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Determinants of hand attractiveness—a study involving digitally manipulated stimuli

Krzysztof Kościński
Institute of Anthropology, Faculty of Biology, Adam Mickiewicz University, Umultowska 89, 61-614 Poznań, Poland; e-mail: koscinski@amu.edu.pl
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Abstract. Although attractiveness of the human hand is of significance in the social and mating context, thus far it has attracted little scientific interest. In this study, young women and men were presented with pairs of digitally manipulated images of opposite-sex hands and asked to indicate the hand perceived to be the more attractive in each pair. The hands within a pair differed from one another by a single feature: shape averageness, femininity, finger length, second-to-fourth-digit ratio, or skin smoothness. All these features, with the exception of the digit ratio, were shown to increase hand attractiveness in each sex in both dorsal and ventral views. Skin smoothness was preferred more strongly in female than in male hands. Women also tended to prefer medium degrees of shape femininity and skin smoothness in male hands compared to both high and low levels. Adaptive and non-adaptive (related to perceptual bias) mechanisms underlying these preferences are discussed.

1 Introduction

Although much scientific interest has been directed at the attractiveness of the human face, body size and its proportions, voice, and smell (see reviews by Gangestad and Scheyd 2005; Havlicek and Roberts 2009; Rhodes 2006; Weeden and Sabini 2005; Wells et al 2009), the attractiveness of the hand has thus far received little attention. Research conducted on images of real (Manning 2002, 2008; Saino et al 2006; Voracek and Pavlovic 2007) and digitally manipulated hands (Saino et al 2006) indicates that long fingers (more specifically, the index and ring finger) are attractive in both sexes, although reasons for this preference are not clear (Manning 2002; Saino et al 2006). The second-to-fourth-digit ratio, a putative measure of the prenatal androgen-to-estrogen ratio (Lutchmaya et al 2004, but see Kratochvíl and Flegr 2009), was not, however, associated with hand attractiveness in studies by Saino et al (2006), Voracek and Pavlovic (2007), and Manning (personal communication cited in Saino et al 2006). Manning (2002) also found that more attractive hands are possessed by slight men and women, and tall men and young women compared to their heavier, shorter, and older counterparts. This mirrors preferences for young women, tall men, and relatively slim individuals (Gangestad and Scheyd 2005; Weeden and Sabini 2005), and thereby suggests that observers can decipher the cues to these traits located on the hand.

That there has been little scientific interest in hand attractiveness is surprising as hand appearance seems to be of some significance in social relations, including mating. Questionnaire data indicate that attractiveness of hands matters to a potential partner, even if not as much as that of the face and the body (Montoya 2007; Saino et al 2006). Worldwide hand beautification, mainly by women, with rings, bracelets, henna, nail varnishing and decorating and, more recently, hand skin rejuvenating with aesthetic medicine and cosmetic surgery, as well as the employment of hand understudies in the film industry, also emphasise the importance of hand appearance (Etcoff 1999; Jakubietz et al 2008; Morris 2004; Saino et al 2006). This importance may be relatively large in moderate climates where hands, after the face, are the second most visible body part (Jakubietz et al 2005b). People often look at someone's hands when sitting at a table and keeping their hands on its surface, when watching someone's hand activity,

and during hand greetings (eg handshaking). Hand gestures are common during speech and they draw listeners' attention (Kendon 1994). 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).

To estimate how important people regard the appearance of hands we asked fifty-one young participants (nineteen men) to answer three questions on a 0 to 5 scale: "How important to you is attractive appearance of your partner's hands?", "Do you pay attention to the appearance of the hands of people you meet?", "Can a person of normal physique and typical facial appearance arouse your distaste if he/she has ugly hands?". The mean values of their answers to these questions were 3.39 (mode = 4), 3.25 (mode = 3), and 3.31 (mode = 4), respectively (no sex differences existed according to the Mann–Whitney U test). This finding supports previous reports that hand appearance is of some considerable importance in mating and social contexts.

The above-mentioned studies prompted me to investigate components of hand attractiveness in more detail. In a previous study (Kościński, in review) I found that attractiveness of real female and male hands is predicted by averageness and femininity of their shape, perceived fattiness and skin healthiness, the appearance of nail vicinity, and, in women only, grooming, but not by the second-to-fourth-digit ratio. However, results of this correlational study may potentially be confounded by some hand features not being controlled for. In the present study participants assessed attractiveness of digitally manipulated hand images varying in geometrical typicality (averageness), conspicuousness of sexually dimorphic traits (femininity/masculinity), skin smoothness, finger length, and the second-to-fourth-digit ratio (2D : 4D). The choice of these features was guided by current knowledge of determinants of physical attractiveness (Gangestad and Scheyd 2005; Rhodes 2006; Weeden and Sabini 2005), results of previous research on hand attractiveness (see above), and the presumptions stated by Jakubietz et al (2005b). Although the 2D : 4D digit ratio did not predict hand attractiveness in any of the previous studies, it was included in the present study because it was found to correlate negatively with male facial attractiveness (Ferdenzi et al, in press; but see Neave et al 2003), self-assessed facial and body attractiveness (Bogaert et al 2009; Manning and Quinton 2007), and physical attractiveness assessed by women after a short period of contact with a man (Bogaert et al 2009; Roney and Maestripieri 2004), and correlate positively with self-assessed physical attractiveness in women (Wade et al 2004). On the basis of above-mentioned literature findings, hand attractiveness was predicted to be positively correlated with shape averageness, shape femininity, skin smoothness, and finger length in both sexes. I did not, however, expect to find a relationship between hand attractiveness and 2D : 4D digit ratio.

2 Methods

2.1 *Stimuli*

Hand photographs were taken of 130 women (aged 18.9 – 25.6 years, $M = 20.8$ years) and 126 men (aged 18.3 – 26.6 years, $M = 21.5$ years), all Caucasian and students of universities in Poznań (Poland). Colour photographs of dorsal and ventral sides of both hands were taken with a digital camera (Panasonic DMC-FZ18, 8.1MPx) from a distance of 1 m. Participants placed their hands 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. Since 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 (eg Manning et al 1998b; Lutchmaya et al 2004), this analysis was confined to the right hand.

In my previous study, measurements of all hands have been taken from ventral-side images so as to determine finger lengths and averageness and femininity of hand shapes [refer to Kościński (in review) for details]. In addition, independent judges rated attractiveness of the dorsal and ventral side for each hand and evaluated skin healthiness (Kościński, in review). For the present study I selected hands of 12 female and 12 male individuals, half of them viewed from their dorsal side, and the rest from the ventral side. The hands varied substantially in attractiveness, and their nails were relatively short and without varnish.

Hand images were manipulated with ElasticHand software developed by me for purposes of the present study, It allows for distortion of hand shape and manipulation of skin smoothness by warping and morphing. These techniques have been frequently used to modify images of faces (eg Perrett et al 1994) and silhouettes (Little et al 2007; Tovée et al 2000). The essentials of the methods were described, amongst others, by Rowland and Perrett (1995). In the present study, 159 landmarks were located on a hand image so as to define its contours: 23 landmarks were located manually by me, and the position of the remaining ones was determined with the software algorithm for detecting hand edges. The image was subsequently triangularised, ie divided into triangles (figure 1), so as to be able to apply the warping technique. Then, each hand image was digitally manipulated in respect to shape averageness, shape femininity, finger length, 2D : 4D digit ratio, and skin smoothness.

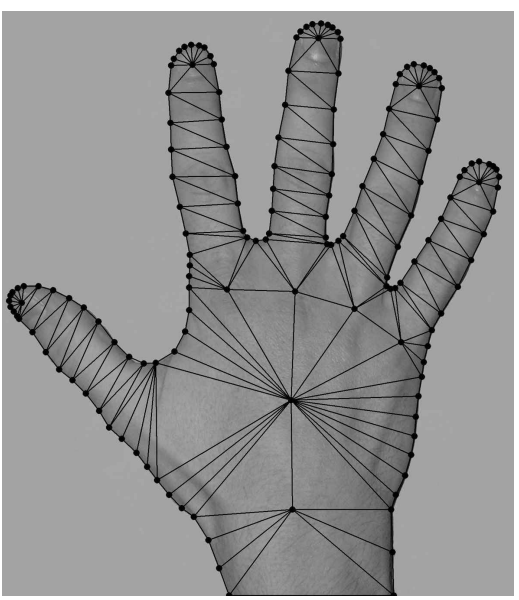
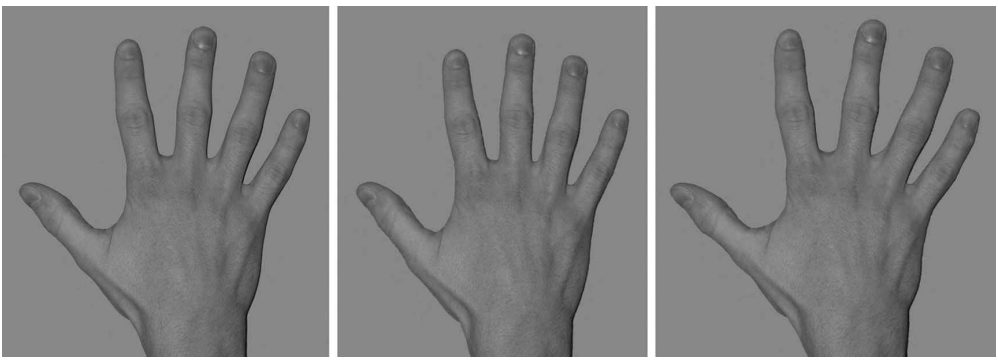


Figure 1. Preparation of hand image for modifications: locations of 159 landmarks have been identified and triangulation performed.

2.1.1 *Averageness.* To manipulate a hand's averageness, a geometrically average hand is required. I manufactured images of average female and male hand dorsal and palmar aspects, each of them being based on images of 70 real hands of specific sex and in appropriate view. Coordinates of the landmarks were arithmetically averaged across all source hands to obtain landmark coordinates for the average hand. The resultant composite hand served as a reference for increasing or decreasing shape averageness of a real hand. Half of differences between landmarks' coordinates of given hand and the composite hand were subtracted from landmark coordinates of the real hand to increase its shape averageness, or added to coordinates of its landmarks to decrease

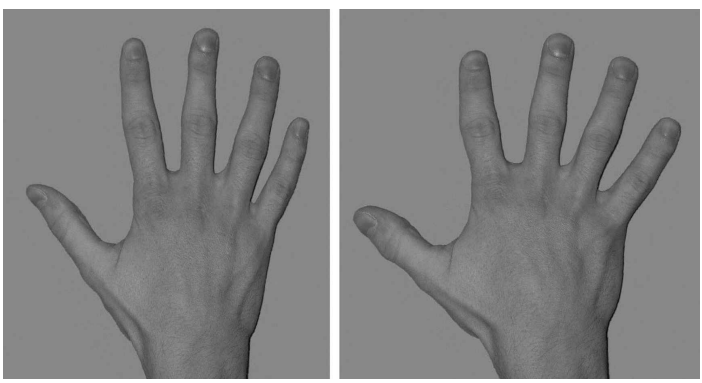
shape averageness. This caused the landmark-based triangles to change their shape, which was used for calculating new locations of all pixels inside the triangles, thereby effecting the manipulation of all pixels of the hand. In other words, the hand's shape was changed by $\pm 50\%$ of the difference between the studied hand and the average hand (figure 2). The same procedures for manufacturing digital composites, altering level of averageness, and producing the same magnitude of distortion have been often applied in research on faces (eg Rhodes et al 1999).



(a) (b) (c)

Figure 2. Manipulation of hand shape averageness in dorsal view: the original hand (a), increased averageness (b), decreased averageness (c).

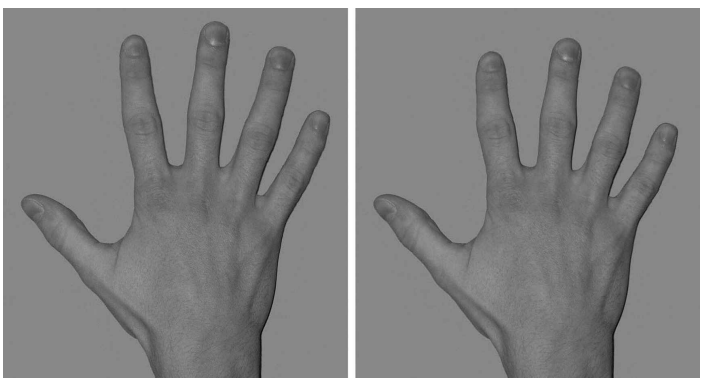
2.1.2 *Femininity.* Compared with male hands, female hands possess more slender palms and digits, and a higher 2D : 4D digit ratio (Jakubietz et al 2005b; Kościński, in review). Hand images were feminised and masculinised by changing their shape toward the shape of the average female or male hand. I first calculated differences between the landmark coordinates of the female and male composite hands in dorsal and then in ventral view. 150% of these differences were either added to the landmark coordinates of real hands to feminise them (increase femininity), or subtracted to masculinise them (decrease femininity). The new locations of the landmarks were used to calculate the new position of all hand pixels in the above-mentioned way. Research on faces, although frequently using similar methodology, applied only 50% of the female – male difference to manipulated images (eg DeBruine et al 2010). Sexual dimorphism is, however, much less conspicuous in hands than faces; hence 150% of the difference had to be applied to make the visual effects of the manipulations more easily perceptible (figure 3).



(a) (b)

Figure 3. Manipulation of shape femininity: increased femininity (a), decreased femininity (b). See figure 2a for the original hand.

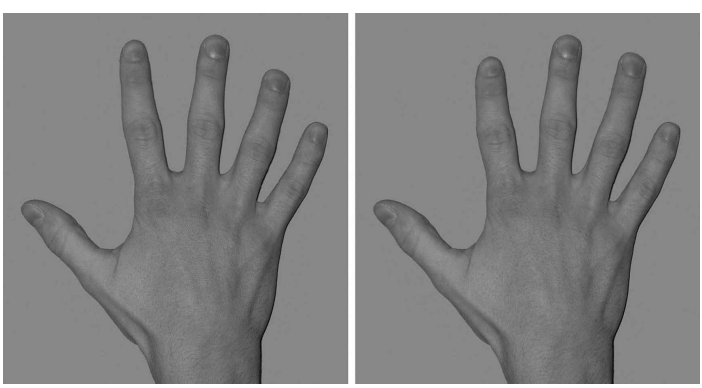
2.1.3 *Finger length.* Length of digits from the second to the fifth was increased and decreased by 5% (approximating to 0.8 of their standard deviations). To this end, imagined rectangles encompassing each finger were elastically lengthened or shortened. Consequently, landmarks inside each rectangle changed their location and triangles based on these landmarks changed their shape, which permitted calculation of new locations of all pixels inside the fingers (figure 4). The increase (decrease) of finger length, with finger width kept constant, increases (decreases) finger slenderness, and thus is a form of hand feminisation (masculinisation).



(a) (b)

Figure 4. Manipulation of finger length: increased finger length (a), decreased finger length (b). See figure 2a for the original hand.

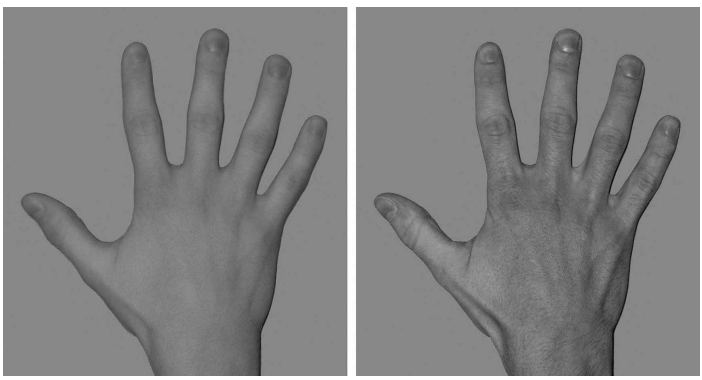
2.1.4 *Second-to-fourth-digit ratio.* The ratio of the second to the fourth digit was manipulated by simultaneous change of the two finger lengths in opposite directions, ie the second digit was lengthened and the fourth digit shortened to increase the 2D : 4D digit ratio, and the opposite manipulation was applied to decrease it. The magnitude of each change was 5% of the original length of the digit (figure 5). The average 2D : 4D was 0.98 for female hands ($n = 12$, SD = 0.05) and 0.96 for male hands ($n = 12$, SD = 0.03). After the decrease, the average was 0.89 and 0.87, and after the increase it was 1.08 and 1.06, for female and male hands, respectively. These changes to 2D : 4D approximated to 2.7 and 3.2 of its standard deviation in female and male hands, respectively. The changes were therefore much larger than those resulting in one standard deviation as applied by Saino et al (2006).



(a) (b)

Figure 5. Manipulation of the second-to-fourth-digit ratio: the increased ratio (a), the decreased ratio (b). See figure 2a for the original hand.

2.1.5 *Skin smoothness.* To manipulate skin smoothness, four hands (one for each female/male × dorsum/palm category) with very smooth skin were made to serve as references. Each of these hands had a skin which was the average of skin taken from seven real hands of specific sex and in appropriate view. More specifically, colour information (in RGB mode) of corresponding pixels was arithmetically averaged across the source hands. The resultant hands possessed very smooth skin without flaws, but large furrows, and the nails were still clearly visible. Half of differences between colours of corresponding pixels in the studied hand and the reference hand were subtracted from pixels' colours of this hand to smooth its skin, or added to coarsen it. In other words, the colour values of the hand were changed by $\pm 50\%$ of the difference between the colour of the studied hand and that of the reference hand (figure 6). A similar method of skin smoothness manipulation has repeatedly been used in research on faces, but here 100% of the difference between the colour of the manipulated face and that of the composite face was usually applied (eg Little and Hancock 2002). In the present study I applied half of the difference to facilitate the comparability between the magnitude of skin smoothness and shape averageness manipulations.



(a) (b)

Figure 6. Manipulation of skin smoothness: increased smoothness (a), decreased smoothness (b). See figure 2a for the original hand.

11 versions for each of 24 real hands were thus produced: original (Ori), high and low averageness (AveH, AveL), femininity (FemH, FemL), finger length (FingersH, FingersL), 2D : 4D digit ratio (2D : 4DH, 2D : 4DL), and skin smoothness (SkinH, SkinL).

2.2 *Procedure*

97 women and 63 men (aged 17 – 38 years, $M = 23.6$ years) participated in the study, all Caucasian and students at universities in Poznań (Poland). The study was conducted online and participants were given the Internet address for the research questionnaire. Each participant viewed only opposite-sex hands and was randomly assigned to assess hands in dorsal or ventral view. In this way, female dorsa were assessed by 31 men, female palms by 32 men, male dorsa by 46 women, and male palms by 51 women. Participants were each presented with 16 hand pairs and asked to mouse-click the more attractive hand (there was no time constraint during the selection process). Each pair consisted of two versions of a real hand, and each hand image was displayed with a width resolution of 400 pixels.

There were three pairs stipulated for each manipulated trait: Ori – High version, Ori – Low version, and High version – Low version (for example, for averageness these are Ori – AveH, Ori – AveL, and AveH – AveL). In addition, one pair consisted of AveH and SkinH images to check which feature was the more important for each of hand attractiveness, averageness, or skin smoothness. The location of hands on the screen

Table 1. List of hand pairs presented to judges, their example order and judges' assessments. The location of high-attractiveness (HA) and low-attractiveness (LA) hands on the screen (left/right) as well as the sequence of hand pairs were random and unique for each participant. Preference for a hand feature is the number of HA-hand choices in three relevant hand pairs.

Hand pair no.	HA hand	LA hand	Screen side for HA hand	Position in sequence	Hand owner ID	Chosen hand	Preference
1	AveH	Ori	Left	9	5	HA	Averageness = 2
2	Ori	AveL	Right	14	4	HA	
3	AveH	AveL	Right	3	5	LA	
4	FemH	Ori	Right	8	4	LA	Femininity = 2
5	Ori	FemL	Left	1	3	HA	
6	FemH	FemL	Right	10	6	HA	
7	FingersH	Ori	Left	4	6	HA	Long fingers = 3
8	Ori	FingersL	Right	15	5	HA	
9	FingersH	FingersL	Left	13	3	HA	
10	2D : 4DH	Ori	Left	16	6	LA	High 2D : 4D = 1
11	Ori	2D : 4DL	Right	5	1	HA	
12	2D : 4DH	2D : 4DL	Right	6	2	LA	
13	SkinH	Ori	Right	2	4	HA	Smooth skin = 2
14	Ori	SkinL	Left	11	1	LA	
15	SkinH	SkinL	Left	7	3	HA	
16	SkinH	AveH	Right	12	2	HA	

Note: Ori = original, Ave = averageness, Fem = femininity, Fingers = finger length, 2D : 4D = digit ratio, and Skin = skin smoothness; with H and L added for 'high' and 'low'.

(ie its left or right side) was random. The sequence of pairs was random and unique for each participant. Hand images of subsequently displayed hand pairs were derived from different individuals (table 1).

2.3 *Analysis*

Participants' assessments were coded as 1 when the hand being theoretically more attractive was chosen from a pair, and as 0 when the theoretically less attractive hand was chosen. The theoretically more attractive hands were those in High versions (that is, AveH, FemH, etc), or, in case of Ori – Low version pairs, hands in their original versions. The SkinH version was arbitrarily regarded as theoretically more attractive in SkinH – AveH pairs. I next determined the preference of each judge for hand averageness, femininity, finger length , 2D : 4D, and skin smoothness by summing his/her assessments of three relevant hand pairs. For example, the preference for averageness equaled the sum of judgments for AveH – Ori, Ori – AveL, and AveH – AveL pairs. A participant's preference for a hand trait was thus 0, 1, 2, or 3 (table 1). Values of 0 and 1 were further coded as 0 (ie preference for low values of the trait), and values of 2 and 3 as 1 (ie preference for high values of the trait). The preference for skin smoothness to shape averageness was set as 0 or 1 according to the choice made for the SkinH –AveH pair.

To check whether participants' choices were non-random, ie some values of a hand feature were systematically preferred to others, they were modeled with binomial distribution where the number of observations (n) was equal to the number of judges and the number of successes (k) was equal to the number of judges who had a preference of 1. According to the null hypothesis, participants' choices were random so I assumed the probability of success (ie a judge with the preference of 1) to be $p = 0.5$. If this hypothesis was correct, the preference for high values of hand features would occur in about half of judges (the expected k was $n/2$). One-tailed p-value for the hypothesis is then the sum of probabilities in binomial distribution across the number of successes

from k to n (if $k \geqslant n/2$), or from 0 to k (if $k < n/2$). Because the assumed distribution is symmetric ($p = 0.5$), the two-tailed p-value is twice as large as the one-tailed p-value. This analysis was performed with MS Excel using the 'BinomDist' function.

To check whether a preference for a trait depended on sex, the Fisher's exact test was applied. The test was run on 2×2 contingency tables with the number of women and, separately, men who preferred high or low values of a hand feature being entered into their cells. In a similar way a check was made whether the preferences for hand features were dependent on the view (dorsal/palmar). The analysis was conducted with Statistica StatSoft software.

3 Results

According to Fisher's exact test, no significant difference existed between the strength of preference for any hand feature in dorsal and ventral view, both in male and female hands (all ps > 0.09). For purposes of further analysis the data for both views were collapsed. As seen in table 2, both women and men preferred opposite-sex hands in variants of high averageness, femininity, long fingers, and smooth skin (all ps < 0.003). There was, however, no evidence of a preference for low or high 2D : 4D digit ratio in any sex (both ps > 0.2). Assessments made for the pair consisting of high-averageness versus high-skin smoothness hands showed that males prefer skin smoothness to shape averageness in female hands (smooth skin was chosen by 89% of judges, $p < 0.001$), while the opposite was true for female preference for male hands (smooth skin was chosen by 36% of judges, $p = 0.008$; this, however, does not survive the Bonferroni correction for 6 traits $\times$ 2 sexes = 12 comparisons, which sets the significance threshold at 0.004). The Fisher's exact test also revealed a stronger preference for skin smoothness in female than male hands ($p < 0.001$), and a significant difference between females and males in judgments of high averageness versus high-skin-smoothness hand pairs ($p < 0.001$). No sex differences were found for the other hand features (all ps > 0.1).

Table 2. Frequencies (n) and frequencies (%) of judges preferring high values of hand features, and p-values for the hypothesis that judges' choices were random.

Preference	Female hands assessed by 63 men			Male hands assessed by 97 women		
	n	%	p-value	n	%	p-value
Averageness	53	84.1	0.000	75	77.3	0.000
Femininity	44	69.8	0.002	68	70.1	0.000
Finger length	46	73.0	0.000	74	76.3	0.000
2D : 4D digit ratio	26	41.3	0.207	53	54.6	0.417
Skin smoothness	62	98.4	0.000	73	75.3	0.000
Skin smoothness to averageness	56	88.9	0.000	35	36.1	0.008

Note: The Bonferroni-corrected significance threshold is $0.05/12 = 0.004$.

It is noteworthy that preferences for hand femininity, long fingers, and smooth skin did not result from the fact that the real hands selected for the study were characterised by low shape femininity, short fingers, or coarse skin. The average z-scores of femininity, finger length, and perceived skin healthiness of these hands against all measured own-sex hands (130 female, 126 male) were, respectively, 0.09, 0.11, 0.06 for female hands, and 0.28, 0.11, 0.07 for male hands. The hands selected for the present study are therefore typical or even somewhat above average for these features. Average z-scores for 2D : 4D digit ratio were also close to zero (0.16 female and 0.07 for male hands), but the values for shape averageness were -0.64 and -0.62 for female and male hands respectively,

indicating that hands used in this study had relatively atypical shapes. I thus repeated the analysis of preferences for averageness, involving only six female and eight male hands of highest averageness index (mean z-scores of 0.05 and 0.01, respectively). For this sample, 29 men and 67 women tended to prefer hand version of high averageness, and 10 men and 16 women tended to prefer low averageness. The proportion of those preferring high averageness was 0.74 for men and 0.81 for women, each being significantly different from 0.5 ($p = 0.003$ and $p < 0.001$, respectively). The preference for hand averageness reported above therefore did not result from a bias in features of hands taken for the study.

I next checked for curvilinear preference functions, ie situations in which the image of original hand was preferred (or disliked) to hands with a trait manipulated in any direction. Some evidence for curvilinear preference was observed for femininity and skin smoothness in male hands. The original hand was clearly preferred to the hand with decreased femininity or decreased skin smoothness (both ps < 0.001), and tended to be preferred to the hand with increased femininity ($p = 0.104$) or increased skin smoothness ($p = 0.067$). This suggests that females dislike not only masculine and rough-skinned male hands but also, to some degree, feminine and smooth-skinned ones.

Finally, I checked whether the strength of preference for hand features depended on the characteristics of original hands. For example, one may expect that the increase of shape averageness is more favourable for hands of atypical than typical shape. This leads to the prediction of negative correlation between initial averageness of a hand and the strength of preference for averageness in images derived from the hand. On similar grounds, I expected negative correlations between original femininity, finger length, 2D : 4D digit ratio, and perceived skin healthiness, and strength of preferences for femininity, finger length, 2D : 4D, and skin smoothness, respectively. Because of the low number of hands ($n = 24$), the analysis was conducted on a pooled sample of the female and male hands. Two-tailed Spearman's correlation coefficients showed such relationships for femininity ($r = -0.49$, $p = 0.015$) and finger length ($r = -0.47$, $p = 0.019$) only. For the other traits, p-values were above 0.19.

4 Discussion

The present study showed that both women and men prefer shape averageness, femininity, long fingers, and smooth skin in opposite-sex hands, irrespective of whether dorsal or ventral side of the hand was presented. No preference, however, was observed for 2D : 4D digit ratio. In addition, skin smoothness was found to be more important for attractiveness of female than male hands. These results, obtained with digitally manipulated hand images, corroborate those reported in my previous study on real hands (Kościński, in review), and preferences for averageness, femininity, and smooth skin in hands follow similar preferences pertaining to faces (Little and Hancock 2002; Rhodes 2006). I also showed that the results obtained were not artifacts resulting from biased selection of hands for this study.

Hands of average shape may be preferred for several reasons. First, averageness of morphological structures is regarded as a sign of developmental stability and good genes (Koeslag 1990; Lie et al 2008; Thornhill and Møller 1997). The development of individuals of low genetic quality (eg mutation-loaded) is relatively more labile and may lead to atypical proportions of a structure. Symmetry is yet another sign of developmental stability and genetic quality, and Manning et al (1998a) found that men with greater finger symmetry (in left versus right hand) had higher sperm number and motility. The preference for averageness may thus be an evolutionary adaptation for choosing a partner with good genes (Gangestad and Scheyd 2005; Rhodes 2006). Second, some diseases, eg acromegaly, distort hand proportions (Anton 1972), so people may prefer hand averageness because it is a reliable cue to phenotypic health. Third, the neural

system processes stimuli typical for their category more easily than atypical ones and therefore typical stimuli are preferred to the atypical (Halberstadt 2006; Reber et al 2004). The preference for average hands may thus be an effect of the manner in which the neural system functions.

The prominence of sexual features is dependent on the level of sex hormones, where a high ratio of androgens to estrogens results in a masculine phenotype while a low ratio has a feminising effect (Feinberg 2008; Singh 1993). High androgen-to-estrogen ratio in men, and its low values in women is believed to signal good biological quality (Feinberg 2008; Gangestad and Scheyd 2005; Singh 1993). Because high biological quality of a mate is desirable by both sexes, one may predict a female preference for masculine male hands and male preference for feminine female hands. The effect of learning to discriminate one category of stimuli from another leads to the same prediction (Enquist and Arak 1993). Specifically, objects with conspicuous features characteristic for own category (eg highly masculine male hand) are preferred more strongly than those with these features less marked (eg typical male hand).

Although the present results support this prediction in that feminine and long-fingered female hands were regarded the most attractive, they contradict it in that femininity and long fingers were also preferred in male hands. Preference for long-fingered male hands has also been reported in previous studies (Manning 2002, 2008; Saino et al 2006; Voracek and Pavlovic 2007). Two factors may potentially cause women to prefer feminine hands in men. First, male phenotypic masculinity is related to some undesirable psychological traits, such as aggression (Berry 1991) and promiscuity (Boothroyd et al 2008), and women attribute more favourable personality to phenotypically more feminine men (eg Perrett et al 1998). Second, a hand with feminine shape (ie slender and long-fingered) may signal high socio-economic status. People descending from families of high socio-economic status have slender bodies (Meyer and Selmer 1999; Sundquist and Johansson 1998), and thus may also have more slender hands. In popular opinion, slender hands with long fingers are perceived as shapely and elegant (Jakubietz et al 2005b), and more suitable for playing instruments rather than performing arduous physical work (Manning 2008; Wagner 1988). Women who prefer feminine male hands may thus trade high biological quality for good personality and high socio-economic status. A woman's tendency to prefer original male hands to their masculinised or feminised versions as observed in the present study may thus be a result of a trade-off between the preferences for these virtues. Furthermore, long fingers in men may also be a signal for reproductive fitness, since Manning (2002) found that the length of fourth digit positively correlated with testosterone level and sperm count.

The second-to-fourth-digit ratio is another sexually dimorphic feature in hands. Although it is associated with many physical and psychological sex-related traits (Manning 2002, 2008) and cues of reproductive fitness (Auger and Eustache 2011), it does not influence attractiveness of the hand (Saino et al 2006; Kościński, in review, this study; Voracek and Pavlovic 2007). In the present study the null result was meaningful since it applied a magnitude of 2D : 4D ratio manipulation three times larger than in Saino et al (2006). This ratio also does not impact on the perceived health, sexiness, and masculinity/femininity of the hand (Voracek and Pavlovic 2007). It seems therefore that people simply pay scant attention to digit ratio and previously reported relationships between this ratio and physical attractiveness (see section 1) are likely to be mediated by the prenatal androgen-to-estrogen ratio.

We found that skin smoothness was preferred in hands of both sexes, but more strongly in women than men. Smooth skin is perceived as belonging to a young and healthy person (Fink and Matts 2008). Some serious diseases, such as scleroderma, substantially coarsens hand skin (Jakubietz et al 2005a). 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). Another factor of skin coarsening is persistent manual labour (Sanders et al 1995). Hands with a smooth skin are therefore reliable cues to an individual's good health, young age, and high socio-economic status (non-manual labour). It should, however, be emphasised that, owing to perceptual bias, the skin of a totally healthy individual may be perceived as unhealthy and unattractive if it possesses features resembling the symptoms of a disease (Zebrowitz et al 2003). Young appearance (Kościński 2007) and good skin condition (Fink and Neave 2005) are more important for attractiveness in women than in men. It is therefore understandable that in the present study skin smoothness was preferred more strongly in female than male hands, and preferred to shape averageness in females while the opposite result was observed for male hands.

The present study possesses several limitations. Both the sitters and raters were native Poles and only opposite-sex hands were assessed. Research conducted on people of other ethnicities and investigating preferences for own-sex hands would therefore be a welcome addition. Another limitation is that hand images varying in fattiness have not been produced. The preference for slimness has increased enormously in the past few decades (Garner et al 1980; Wiseman et al 1992) and there is a dislike for fatty bodies (Puhl and Heuer 2009; Tovée et al 1999) and faces (Coetzee et al 2009). Such dislike was also found for real hands (Kościński, in review) and future research may endeavour to verify this with digitally manipulated stimuli.

5 Conclusions

The present study demonstrated that women and men perceive the attractiveness of opposite-sex hands in a non-random manner, most of them preferring shape averageness, femininity, long fingers, and smooth skin. Apart from finger length, these criteria of attractiveness coincide with those for facial attractiveness. The experimental character of this study, which involved digitally manipulated hand images, acknowledges that these hand features are causative factors of hand attractiveness. It has also been demonstrated that the results obtained were not artifacts arising from biased selection of hands for this study. The results as a whole also agree with anecdotal insights and declarations provided by participants of the mini-questionnaire that hand attractiveness is of significance in the social and mating context. Hand preferences may be underpinned by adaptive and/or non-adaptive (related to perceptual bias) mechanisms. The women's preference for femininity in male hands cannot, however, be explained by perceptual bias and probably reflects the female desire for good personality and high socio-economic status in males.

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