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ANTHROPOSCOPY AS AN ADDITIONAL TOOL FOR THE ASSESSMENT OF FACIAL MASCULINITY/FEMININITY

ABSTRACT: In previous studies, the masculinity/femininity of faces has been assessed in several ways: by way of subjective ratings of facial photographs using a feminine/masculine Likert scale, by photogrammetric methods, or by anthropometric measurement. All these methods have in common that they are strictly quantitative and describe morphological shape by numerical assessment. They have other methodological limitations as well. We therefore propose using the anthroposcopic method as an additional tool for the assessment of facial masculinity/femininity. This method can be used either for the qualitative description of the facial morphology of individual faces or for quantitative descriptions of intra-population variability in facial morphology. The first aim of the present article is to introduce the method of anthroposcopy and compare the results it produces with those obtained by masculinity-femininity ratings and anthropometric measurement. Our results indicate that the anthroposcopic method is a more sensitive technique of femininity-masculinity assessment in investigations of the development of male-female morphological traits than masculinity-femininity ratings are. The second aim is to present a set of comparative images that illustrate the variability of masculine/feminine facial features among male and female university students in the Czech population. We documented these anthroposcopic traits through a series of illustrations of 10 specifically masculine and 16 specifically feminine facial traits based on photographs depicting 10 particularly pronounced masculine and 16 particularly pronounced feminine facial traits that reflect the actual morphological variability within the Czech population of European origin.

KEY WORDS: Face – Morphology – Masculinity – Femininity – Anthroposcopy

INTRODUCTION

Human face contains a number of sexually dimorphic features. Although these dimorphic traits exist to some extent from birth, they become more pronounced during puberty due to the release of steroid hormones such as testosterone (Bardin, Catterall 1981). Triggered by a high testosterone-to-estrogen ratio, the cheekbones, mandibles

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and chin of pubertal males grow laterally, the bones of the eyebrow ridges and central face grow forward, and the lower facial bones lengthen. Hence, larger jawbones, more prominent cheekbones, and thinner cheeks are all male-typical features (Swaddle, Reierson 2002). The male nose tends to be more protrusive, longer, wider, and fleshier, and to have larger and more flared nostrils than the female nose. Also, in the population of European origin, the male nose usually ranges from a straight to a convex profile, whereas the female nose tends to range from a straight to a somewhat concave profile (Enlow, Hans 1996). The tip of the male nose is often more pointed and has a greater tendency to turn downward and the somewhat more rounded female nose often tips upward (Enlow, Hans 1996). In males, the interorbital part of the nasal bridge tends to be higher (Enlow, Hans 1996). Another male-typical feature is the relatively smaller size of the eyes, which is partly due to larger brow ridges (Johnston *et al.* 1997).

Sexually dimorphic features are hypothesized to be involved in intersexual and intrasexual communication and in the ability to engage in intrasexual confrontation (Thornhill, Møller 1997). They can signal aggressiveness, strength, fighting ability (in men), and fecundity (in women) and are considered honest signals of genetic quality connected with health and fitness (Folstad, Karter 1992, Zahavi 1975). Masculinity/ femininity is one of two basic monitored facial characteristics (the second one is attractiveness) used in studies that focus on mate choice, the attribution of personality or behavioral characteristics, or the adequacy of these judgments (Appicella *et al.* 2008, Penton-Voak *et al.* 2004, Perret *et al.* 1998).

In previous studies, facial masculinity/femininity has been assessed perceptually by raters and through the method of photogrammetry or anthropometry. Perceptual masculinity-femininity is based on subjective ratings of masculinity/femininity from facial photographs mainly using Likert scale (e.g., Chen 2004, DeBruine *et al.* 2006, Johnston *et al.* 2001, Koehler *et al.* 2004, Neave *et al.* 2003, Penton-Voak *et al.* 2004). In our opinion, however, this method can to a certain extent be problematic, because it is impossible to establish to what degree the ratings are influenced by common stereotypes about what constitutes a masculine/feminine face and to what degree they reflect actual anatomical sex differences. The main limitation of this approach is that the ratings may reflect commonly held ideas about femininity and masculinity that may not be strongly related to morphological sex characteristics, thus they could be culture specific. Furthermore, this method can be affected by confounds such as individual rater variability. Although a number of previous studies have found that the consensus between raters in the assessment of masculinity/ femininity is relatively high (e.g., DeBruine *et al.* 2006, Quist *et al.* 2011), the results of our previous study (Pivonkova *et al.* 2011) showed that ratings of facial masculinity differed significantly between the groups of female and male raters. These differences were connected to differences in personality judgment made on the basis of the facial photographs. Specifically, men used cheekbones-jaw prominence and inner face breadth as cues for masculinity judgments; women, on the other hand, seemed to perceive masculinity in a more holistic way (Pivonkova *et al.* 2011).

Photogrammetry is another method used to assess masculinity/femininity (e.g., Cunningham *et al.* 1990, Koehler *et al.* 2004, Penton-Voak *et al.* 2001). This method consists of measuring the standardized distances between anthropometric landmarks located on the facial image with the use of computer software. The ratios between the distances are usually measured in pixels. The accuracy of the photogrammetric method strongly depends on the exact vertical positioning of the head during image acquisition, as even a slight deviation from this position can potentially affect the validity of the measurements (Penton-Voak *et al.* 2001).

Another method used to assess masculinity is direct anthropometric measurement of the human face. The anthropometric method makes it possible to measure both the distances between anthropometrical landmarks and 3D spatial curves of the sexual dimorphic traits (e.g., cheekbone arch, jawbone arch, jaw depth). The advantage of this method is that measurements are quoted in millimetres and there is no need to use ratios. This means that the measurement results are easily comparable with the results of previous studies, because it is possible to use both absolute values and ratios of measurements. And lastly, this method has none of the drawbacks of the photogrammetric method connected with the process of image acquisition.

Due to the above-mentioned limitations of techniques of masculinity/femininity assessment such as photogrammetry and ratings of masculinity/femininity, we suggest using anthroposcopy as an additional method for assessing the level of masculinity/femininity. Anthroposcopy, a method, which is based on the detailed description of morphological features, could prevent confounds given by the gender of the raters or other methodological limitations inherent in quantitative methods.

INTRODUCTION TO ANTHROPOSCOPY

The anthroposcopic approach aim is to provide more complex information on the relation of particular physical features to their vicinity than absolute metric data and their qualitative assessment do (Farkas 1981). Anthroposcopy (from the Greek *anthropos*, "human", and *skopein*, "to examine") means assessing the body's physical characteristics by visual observation. The technique is commonly used under this name in plastic surgery for the qualitative assessment of morphological features (Powell, Humphreys 1984). To our knowledge, the method has not been used to date in a study of the social perception of faces. Anthroposcopy does not generally use many categories to describe the relative size or shape of particular traits (Farkas 1981, Fetter *et al.* 1967). In our anthroposcopic assessment of masculininy/femininity, we used three basic qualitative categories to describe a particular shape (e.g., the shape of the nose or the chin) or relative size (i.e., the size of a particular feature relative to the size of the surrounding area) (see *Table 1*, *Table 2*). These three qualitative categories were matched with the three categories describing the level of masculinity or femininity used in the previous literature. A summary of these studies is given below.

The aims of our study were to propose the method of anthroposcopy into the field of social perception research, to compare the results obtained with this method with masculinity/femininity ratings as well as with anthropometric measurements of target faces and to present an update of a set of comparative illustrations designed to describe the actual variability of morphological traits in the sample derived from Czech population of European origin and depicting 10 specific head traits in men and 16 specific traits in women. The categories of morphological traits used in anthroposcopy may aid future research in that they will allow us to categorize and describe morphological variability within the present-day populations of European origin.

MATERIAL AND METHODS

Participants

Stimuli

Facial images were obtained from 218 undergraduate students all of European origin (138 females, mean age = 22.6 years, SD = 2.1 years and 80 males, mean age 24.4 years, SD = 2.1 years) of the Faculty of Science at Charles University in Prague, Czech Republic. The photographs of 71 of the males face previously used for ratings of stimuli in a study by Pivonkova *et al.* 2011). The participants were recruited from within a more complex project (for details, see Lindová *et al.* 2006) and were compensated for their time (on average CZK 200, i.e., about $10). Informed consent was obtained from all participants. The study was approved by the Ethics Committee of the Faculty of Science. All data were handled in accordance with Czech law and the Declaration of Helsinki.

TABLE 1. Anthroposcopic traits (male).

	Level of masculinity		
Facial trait	Low masculinity (1 point)	Average masculinity (2 points)	High masculinity (3 points)
Jaw width	Narrow	Medium	Large
Chin height	Small	Medium	High
Chin profile	Recessed	Orthogonal	Protruded
Brow ridge	Unmarked	Marked	Prominent
Glabella	Unmarked	Marked	Prominent
Forehead profile	Vertical	Protruded	Backward tilted
Nose height	Small	Medium	High
Height of eye opening	Large	Medium	Small
Eyebrow density	Thin	Medium	Bushy
Eyebrow thickness	Thin	Medium	Thick

TABLE 2. Anthroposcopic traits (female).

	Level of femininity		
Facial trait	Low femininity (1 point)	Average femininity (2 points)	High femininity (3 points)
Jaw width	Large	Medium	Narrow
Chin height	High	Medium	Small
Jaw shape	Squared	Rounded	Elliptical
Lip thickness	Thin	Medium	Thick
Facial form	Pentagonal	Oval	Elliptical narrower in chin area
Forehead height	Small	Medium	High
Tubera frontalia	Prominent	Marked	Unmarked
Nose height	High	Medium	Small
Shape of nose profile	Corrugated, convex	Straight	Concave
Direction of nose tip	Downwards	Forward	Upwards
Chin profile	Protruded	Orthogonal	Recessed
Brow ridge	Prominent	Marked	Unmarked
Glabella	Prominent	Marked	Flat
Forehead profile	Backward tilted	Protruded	Vertical
Eye opening height	Small	Medium	Large
Eyebrow thickness	Thick	Medium	Thin

Raters

The frontal photographs were rated for attractiveness by 15 females (mean age = 21.3 years, SD = 1.7 years) and 15 males (mean age = 22.3 years, SD = 4.6 years) and for masculinity by 20 females (mean age = 23.0 years, SD = 4.1 years) and 15 males (mean age = 22.0 years, SD = 2.4 years). All raters were undergraduate students at the Faculty of Humanities, Charles University in Prague and were Czech origin.

Anthropometric measurements

Anthropometric measurements of the targets' faces were conducted in front and profile view. We used the basic anthropometric measurements we had performed in a previous study (Pivonkova *et al.* 2011). All measurements represented the distances between facial characteristics described by anthropometric definitions (Farkas 1981). The following anthropometric head measurements were taken by an anthropologist (VP) with a sliding caliper: distance between inner eye corners (en-en), distance between outer eye corners (ex-ex), distance between pupils, nose width (al-al), mouth width (ch-ch), physiognomic face height (tri-gn), morphological face height (n-gn), physiognomic height of upper face (n-sto), nose height (n-sn), nose depth (sn-prn), nose width (al-al); with a small pelvimeter: face width (zy-zy), jawbone angle width (go-go), jawbone depth (gn-go); and with a soft metric tape: cheekbone arch (tr-sn-tr) and jawbone arch (go-gn-go).

The photographic procedure

The facial photographs were taken under the following conditions. The women were asked not to wear make-up and the men were asked to be clean-shaven on the day their photographs were taken. The photographs were taken in a quiet room with fluorescent lighting, and the participants were instructed to stand up straight, look into the camera and maintain a neutral facial expression. A white-painted wall served as a background. The photographs were taken with a digital camera on a tripod from a distance of 1.5 m from the target at a resolution of 2048×1546 pixels. A black headband was used to pull the hair off the participants' foreheads.

Preparing the photographs for rating all images were edited using Adobe Photoshop software to achieve a standardized look. First the pictures were standardized for horizontal positioning of the eyes. Eye distance was not modified, as this would have distorted relative head size. Then the hair, background and visible parts of clothing were digitally blackened so that only the face,

ears and a standardized length of neck were visible. This procedure removed the possible confounding cues of hairstyle and clothing. Masculinity and attractiveness were rated on scales ranging from 1 (i.e., feminine or unattractive) to 10 (i.e., masculine or attractive).

Anthroposcopy

The two facial photographs (frontal and profile view) taken of each participant were then analyzed using the anthroposcopic method by an anthropologist trained in the use of this method (VP). In the analysis, each face was given an overall assessment with regard to the development of those traits that are considered by the literature to be most distinctive of facial sexual dimorphism. The shape of each facial trait was evaluated in comparison with prototypical photographs and illustrations, and the trait was then assigned a category (Fetter *et al.* 1967). Finally, we updated the illustrations of anthroposcopic traits by using the most typical example of particular category of a trait we found in the target population (*Figures 1, 2*).

Using anthroposcopy to assess the level of masculinity in male faces

To assess the degree of facial masculinity, we chose 10 of the most distinctive sexually dimorphic features reported in the literature (Enlow, Hans 1996, Farkas 1981, Iscan 1993, Walrath *et al.* 2004): size of the brow ridge and glabella, forehead profile, nose height, jaw width, chin height, chin profile, height of the eye opening, eyebrow density, and eyebrow thickness. Some of these features could be assessed metrically as well; others, however, are impossible to measure or are intrinsically qualitative – e.g., eyebrow density or eyebrow thickness. Each trait was assessed on a three-point scale (with a higher value indicating a higher level of masculinity on this particular trait, see *Table 1*). The main advantage of the anthroposcopic method here is that it allows direct evaluation of the degree of masculinity/femininity of individual traits or configurations, which can subsequently be expressed as numerical scores on an index of masculinity or femininity that represents the degree of facial masculinity/femininity of each target. We termed this numerical scale the Masculinity Index; it represented the sum of the values for each trait for each individual and ranged from 10 (extremely feminine) to 30 (extremely masculine).

Using anthroposcopy to assess the level of masculinity in female faces

Since in general female faces have, compared to male faces, less pronounced features, we decided to use a higher number of characterizing features and assessed the level of femininity by choosing 16 of the most distinctive sexually dimorphic features reported in the scientific literature (Enlow, Hans 1996, Farkas 1981, Iscan 1993, Walrath *et al.* 2004): facial form, forehead height, size of the *tubera frontalia*, jaw width, chin height, jaw shape, lip thickness, nose height, shape of the nose profile, direction of the tip of the nose, brow ridge, glabella, forehead profile, chin profile, height of the eye opening, and eyebrow thickness. We calculated a Femininity Index of 16 traits by using a three-point scale to express the level of femininity for each trait. The qualitative assessment of traits and the number of points expressing the level of femininity is shown in *Table 2*. The Femininity Index ranged from 16 (extremely masculine) to 48 (extremely feminine) and represents the sum of the values for each trait scored by each individual.

The reliability of the anthroposcopic method

We tested the reliability of repeated anthroposcopic assessments carried out by one of the examiners (VP) for 10 masculine traits in 20 participants. The assessment was repeated after two years. We computed Spearman's correlation coefficient (rho = 0.779, $P < 0.001$) to assess the test-retest reliability for repeated measures.

Data Analysis

Statistical analysis was performed with SPSS version 16.0. We used the Kolmogorov-Smirnov test of normality for testing data distribution. As the data not showed a normal distribution, Kendall's tau-b two-tailed correlation coefficient was used to investigate the relationship between the variables.

RESULTS

Male targets

We conducted a bivariate non-parametric correlation analysis to examine the relationship between the Masculinity Index scores (mean MI = 22.6, SD = 2.5, range = 15–28) and perceived masculinity (rated by men and women separately) in order to assess the comparability of the two methods of masculinity assessment. We found positive correlations between the Masculinity Index and masculinity as rated by men (Kendall's tau-b two-tailed = 0.223; $P = 0.005$) as well

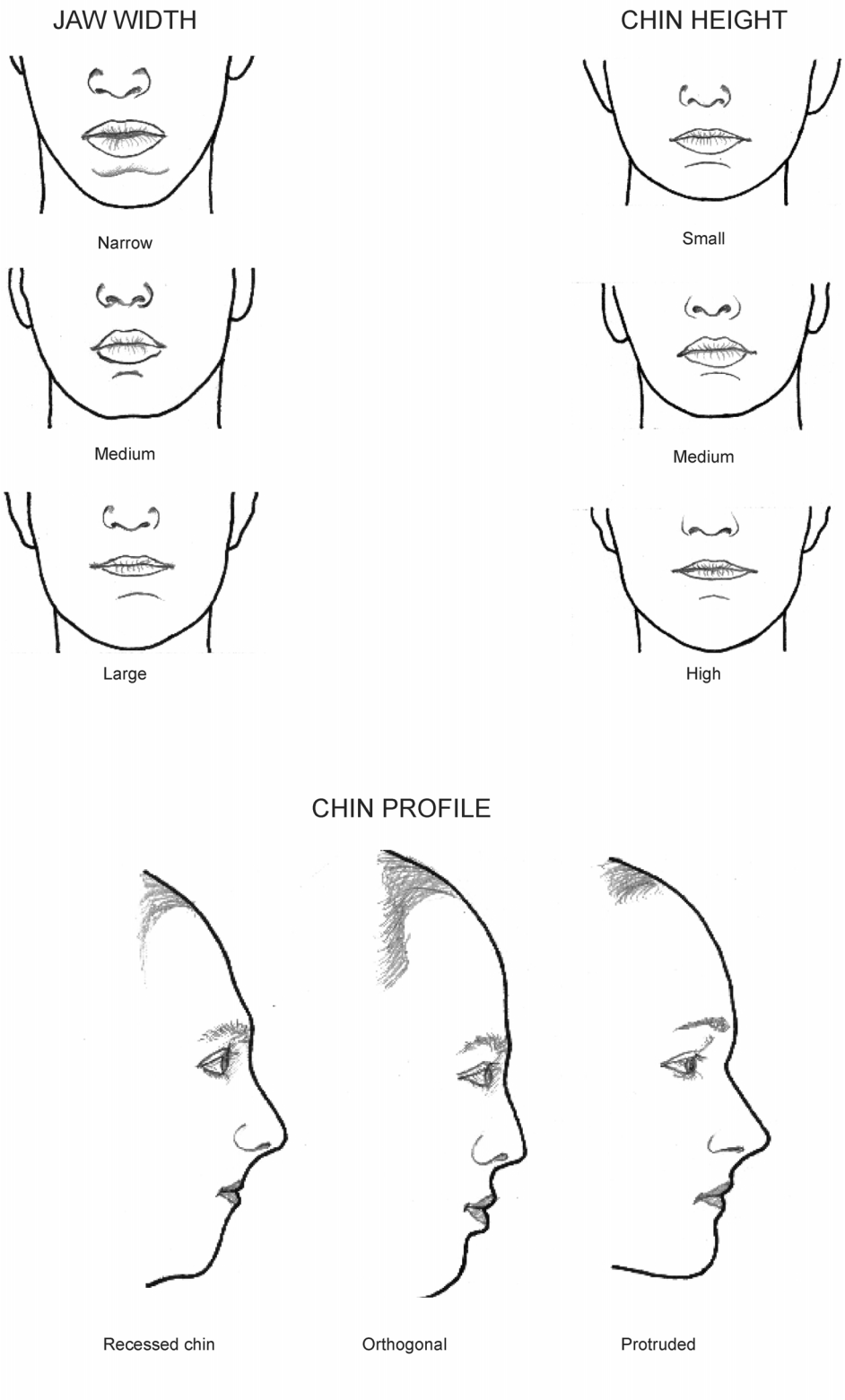
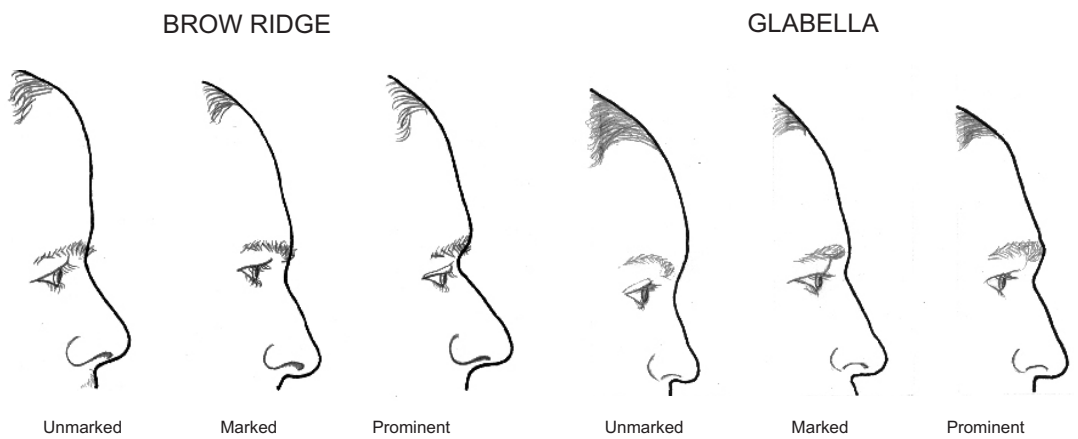
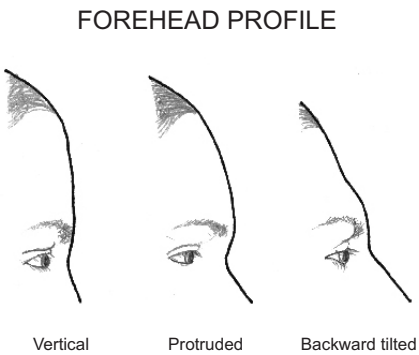


FIGURE 1. Illustrations of 10 male traits used in the anthroposcopic method.





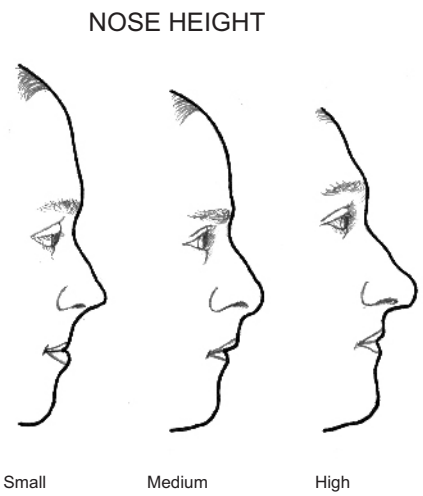


FIGURE 1. Continued.

HEIGHT OF EYE OPENING

Small

Medium

Large

EYEBROW DENSITY

Thin

Medium

Bushy

EYEBROW THICKNESS

Medium

Thick

FIGURE 1. Continued.

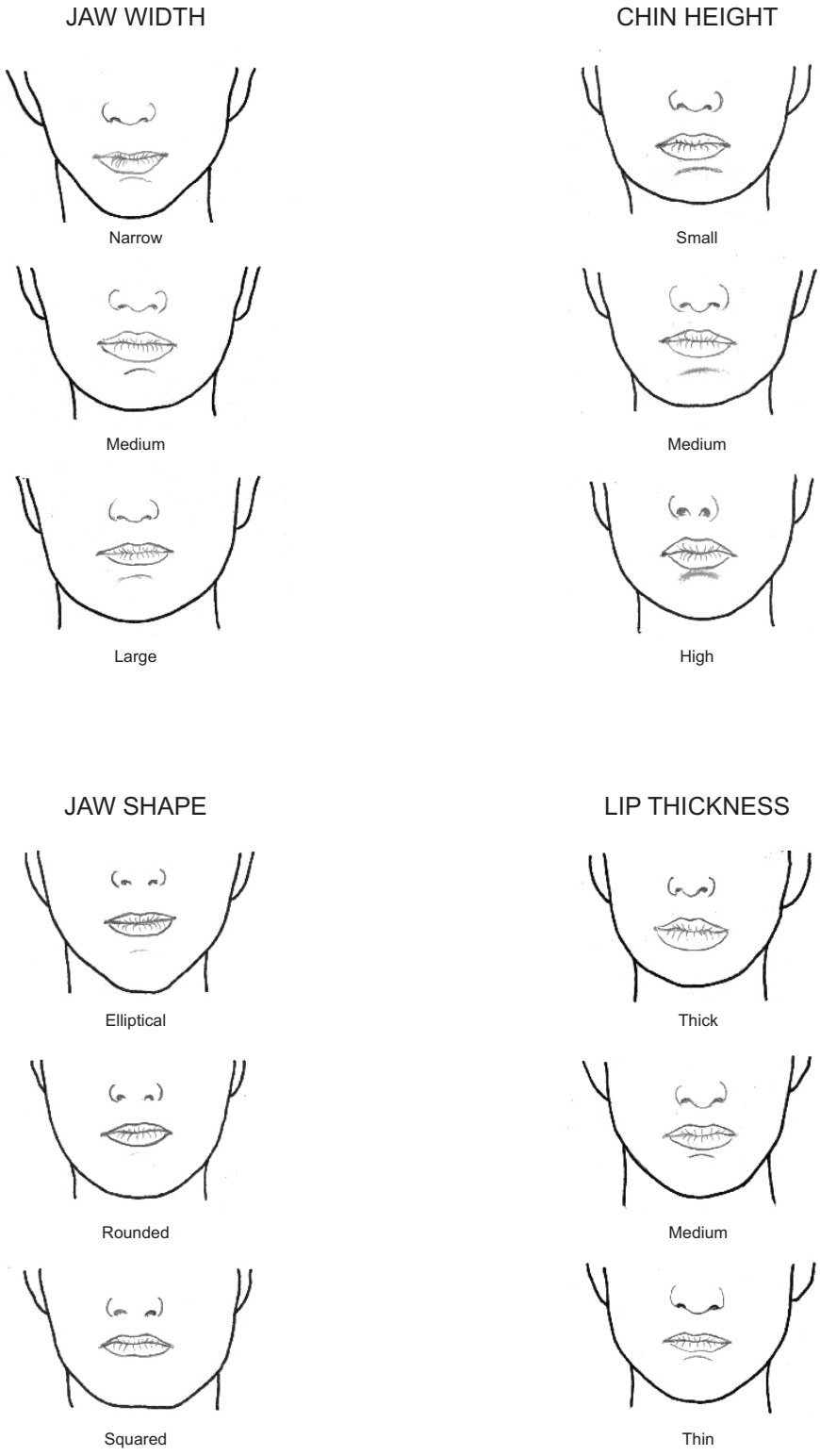


FIGURE 2. Illustrations of 16 female traits used in the anthroposcopic method.

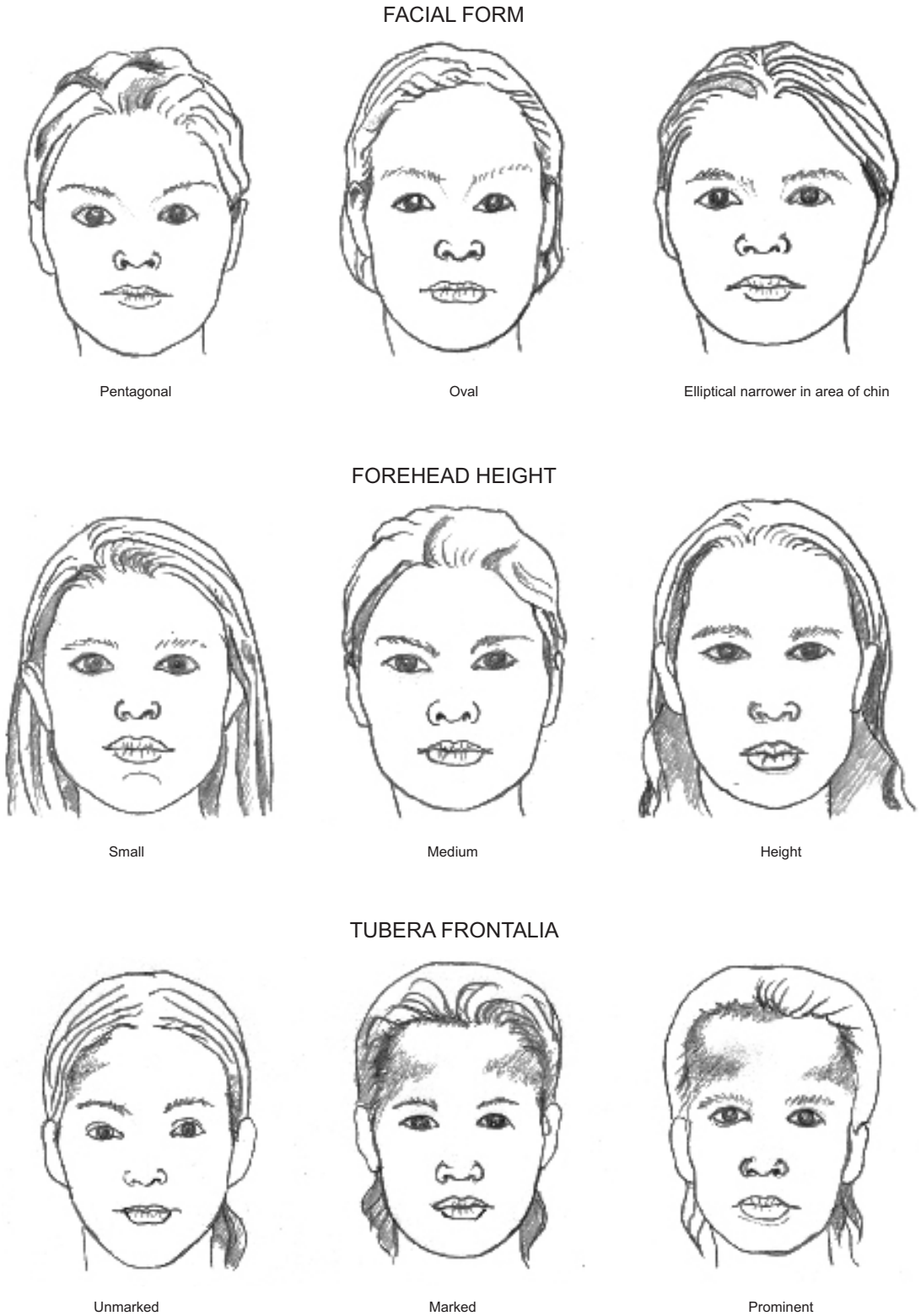


FIGURE 2. Continued.

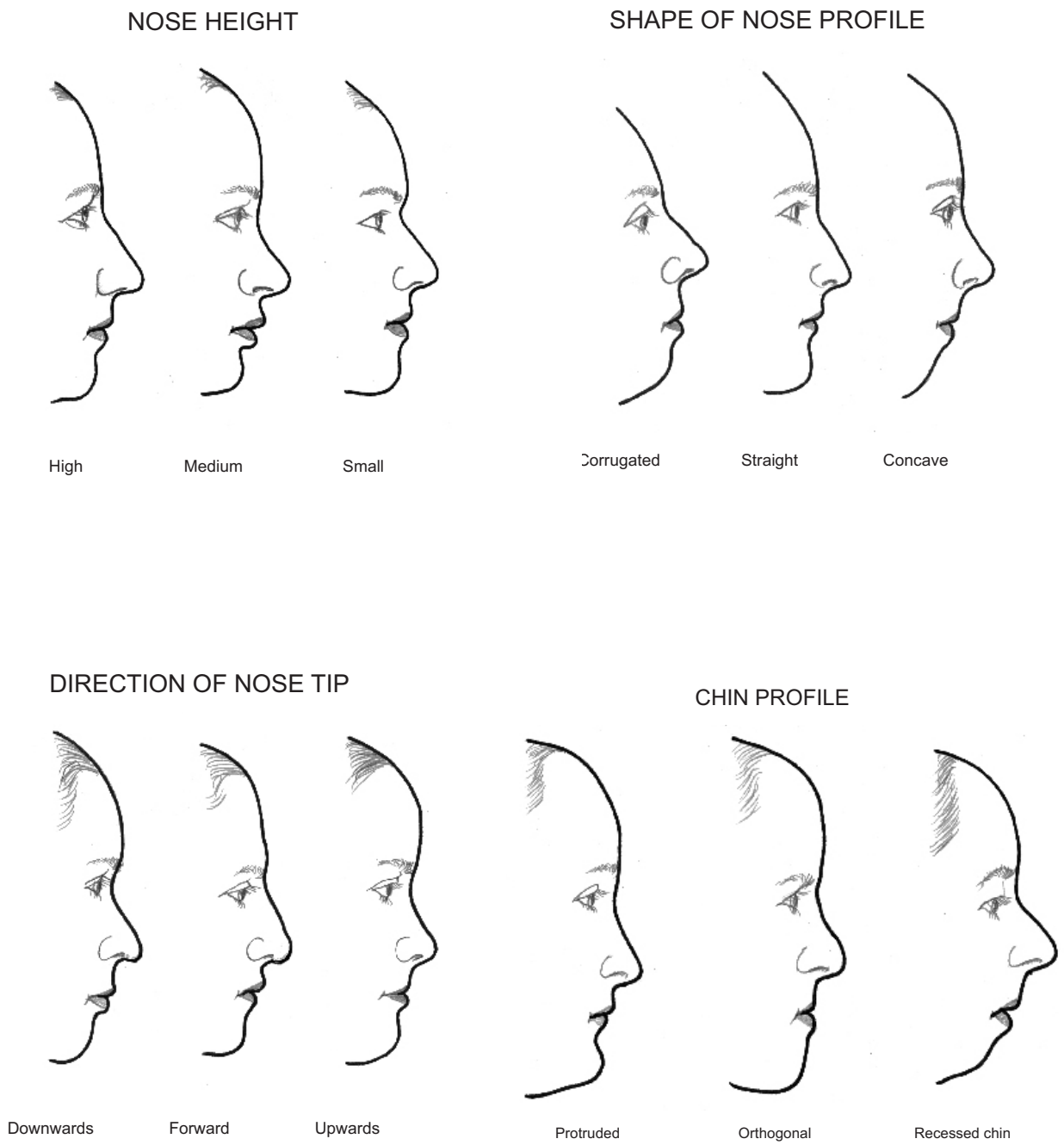


FIGURE 2. Continued.

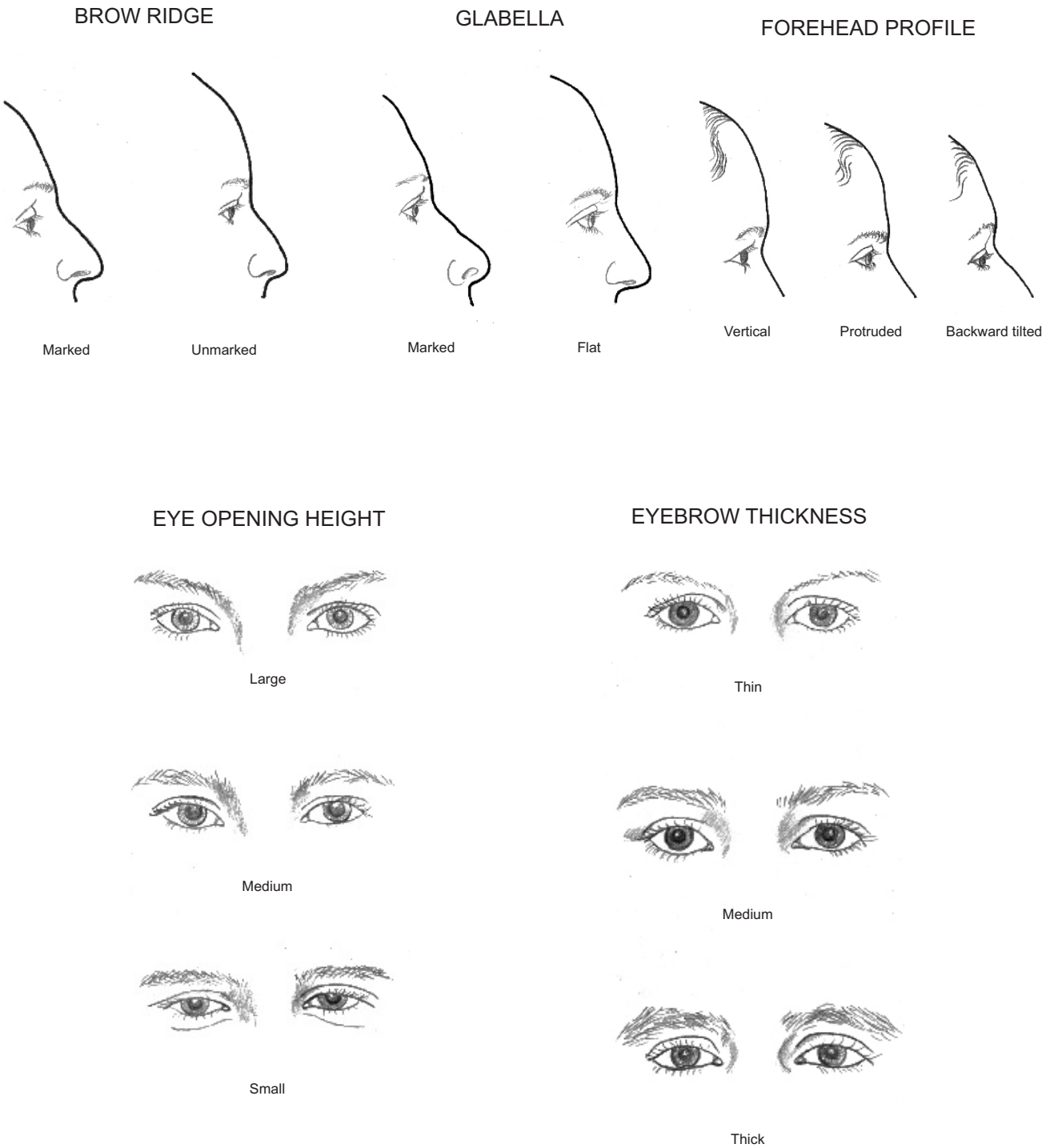


FIGURE 2. Continued.

TABLE 3. Correlations between anthropometric measurements, rated masculinity and Masculinity Index.

	Kendall's tau-b two-tailed correlation coefficient		
	Rated masculinity		
Anthropometric measurements	Male raters	Female raters	Anthroposcopic Masculinity Index
Cheek bone arch (tra-sn-tra)	ns	ns	0.374*
Jawbone arch (go-gn-go)	ns	ns	0.321*
Jawbone depth (gn-go)	0.174*	ns	0.185*
Distance between pupils	−0.227**	ns	ns
Distance between outer eye corners (ex-ex)	−0.224**	ns	ns
Distance between inner eye corners (en-en)	−0.166*	ns	ns
Physiognomic height of upper face (n-sto)	ns.	ns	0.183*
Nose depth (sn-prn)	ns	−0.209*	ns

* Correlation is significant at the level of 0.05.
** Correlation is significant at the level of 0.01.

TABLE 4. Correlations between anthropometric measurements, rated femininity and Femininity Index.

	Kendall's tau-b two-tailed correlation coefficient		
	Rated masculinity		
Anthropometric measurements	Male raters	Female raters	Anthroposcopic Femininity Index
Face width (zy-zy)	ns	ns	−0.136*
Cheek bone arch (tra-sn-tra)	ns	ns	−0.137*
Jawbone angle width (go-go)	ns	ns	−0.208*
Jawbone arch (go-gn-go)	ns	ns	−0.271**
Jawbone depth (gn-go)	ns	ns	−0.215**
Physiognomic face height (tri-gna)	ns	−0.129*	ns
Nose width (al-al)	−0.129*	ns	ns

* Correlation is significant at the level of 0.05.
** Correlation is significant at the level of 0.01.

as by women (Kendall's tau-b = 0.167; $P = 0.037$). We also examined the relationship between 15 anthropometric measurements, rated masculinity and the anthroposcopic Masculinity Index (see *Table 3*). Table 3 shows only those anthropometric measurements that were found to have a significant relationship with the results of at least one method of masculinity assessment. In the case of masculinity as rated by males, we found a positive correlation with the measurement result for jawbone depth as well as three negative correlations with anthropometric measurements describing intraocular distance. Masculinity as rated by females was significantly negatively correlated only with the anthropometric measurement result for nose depth. In the case of anthroposcopically assessed masculinity, we found three positive correlations with anthropometrical measurements describing the size of the maxilla and mandible. We also have found a positive correlations between the anthroposcopically assessed masculinity and physiognomic height of upper face measurement.

Female targets

A similar analysis was conducted for female targets. We did not found significant correlation between the

Femininity Index scores (mean FI = 33.1, SD = 2.7, range = 28–48) and femininity as rated by men (Kendall's tau-b = 0.110; $P = 0.069$) as well as by women (Kendall's tau-b = 0.113; $P = 0.062$). We conducted a nonparametric bivariate correlation to assess the relationship between anthropometric measurements, rated femininity, and anthroposcopic Femininity Index (see *Table 4*). *Table 4* shows only those anthropometric measurements that were found to have a significant relationship with the results of at least one method of femininity assessment. In the case of femininity as rated by males, we found a negative correlation with the measurement result for nose width. Femininity as rated by females was significantly negatively correlated only with the anthropometric measurement result for physiognomic face height. Anthroposcopically assessed femininity was negatively correlated with five anthropometric measurements describing the size of the maxilla and mandible.

DISCUSSION

The results of the reliability test for the anthroposcopic method show that the reliability of this method is relatively high. However, it should be noted that the reliability of qualitative assessments is generally somewhat weaker compared to the reliability of metric measurements due to their primary emphasis on shape rather than size. Secondly, the observer's experience is likely to play a more significant role in qualitative assessments. Comparable reliability estimation are found in diverse qualitative assessments used in biological anthropology, such as maturity evaluation using Tanner stages (Espeland *et al.* 1990), dental age determination (Liversidge 1994), paleopathological diagnosis (Waldron, Rogers 1991). Interobserver or intraobserver discordances have in the past mostly been due to subjective trait descriptions (i.e., imprecise verbal descriptions due to a lack of precise judging criteria; Walrath *et al.* 2004). By updating the above-mentioned illustrations, we are enabling future researchers to accurately apply the anthroposcopic method on the basis of up-to-date sets of images.

In a comparison of the masculinity assessments obtained through anthroposcopic measurements (the Masculiny Index) and those obtained through masculinity ratings, we found positive correlations between the Masculinity Index and masculinity as rated by men as well as by women. But it should be note that this relationship was relatively weak.

We also examined the relationship between rated masculinity and the anthropometric measurements. We found a positive correlation between masculinity as rated by men and jawbone depth and negative correlations and negative correlation with distance between pupils, distances between outer, and inner eyes corners. These expected results because jawbone depth correlates with the anatomical development of mandible, which, according to the literature, is an extremely masculine one. The negative correlations between the distance between the pupils, distances between inner and outer eyes corners and masculinity are in line with the results of previous studies (Keating 1985). The masculinity as rated by women negatively correlated with nose depth. This result was unexpected and we have no explanation for this finding. Additionally, and as expected, we found a positive correlation between the Masculinity Index and the three anthropometric measurements for the size of the maxilla and mandible. Thus, the Masculinity Index reflected the morphological development of these traits, which, according to the literature, is regarded as characteristic for masculine faces. Comparison of these findings indicates that the anthroposcopic Masculinity Index is a more sensitive technique of assessing masculinity in investigations of the development of masculine morphological traits than ratings of masculinity are.

We also tested the relationship between rated femininity and the anthropometric measurements and found a significant negative relationship between femininity as rated by males and nose width as well as a significant negative relationship between femininity as rated by females and physiognomic face height. In other words, in these cases rated femininity did not reflect the development of traits considered to be typically feminine.

We also examined the relationship between the Femininity Index and the anthropometric measurements and found significant negative relationships between the Femininity Index and face width, jawbone angle width, jawbone depth, cheekbone arch and jawbone arch. These results are in agreement with previous findings (Gangestad, Thornhill 2003). The Femininity Index here reflects the morphological development of traits regarded as typically feminine according to the literature: smaller jawbone angle width, smaller jawbone depth, smaller cheekbone arches and smaller jawbone arches compared to the typical development of these traits in men. The comparison of femininity as rated by judges and the Femininity Index, respectively, with the anthropometric measurements indicates that the anthroposcopic Femininity Index is a more sensitive technique of assessing femininity and more accurately reflects the

development of feminine morphological traits than ratings of femininity do.

This particular strength of the anthroposcopic method can be useful in studies focusing on the social perception of faces that have to control not only for the targets' attractiveness level but also for their level of masculinity-femininity, in studies focusing on the relationship between the level of sex hormones and facial morphological variability, etc. We also suggest using anthroposcopy for the description of the shape of individual faces and composite pictures as well as for images generated in other ways (e.g., illustrations based on thin-plate splines analysis, a technique from geometric morphometric analysis). Finally, the anthroposcopic method allows not only the description of shapes but also the subsequent expression of the results as numerical variables that can then be used for additional statistical analysis of the relationship between morphological variability and various variables in population samples.

CONCLUSION

In this article, we introduced the method of anthroposcopy as an additional tool in the assessment of facial masculinity/femininity and to show its potential advantages. Anthroposcopy can be used either for the qualitative description of the facial morphology of individual faces or for quantitative descriptions of intra-population variability in facial morphology. Our results indicate that the anthroposcopic method is a more sensitive technique of femininity-masculinity assessment in investigations of the development of male-female morphological traits than masculinity-femininity ratings are, although the results are significantly positively correlated.

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