the perceived age of its owner (Bains et al. 2006). A young appearance is much more desirable in women than in men (Kościński 2007) and may be another reason for the influence of skin quality on hand attractiveness seen only in women in the present study.

### Fattiness

The preference for slimness has broadened enormously in last few decades (Garner et al. 1980; Wiseman et al. 1992) and a dislike exists not only for an excessive body fat (Tovée et al. 1999; Puhl and Heuer 2009) but also for a fatty face (Coetsee et al. 2009). Because obesity is associated with many diseases (Kopelman 2000), the preference for slimness appears to be adaptive, especially in Western populations in which the energy-storing function of adipose tissue has subsided (Brown and Konner 1987). In the present sample, the attractiveness of hand dorsa in men was negatively correlated with perceived fattiness. In women, this relationship was clear in bivariate analysis but nonsignificant in the multiple regression. This can be explained by the association between geometrical femininity and perceived fattiness in female hands ( $r = -0.37$ ,  $P < 0.001$ ). In fact, perceived fattiness remained in the regression equation when performing the analysis without hand femininity ( $\beta = -0.20$ ,  $P = 0.014$ ).

Fattiness proved the second mediator, after averageness, of the correlation between attractiveness of hand and face in men, and probably also the second mediator, after grooming, of the same correlation in women. The amount of body fat is partly genetically determined, but it is also strongly dependent on lifestyle, including the diet and physical activity (Kopelman 2000). The mediation of the hand–face attractiveness correlation by an individual's fattiness may thus result from genetic factors, cultural factors, or both.

### Grooming

Varnish prominence increased the attractiveness of female hands and correlated with the application of eye makeup. Nail length, another form of hand grooming, however, did not influence hand attractiveness or correlate with eye makeup (both  $|r_s| < 0.15$ ,  $P_s > 0.12$ ). The appearance of the nail vicinity proved a strong predictor of the attractiveness of the hand dorsum in both sexes. This may derive from natural skin qualities and/or grooming but did not correlate either with perceived skin healthiness in any sex or with varnish prominence in women (all  $|r_s| < 0.11$ ,  $P_s > 0.2$ ).

Furthermore, varnish prominence was the only unequivocal factor mediating the association between attractiveness of the hand and face in women (the supposed second factor is the abovementioned fattiness). The fact that residuals of facial attractiveness in structural equation modeling were not correlated with residuals of hand attractiveness in any view (see Supplementary Data) indicates that there is no other factor, not examined in this study, that could mediate hand–face attractiveness relationship in women. Therefore, women of attractive face possess, on average, relatively attractive hands mainly or even only because women who apply eye makeup usually also varnish their nails. It is then an issue of crucial importance that future research on associations between the attractiveness of various body traits controls for possible non-biological confounders, such as makeup or diet, before such association is taken as a sign of biological quality underlying these traits.

### CONCLUSIONS

The present study revealed many determinants of hand attractiveness, most of them being previously reported to impact on facial attractiveness. These determinants embrace shape typicality, shape femininity, perceived fattiness and skin healthiness, and grooming (specifically, varnish prominence). Most of these characteristics seem to indicate good biological quality, present and past health, and socioeconomic status, which suggests that the criteria for hand preferences are adaptive. Hand attractiveness correlated with facial attractiveness in men and the relationship was mediated by individual-level averageness and fattiness. This suggests that hand averageness is a reliable cue to developmental stability and possibly also good genes in men. It is thus possible that women possess an evolutionarily shaped preference for averageness of male hands, and the preference might have acted on the appearance of the hands through a stabilizing sexual selection. The correlation between attractiveness of hand and face was also observed in women, but this time it was mediated by grooming and maybe also by fattiness. This suggests that nonbiological factors, such as grooming, dieting or physical activity, might have confounded associations between attractiveness of various traits at least in some of previous studies which did not control for these factors.

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## Structural equation modeling of relationships between hand and face

To investigate the factors responsible for relationships between attractiveness of hand and face, structural equation modeling was applied. We assumed five latent variables reflecting factors that operate on an individual level and thereby influence both hand and facial appearance: averageness, femininity, fattiness, skin quality and grooming. Paths were traced from these variables to their respective observable variables pertaining to hand and face (e.g. from averageness to hand averageness and to facial averageness). Other paths were traced from observable variables pertaining to hand and face to attractiveness of the hand dorsum and palm, or attractiveness of face, respectively. The modeling was conducted separately for each sex and the variables describing grooming were different in both cases. It should be noted that these analyses were conducted on somewhat smaller samples than multiple regressions (see above), which may partially account for the slightly different results obtained with these two methods.

Figure S1 depicts the best model for men that we found. Statistical parameters indicated a good fit of the model ( $\chi^2_{51} = 61.3$ ,  $P = 0.194$ , *SRMR* (the standardized root mean square residual) = 0.078). As seen from the graph, averageness and fattiness were the only mediators between attractiveness of hand and face. Averageness impacted on both hand and facial averageness, which in turn influenced attractiveness of hand and face, respectively (the influence on hand attractiveness in dorsal view was only marginally significant). Fattiness impacted both hand and facial assessed fattiness, which in turn negatively influenced attractiveness of hand and face, respectively (the influence on hand attractiveness occurred only for the dorsal view). Residuals of facial attractiveness were correlated with residuals of hand attractiveness, both in dorsal ( $r = 0.22$ ,  $P = 0.001$ ) and ventral view ( $r = 0.25$ ,  $P < 0.001$ ). This indicates that there exists another factor (or factors), not measured in this study, that mediates the hand-face attractiveness relationship.

The model arrived at for women also proved well fitted ( $\chi^2_{76} = 75.2$ ,  $P = 0.503$ , *SRMR* = 0.080). As seen in Figure S2, the only mediator between attractiveness of hand and face was grooming: it impacted on varnish prominence, which influenced attractiveness of the hand's dorsal view; it also

impacted on eye makeup, which influenced facial attractiveness. Fattiness, however, is a candidate for the second mediator: it influenced both facial and hand assessed fattiness, which, in turn, tended to negatively predict facial (path coefficient = -0.13,  $P = 0.08$ ) and dorsal hand attractiveness (path coefficient = -0.14,  $P = 0.14$ ), respectively. These tendencies are also suggested by the above analyses (see Table 2 in the main text). Residuals of facial attractiveness were not correlated with residuals of hand attractiveness in any view ( $P_s > 0.1$ ). This suggests that there is no other factor, outside of those measured in this study, that could mediate hand-face attractiveness relationship in women.

We also performed Spearman's partial correlations (see <https://www-304.ibm.com/support/docview.wss?uid=swg21474822>) between facial attractiveness and hand dorsum and palm attractiveness with the control of facial and hand averageness and fattiness in men, and eye makeup, varnish prominence, and facial and hand fattiness in women. These correlations were still significant in men (ventral side,  $r = 0.30$ ,  $P = 0.002$ ; dorsal side,  $r = 0.36$ ,  $P < 0.001$ ) but not in women (ventral side,  $r = 0.15$ ,  $P = 0.170$ ; dorsal side,  $r = 0.18$ ,  $P = 0.090$ ). This confirms the claim that some variables not taken into account in the present study mediate hand-face attractiveness correlation in men but not in women.

### Figure captions

Figure S1. Structural equation modeling of associations between facial and hand attractiveness in men. On the left are given two coefficients per path: The upper represents the dorsal and the lower the ventral side of the hand. † –  $P < 0.08$ , \* –  $P < 0.05$ , \*\* –  $P < 0.01$ , \*\*\* –  $P < 0.001$ .

Figure S2. Structural equation modeling of associations between facial and hand attractiveness in women. On the left side are given two coefficients per path: The upper represents the dorsal side and the lower the ventral side of the hand. † –  $P < 0.08$ , \* –  $P < 0.05$ , \*\* –  $P < 0.01$ , \*\*\* –  $P < 0.001$ .



