The Influence of the Hourglass Form of the Neck on Perceptions of Frontal Esthetics

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Abstract: The purpose of this investigation was to evaluate the effect of the neck concavity angle (NCA) on different occupational groups' perceptions of frontal esthetics. An online survey was developed using Google Forms and sent to the observers through WhatsApp. Male and female frontal silhouettes were created, and NCAs that comprise the hourglass form of the neck were altered in 5 degrees increments from 120 degrees to 170 degrees. Observers were asked to score the images using 0 to 10 numerical rating scale. In all, 279 observers (97 orthodontists, 92 oral-maxillofacial surgeons, and 90 laypeople) participated in this study. For the male and female silhouettes, an NCA of 145 degrees was perceived as the most esthetic, while an NCA of 170 degrees was perceived as the least esthetic by all groups. Generally, an NCA greater than 145 degrees was perceived as less esthetic than an NCA smaller than 145 degrees. There was no significant difference between the scores of the observer groups for the silhouettes except for the female silhouettes with an NCA of 125 degrees or 150 degrees and the male silhouettes with an NCA of 145 degrees or 150 degrees. For both the female and male silhouettes, the further the NCA increased or decreased from 145 degrees, the less esthetic it was perceived to be. A significant increase in NCA was perceived as less esthetic than a significant decrease. The range of NCAs perceived as esthetic varied between 120 degrees and 145 degrees for women and between 130 degrees and 150 degrees for men. These ranges of variability of NCA may provide clinicians with useful information for orthognathic surgical planning.

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Received April 8, 2023.
Accepted for publication September 14, 2023.

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S.G., M.S., M.K.T., and S.U. conceived this study. S.G., M.S., and M.K.T. participated in the coordination of the study and collected the data. S.G. drafted the manuscript. S.U. interpreted the findings and edited the manuscript. All authors have read and approved the final manuscript.
Ethical approval was given by the İstanbul Medipol University Institutional Review Board and Ethics Committee (Ethics approval no: 61).
The authors declare no conflicts of interest.
Supplemental Digital Content is available for this article. Direct URL citations are provided in the HTML and PDF versions of this article on the journal's website, www.jcraniofacialsurgery.com.

ISSN: 1049-2275
DOI: 10.1097/SCS.0000000000009868

Key Words: Esthetic perception, frontal view, neck esthetics, orthognathic surgery

(*J Craniofac Surg* 2024;35: 1030–1034)

Facial esthetics plays a significant role in social relations, and in most societies today, an attractive facial esthetic is thought to have a positive effect on an individual's psychosocial health and success in social life.[1] Individuals generally evaluate themselves according to how they see themselves in the mirror, and the effect of the frontal appearance, also called the "social profile," on the perception of social attractiveness is more dominant than that of the profile appearance for most people.[2–4]

In the frontal view, the transition from the upper part of the neck to the inferior border of the mandible generally has a subtle hourglass appearance, which is a determining factor in the perceived attractiveness of the face.[5] The prominence of this hourglass form changes depending on the angle formed between the inferior border of the mandible and the neck. The esthetics of this region should be evaluated as a whole, with other anatomic structures that determine facial esthetics.

The inferior mandibular border defines the demarcation between the face and neck. A lack of definition of this border from the chin to the gonial angle due to submental adipose tissue accumulation, loose skin tissue, low positioning of the hyoid bone, and skeletal insufficiency of the mandible and/or chin may cause an undesirable esthetic appearance in the submental-cervical region.[5–9] In addition to these factors affecting the definition of the mandibular border, sagittal and/or vertical movements of the jaws also affect the submental-cervical esthetics. Mandibular advancement, maxillary impaction, and counter-clockwise rotation of the mandible improve the submental-cervical esthetic, whereas mandibular setback, maxillary vertical lengthening, and clockwise rotation of the mandible worsen it by increasing the submental fullness.[5] Therefore, including the evaluation of submental-cervical esthetics in the treatment planning of patients who are to undergo orthognathic surgery may help to predict undesirable esthetic results and modify the treatment plan as needed.

Facial esthetics is the mathematical balance and harmony of the anatomic components of the face and neck region. Perceptions of attractiveness are subjective and vary depending on many factors such as age, gender, culture, or profession. In the literature, there are several studies evaluating the effects of dimensional and angular changes in various anatomic structures of the face and neck on perceptions of profile or frontal attractiveness.[10–18] Gulsever et al reported that orthognathic surgical procedures to correct Class II dentofacial deformity have caused a significant decrease in the width of the narrowest part of the neck and concavity angle of the neck, therefore positively affecting the hourglass appearance of the neck in the frontal view.[19] To our knowledge, there is no existing study

evaluating the effect of the concavity angle of the neck on the perceived esthetics in the frontal view.

The aim of the present study was to evaluate the influence of the concavity angle of the neck on the perceptions of orthodontists, oral and maxillofacial surgeons, and laypeople regarding frontal esthetics and to determine the norm range of this angle to guide clinicians in orthognathic surgery treatment planning.

MATERIALS AND METHODS

This study was approved by the Medipol University Institutional Review Board and Ethics Committee (ethical approval no. 61) and was conducted in accordance with the World Medical Association Declaration of Helsinki. An online survey was developed using Google Forms, and the link for the survey was sent to the observers through WhatsApp. Approval of the informed consent form was required before successful access to the survey.

Two-dimensional male and female frontal silhouettes that included the face, hair, and the entire neck were created using computer software (Adobe Photoshop CS2 software; Adobe Systems Inc.). The mirror image of the right half of the images was obtained, and the half images, which were copies of each other, were combined to ensure that the silhouettes were symmetrical. Symmetrical images were then manipulated using the same software to alter the neck concavity angle (NCA) formed between the inferior border of the mandible and the neck in 5 degrees increments from 120 degrees to 170 degrees; and 22 images (11 women, 11 men) were created (Fig. 1). The landmarks, reference lines, and angles inset in Fig. 2 were used to describe the NCA.

A sample size of at least 86 observers in each group was calculated using a power analysis software program (G*Power v3.1.9.2; Heinrich–Heine–Universität Düsseldorf, Germany) (power = 90%; $\alpha = 0.05$).[20] Observers participating in the study were separated into the following 3 groups: orthodontists, oral and maxillofacial surgeons, and laypeople. The observers completed and submitted the survey online through Google Forms.

In the first section of the survey, observers were asked to provide demographic information such as age, gender, and profession. In the second and third sections, observers were asked to rate the 11 frontal male and 11 frontal female silhouettes from 0 (extremely unesthetic) to 10 (extremely esthetic) in terms of esthetics, using the 11-point numerical rating scale located below each image. The images were randomly ordered using Microsoft PowerPoint (Microsoft Corporation).

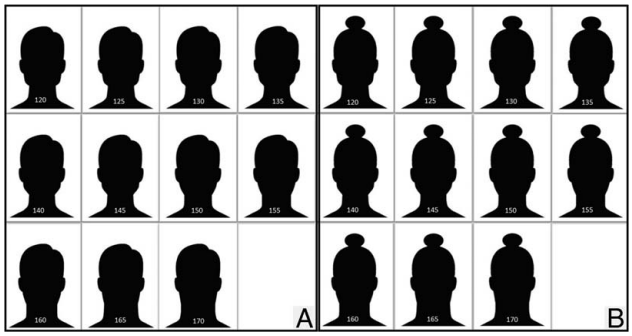

FIGURE 1. (A) Neck concavity angle of a male frontal silhouette was altered in 5 degrees increments from 120 degrees to 170 degrees. (B) Neck concavity angle of a female frontal silhouette was altered in 5 degrees increments from 120 degrees to 170 degrees.

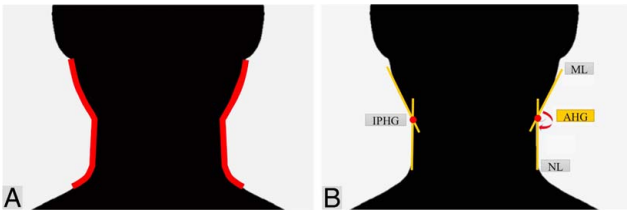

FIGURE 2. (A) Hourglass appearance of the transition from the upper aspect of the neck to the inferior border of the mandible in frontal view. (B) The landmarks, reference lines, and angles used to describe the concavity angle of the neck: IPHG, intersection point of the mandibular border and the neck. ML, a line tangent to the mandibular border and passing through IPHG. NL a line tangent to the neck and passing through IPHG. AHG, concavity angle formed between ML and NL. AHG indicates angle of the hourlglass; IPHG, innermost point of the concavity of the hourglass; ML, mandibular line; NL, neck line.

Statistical Analysis

Statistical analysis was performed using the NCSS (Number Cruncher Statistical System) program. Descriptive statistical methods were used to evaluate the obtained data. The conformity of the quantitative data to the normal distribution was tested with the Shapiro–Wilk test and graphical examinations. To compare quantitative variables between 2 groups, the Student *t*-test was used if normally distributed, and the Mann–Whitney *U* test was used if non-normally distributed. One-way analysis of variance was used for comparisons of normally distributed quantitative variables between more than 2 groups. For pairwise comparisons, Bonferroni-corrected pairwise evaluations were used if the variances were homogeneous, and the Games–Howell test was used if the variances were not homogeneous. The Kruskal–Wallis test and Dunn–Bonferroni test were used for comparisons of non-normally distributed quantitative variables between more than 2 groups. The Wilcoxon signed-rank test was used for intra-group comparisons of non-normally distributed quantitative variables. Pearson χ^2 test was used to compare qualitative data. Pearson correlation analysis and Spearman correlation analysis were used to evaluate the relationships between quantitative variables. Statistical significance was accepted as $P < 0.05$.

RESULTS

Demographic Data

Out of the 400 surveys sent out, 279 surveys were completed, and the response rate was 69.75%. In all, 279 observers (160 females, 119 males) participated in the study and were divided into the following 3 groups: (1) 97 orthodontists, (2) 92 oral and maxillofacial surgeons, and (3) 90 laypeople. The observers ranged in age from 18 to 70 years, with a mean age of 35.62 ± 10.32 y. There was a statistically significant difference between the ages of the observers according to the occupational groups ($P = 0.033$). According to the results of the pairwise comparison, the mean age of the oral and maxillofacial surgeons was significantly lower than that of the laypeople ($P = 0.029$). The difference between the gender distributions of the observer groups was not statistically significant ($P > 0.05$) (Supplemental Table 1, http://links.lww.com/SCS/F676).

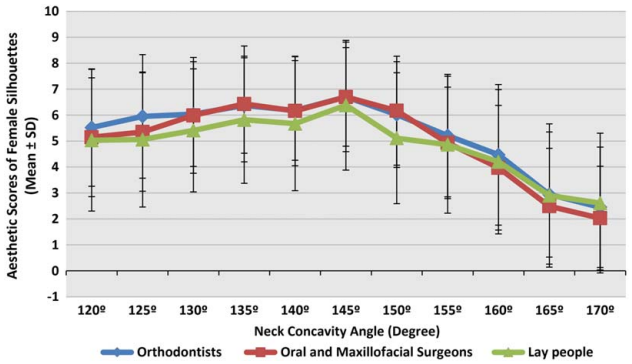

FIGURE 3. Distribution of esthetic scores of female silhouettes according to observer groups.

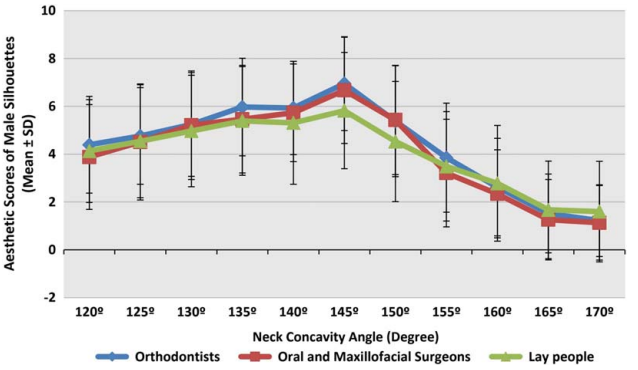

FIGURE 4. Distribution of esthetic scores of male silhouettes according to observer groups.

Perceived Esthetics of Female Silhouettes According to Observer Groups

There was no statistically significant difference between the scores of the observer groups for the female silhouettes, except for those with an NCA of 125 degrees and 150 degrees. The mean score of orthodontists for the female silhouette with an NCA of 125 degrees was significantly higher than that of the laypeople ($P = 0.037$). The mean score of the laypeople for the female silhouette with an NCA of 150 degrees was significantly lower than those of the orthodontists and surgeons ($P = 0.006$). When the mean scores of the groups were evaluated, the NCA of the highest-scored female silhouette was 145 degrees and of the lowest-scored female silhouette was 170 degrees. The female silhouettes with an NCA greater than 145 degrees (except 150 degrees) were scored lower than those with an NCA smaller than 145 degrees by all observer groups (Supplemental Table 2, http://links.lww.com/SCS/F677) (Fig. 3).

Perceived Esthetics of Male Silhouettes According to Observer Groups

There was no statistically significant difference between the scores of the observer groups for the male silhouettes, except for those with an NCA of 145 degrees and 150 degrees. The mean scores of the laypeople for the male silhouettes with an NCA of 145 degrees and 150 degrees were significantly lower than those of the orthodontists and surgeons ($P = 0.003$ and $P = 0.017$, respectively). Like the female silhouettes, the NCA of the highest-scored male silhouette was 145 degrees, the NCA of the lowest-scored male silhouette was 170 degrees, and the scores of the silhouettes with an NCA smaller than 145 degrees were higher than those with an NCA greater than 145 degrees (except 150 degrees) (Supplemental Table 3, http://links.lww.com/SCS/F678) (Fig. 4).

Perceived Esthetics of Female Silhouettes According to Observer Gender

There was no statistically significant difference between the scores of the observers of different genders for the female silhouettes with an NCA of 145 degrees and smaller. According to the mean scores of the observers of both genders, the NCA of the highest-scored female silhouette was 145 degrees and of the lowest-scored female silhouette was 170 degrees. The mean scores of male observers for the female silhouettes with an NCA greater than 145 degrees were significantly higher than those of the female observers (150 degrees; $P = 0.030$) (155 degrees, 160 degrees, 165 degrees, 170 degrees; $P = 0.001$). The mean scores of the male observers for the silhouettes with an NCA greater than 155 degrees and the mean scores of the female observers for the silhouettes with an NCA greater than 150 degrees were lower than their mean scores for the silhouettes with an NCA smaller than 145 degrees (Supplemental Table 4, http://links.lww.com/SCS/F692) (Fig. 5).

Perceived Esthetics of Male Silhouettes According to Observer Gender

There was no statistically significant difference between the scores of the observers of different genders for the male silhouettes with an NCA of 145 degrees and smaller. According to the mean scores of the observers of both genders, the NCA of the highest-scored male silhouette was 145 degrees and of the lowest-scored male silhouette was 170 degrees. The mean scores of male observers for the male silhouettes with an NCA greater than 145 degrees were significantly higher than those of the female observers (150 degrees; $P = 0.002$) (155 degrees, 160 degrees, 165 degrees, 170 degrees; $P = 0.001$). The mean scores of the male observers for the silhouettes with an NCA greater than 155 degrees and the mean scores of female observers for silhouettes with an NCA greater than 150 degrees were lower than their mean scores for silhouettes with an NCA smaller than 145 degrees (Supplemental Table 5, http://links.lww.com/SCS/F693) (Fig. 6).

Difference Between Perceived Esthetics of Female and Male Silhouettes

The mean scores of all observers for all female silhouettes except for the one with an NCA of 145 degrees were statistically significantly higher than the mean scores for the male silhouettes

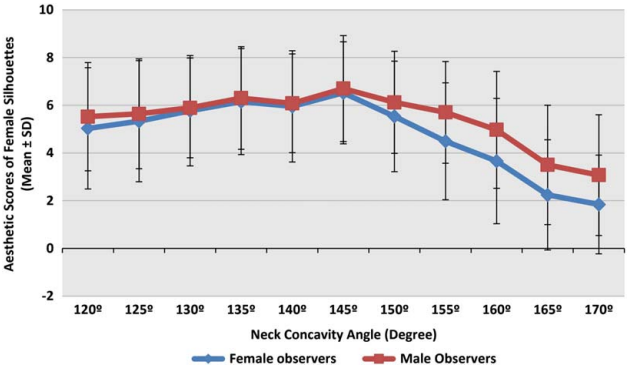

FIGURE 5. Distribution of esthetic scores of female silhouettes according to observer gender.

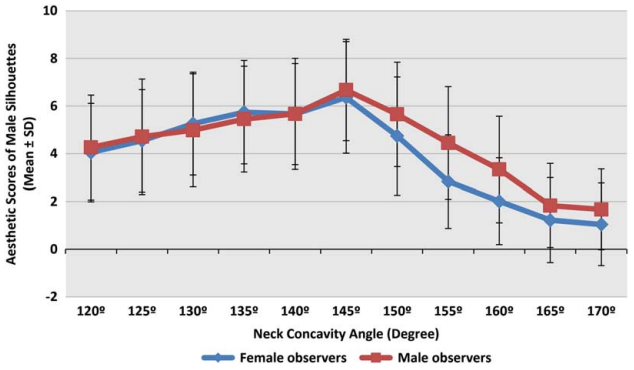

FIGURE 6. Distribution of esthetic scores of male silhouettes according to observer gender.

with the same angles (140 degrees; $P = 0.029$) (120 degrees, 125 degrees, 130 degrees, 135 degrees, 150 degrees, 155 degrees, 160 degrees, 165 degrees, 170 degrees; $P = 0.001$) (Supplemental Table 6, http://links.lww.com/SCS/F694) (Fig. 7).

Correlations Between Perceived Esthetic Scores of Female Silhouettes

The evaluation of the correlations between the mean scores of all observers for the female silhouettes showed that the moderate positive correlations between an NCA of 145 degrees and an NCA of 120 degrees ($r = 0.406$; $P = 0.001$), 125 degrees ($r = 0.405$; $P = 0.001$), 130 degrees ($r = 0.520$; $P = 0.001$), 135 degrees ($r = 0.469$; $P = 0.001$), and 140 degrees ($r = 0.423$; $P = 0.001$) were statistically significant. In addition, the weak positive correlation between an NCA of 145 degrees and an NCA of 150 degrees ($r = 0.376$; $P = 0.001$) and the very weak positive correlation between an NCA of 145 degrees and an NCA of 155 degrees ($r = 0.172$; $P = 0.004$) were also statistically significant (Supplemental Table 7, http://links.lww.com/SCS/F695).

Correlations Between Perceived Esthetic Scores of Male Silhouettes

The evaluation of the correlations between the mean scores of all observers for the male silhouettes showed that the moderate positive correlations between an NCA of 145 degrees and an NCA of 130 degrees ($r = 0.405$; $P = 0.001$), 135 degrees ($r = 0.468$; $P = 0.001$), 140 degrees ($r = 0.435$; $P = 0.001$), and 150 degrees ($r = 0.447$; $P = 0.001$) were statistically significant. The weak positive correlations between an NCA of 145 degrees and an NCA of 120 degrees ($r = 0.391$; $P = 0.001$), 125 degrees ($r = 0.309$; $P = 0.001$), 155 degrees ($r = 0.292$; $P = 0.001$), and 160 degrees ($r = 0.228$; $P = 0.001$) and the very weak positive correlation between an NCA of 145 degrees and an NCA of 165 degrees ($r = 0.142$; $P = 0.018$) were also statistically significant (Supplemental Table 8, http://links.lww.com/SCS/F696).

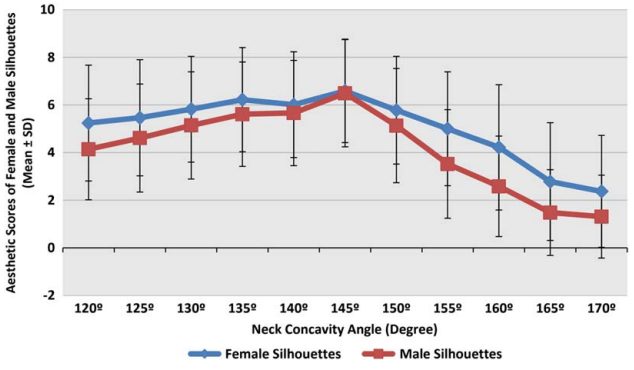

FIGURE 7. Distribution of esthetic scores of female and male silhouettes according to all observers.

DISCUSSION

Variation—that is, difference and diversity—forms the basis of the concepts of beauty and ugliness, inspiring in people the perceptions of like and dislike. People categorize other people or objects as attractive or unattractive owing to the brain's ability to evaluate and judge things as well as attach emotional meanings to people. In the context of facial attractiveness, the term "perception" refers to the neurophysiological processes in which the information generated when the observer looks at a face is processed in the brain and transformed into judgment. Facial attractiveness is considered an important factor in psychosocial well-being because it affects the way people are perceived; on the other hand, it can be a serious source of concern in social life for some individuals.[15]

The morphology of the neck and the transition from the upper part of the neck to the inferior border of the mandible have potentially significant effects on esthetic perceptions of the lower face. As reported in the study by Gulsever et al, orthognathic surgery may cause a significant change in the concavity angle of the neck, which determines the hourglass appearance of the neck in the frontal view.[19] Therefore, to obtain postoperative esthetic results, it would be beneficial to have information about the NCA range perceived as esthetic and to consider it in orthognathic surgery planning. This study aimed to evaluate the effect of the NCA on perceived esthetics and to determine the norm range of NCA to guide clinicians in orthognathic surgery treatment planning.

Although the perception of esthetics or attractiveness is affected by many factors, in some studies it has been stated that it is universal.[21,22] Considering the effects of age, gender, and cultural differences on the perception of esthetics, observers over the age of 18 were included in this study, and evaluation was conducted in terms of gender and occupational groups.

Many confusing factors such as gender, age, skin color, skin contrast, wrinkles, or make-up can affect people's esthetics preferences. In this study, silhouettes created using real female and male frontal photographs were used for evaluation instead of photographs; thus, the images were standardized, allowing the observers to make a more objective and simpler assessment without any bias.

The results of this study showed that the highest-scored and, thereby, the perceived as most esthetic male and female silhouettes were those with an NCA of 145 degrees, and the lowest-scored silhouettes were those with an NCA of 170 degrees. The overall direction of the esthetic perceptions of the observers of different occupations and genders for the male and female silhouettes was nearly similar. The further the angle increased or decreased from 145 degrees, the less esthetic it was perceived to be, and a severe increase in NCA was perceived as less esthetic than a severe decrease.

The brains of male and female individuals are activated differently when evaluating appearance and beauty, consistent with their differences in reproductive strategy. Such different activation causes facial esthetic perceptions to differ between genders.[23] Previous studies evaluating the esthetic preferences of men and women have produced divergent results.[17,24–29] The results of this

study demonstrated that female observers were more critical than male observers and showed a tendency to give lower scores for almost all silhouettes when evaluating both male and female silhouettes. Generally, the male and female silhouettes with an NCA smaller than 145 degrees were scored higher than most silhouettes with an NCA greater than 145 degrees by observers of both genders. For silhouettes with an NCA greater than 145 degrees, the mean scores of the female and male observers differed significantly, and the females perceived these silhouettes as dramatically less esthetic than did the males. Both the male and female observers scored the female silhouettes higher than the male silhouettes with the same NCAs.

In the present study, consistent with previous studies evaluating the effects of dimensional, angular, or positional changes of different anatomic regions of the face on perceived attractiveness or esthetics among different occupational groups,[10,11,16] groups' score rankings and mean esthetic scores for most silhouettes were largely similar, with only minor differences. The esthetic scores of the groups were similar for all silhouettes, except for the female silhouettes with an NCA of 125 degrees and 150 degrees and male silhouettes with an NCA of 145 degrees and 150 degrees. The mean scores of the laypeople were lower than the orthodontists for the female silhouettes with an NCA of 125 degrees, orthodontists and surgeons for female silhouettes with an NCA of 150 degrees, and orthodontists and surgeons for male silhouettes with an NCA of 145 degrees and 150 degrees.

A limitation of this study was not considering the ethnicity, race, and age differences of the observers. Further investigations evaluating the effects of the hourglass form of the neck on the frontal esthetic perceptions of observers of different ethnic-racial and age groups are required.

CONCLUSIONS

- The overall direction of the esthetic perceptions of the observers of different occupations and genders was similar.
- An NCA of 145 degrees was perceived as the most esthetic.
- The more an NCA increased or decreased from 145 degrees, the less esthetic it was perceived to be.
- A significant increase in NCA was perceived as less esthetic than a significant decrease.
- Female observers were more critical than male observers, scoring almost all silhouettes lower.
- The norm range of NCA that was perceived as aesthetic was 150 degrees to 130 degrees for male silhouettes and 145 degrees to 120 degrees for female silhouettes.

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