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Measuring the effects of facial regional changes following excessive aesthetic treatments—A survey and eye-tracking-based investigation

Joanna Kempa [a], Anna Kasielska-Trojan [b], Bogusław Antoszewski [b], Rod J. Rohrich [c], Ting-Song Lim [d], Mikaela V. Cotofana [e], Michael Alfertshofer [f], Sebastian Cotofana [g,h,i,j,*]

[a] *Individual Course of Study in Plastic, Reconstructive and Aesthetic Surgery Clinic, Institute of Surgery, Medical University of Lodz, Lodz, Poland*
[b] *Plastic, Reconstructive and Aesthetic Surgery Clinic, Institute of Surgery, Medical University of Lodz, Lodz, Poland*
[c] *Private Practice, Dallas, TX, USA*
[d] *Clique Clinic, Kualalumpur, Malaysia*
[e] *Cotofana Anatomy, Rochester, MN, USA*
[f] *Department of Oromaxillofacial Surgery, Ludwig-Maximilians-University Munich, Munich, Germany*
[g] *Department of Plastic Surgery, Vanderbilt University Medical Center, Nashville, TN, USA*
[h] *Department of Dermatology, Erasmus Medical Centre, Rotterdam, the Netherlands*
[i] *Centre for Cutaneous Research, Blizard Institute, Queen Mary University of London, London, UK*
[j] *Department of Plastic and Reconstructive Surgery, Guangdong Second Provincial General Hospital, Guangzhou, Guangdong Province, China*

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Summary *Background:* The increasing popularity of minimally invasive soft tissue filler injections has been accompanied by a significant rise in filler reversal procedures, highlighting the concerns regarding adverse effects, including the facial overfilled syndrome (FOS). This trend suggests a growing need to understand individual facial regions contributing to FOS and their influence on patient perception.

* Correspondence to: Department of Plastic Surgery, Vanderbilt University, 331 Light Hall, Nashville, TN 37232-0260, USA.
E-mail address: scotofana24@gmail.com (S. Cotofana).

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Facial aesthetics

Objective: To investigate the influence of exaggerated volumization of facial regions on the perceptions of attractiveness and gender traits using eye-tracking and survey methods to better understand FOS.
Methods: A total of 50 volunteers (30 women and 20 men) rated frontal images of different modified facial regions (*i.e.*, eyes, cheeks, and lips) and the combination thereof on 5-point Likert scales for attractiveness, unattractiveness, masculinity, and femininity. Their gaze patterns and eye movements were analyzed using eye-tracking technology.
Results: Elevating the lateral canthal angle sharply reduces the attractiveness in male and female faces. Accentuating the zygomatic arch generally decreases attractiveness and masculinity, particularly in men, while slightly increasing femininity. Lip volumization in women marginally increases attractiveness without significantly altering femininity. In combined modifications, the decrease in attractiveness is predominantly driven by the eye modification aspect, leading to the most substantial decline in the perceived attractiveness and gender-specific traits.
Conclusion: Certain facial modifications such as lip enhancement may increase attractiveness, while cheek enhancements may increase femininity. However, most alterations, particularly those involving the eyes or combinations of treatments, generally decrease attractiveness and impact the perceptions of femininity and masculinity. This underscores the need for balanced aesthetic treatments to prevent overcorrection.

In 2021, the aesthetic society released their annual statistic and reported that the procedural count of minimally invasive soft tissue filler injections in the US was 1,857,339, representing an increase of 42% in comparison to 2020. They also noted a 57% rise in soft tissue filler reversal procedures with 23,031 recorded cases, compared to the previous year. This indicates that the number of reversal procedures increased concomitantly with the number of facial aesthetic procedures.[1,2]

Reasons for removing previously implanted soft tissue filler material include the management of adverse events, such as redness, swelling, pain.[3-6] Other reasons removing facial filler material is the presence of excessive volume due to the administration of disproportionately large amounts of facial fillers. The above symptoms have been previously summarized by Lim et al. into a symptom complex termed the facial overfilled syndrome (FOS) and Cotofana et al. provided the underlying anatomic explanation for its occurrence.[7,8]

In 2024, Schelke et al. presented a case series of 28 patients suffering from an unnatural smile following hyaluronic acid-based (HA) midfacial soft tissue filler injections.[9] An average amount of 81.6 cc of hyaluronidase was sufficient to dissolve the midfacial filler material, reverse the symptoms, and restore natural facial mobility. Despite the sole symptom being an unnatural smile, the diagnosis was FOS due to excessive cheek fillers. Limited understanding of the causes of FOS can hinder clinical judgment and delay decisions to reverse the implanted HA material.

The present study was designed to better understand the perception of FOS and how unnaturally increased volumes of the various facial regions can impact attractiveness, femininity, and masculinity. Images showing digitally enhanced lips and cheeks, hyper-elevated lateral canthal regions, and eyebrows (Foxy eyes modification) were presented to independent observers. Eye-tracking technology monitored the eye movements, while perceptions of attractiveness, unattractiveness, femininity, and masculinity were assessed *via* an anonymous survey. The findings aimed to clarify the perceptions regarding FOS and identify which overly altered facial region most reduces the attractiveness.

Materials and methods

Study sample

This study included 50 volunteers (30 women and 20 men) of Polish Caucasian descent. The study was carried out in Łódź, between February and May 2024. Study participants (observers) were recruited from among the out-patients, medical staff (excluding those specializing in plastic surgery or aesthetic medicine), and non-medical staff from the hospital and university.

Prior to the study, participants were informed about the general scope of the investigation but not the specific aim of the study, and each volunteer provided informed consent for the use of their demographic and analytic data for the purpose of this study. The study was approved by the bioethical committee of the Medical University of Lodz (RNN/217/22/KE).

Study design

The study was designed as a survey and eye-tracking-based study. Both components (survey and eye-tracking component) of this study required the observers to evaluate the same modified facial images. The manuscript was checked against the strengthening the reporting of observational studies in epidemiology (STROBE) checklist (Supplemental Appendix).

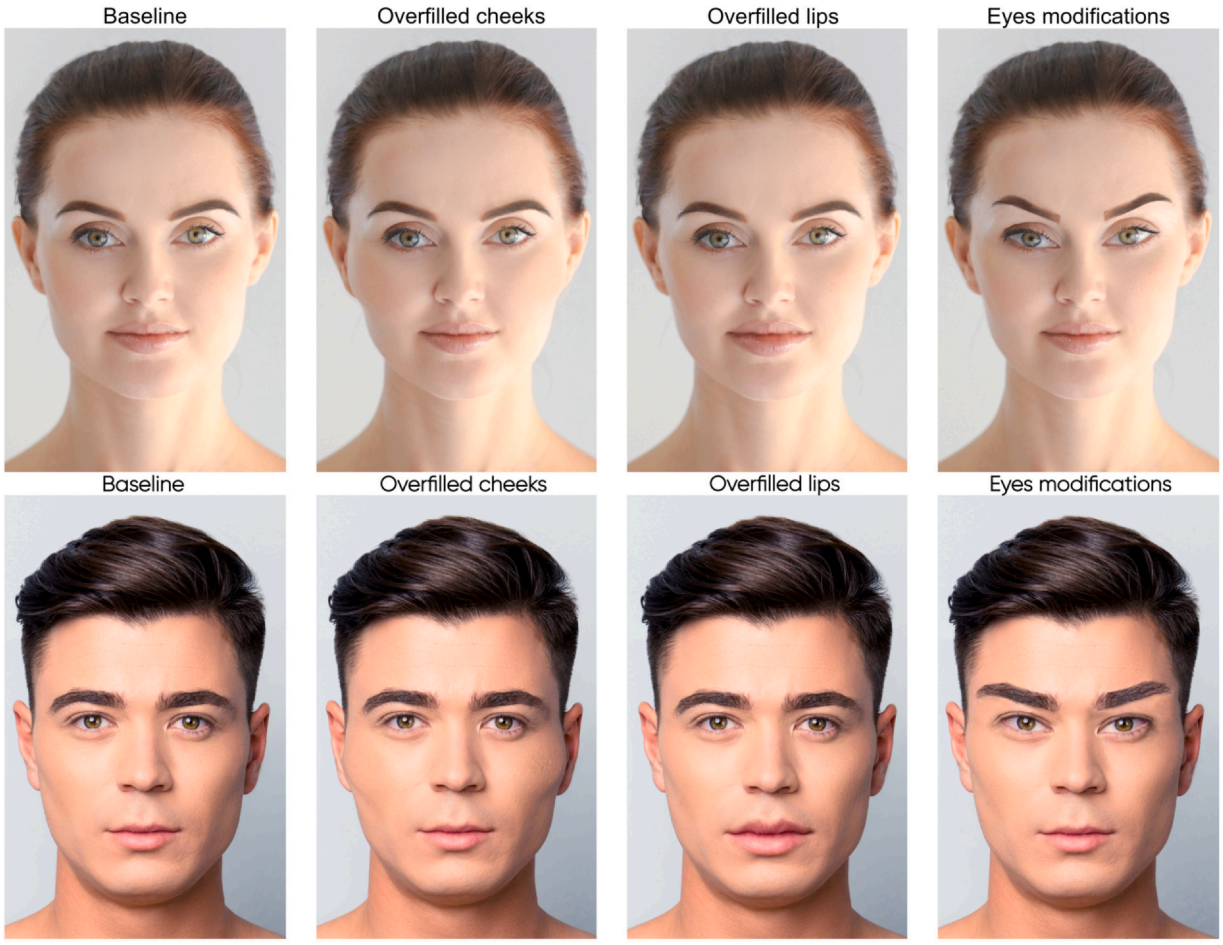

Figure 1 Baseline and modified images of female and male models, displaying overfilled cheeks, overfilled lips, and eye modifications.

Displayed images

Sixteen frontal facial images (14 modified and 2 unmodified) of female and male models were displayed in a randomized order for 6 s, each with a 2-second interval between them. Baseline photos of both sexes were chosen from the Adobe Stock database (Adobe System, Inc., San Jose, California). Faces, male and female, were modified using Adobe Photoshop Version 21 (Adobe System, Inc., San Jose, California) according to the following criteria (Figure 1):

- Lips modification: The original (unmodified) lips were increased in volume until they reached 130% of their baseline volume[10]
- Cheeks modification: The original (unmodified) cheeks were increased in volume until they reached approximately 140% of their baseline volume
- Eyes modifications: The lateral canthal angle and position of the eyebrows were elevated until they reached a lateral canthal angle of approximately 15° and a lateral eyebrow height of approximately 10% of the total forehead length[11]

The above modifications and combinations of those were presented individually to the observers (Figure 2):

- Lips and Cheeks modification
- Lips and Eyes modification
- Cheeks and Eyes modification
- Lips, Cheeks, and Eyes modification

Within the respective images, the facial regions of interest were created to enable regional facial analyses during the eye-tracking examination: frontal, periorbital, nasal, perioral, cheeks, jawline, and chin.

Eye movement analysis

The eye-tracking system used was the Tobii Pro Spark (Tobii, Sweden), which consists of one camera eye-tracking system attached to monitor frame. The images for the observers were displayed on a 21.5-inch monitor (ASUS VS229HV, Taiwan) which was positioned at 70 cm in front of the observers as described previously.[12,13] The camera recorded the movement of the eyes while the observers inspected the randomized images displayed on the monitor. The eye movement data were captured and exported (Tobii Pro Lab software, Tobii, Sweden). The variable of interest in this study was the time of total fixation duration which is defined as the total viewing time of one facial region lasting

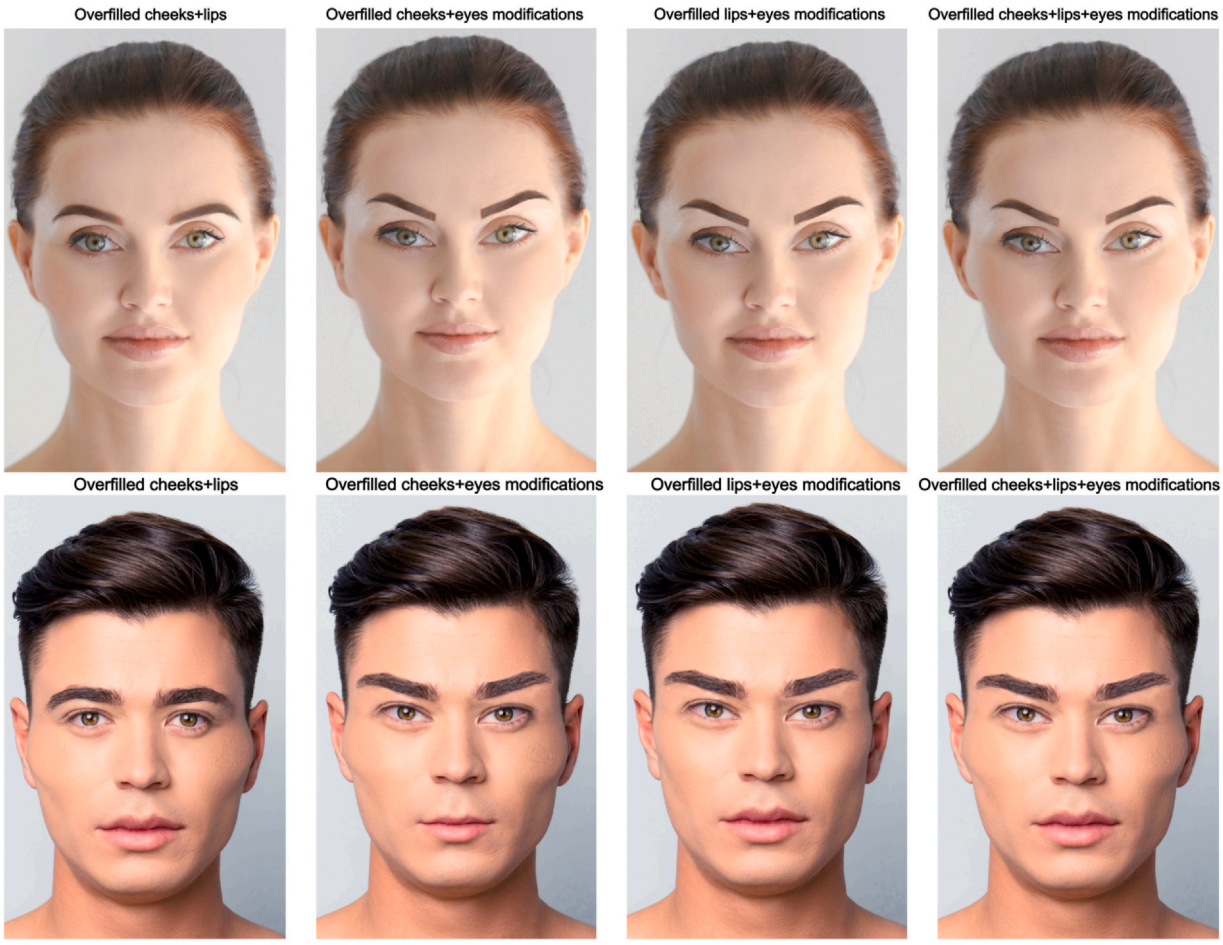

Figure 2 Modified images of female and male models, displaying different combinations of individually altered facial regions.

longer than 0.08 s (0.08 s is considered a stable fixation on a single facial region).

Survey

The participants inspected images in randomized sequence and were asked to rate the them following this question: I perceive the displayed image as 1) Attractive, 2) Unattractive, 3) Feminine, and 4) Masculine. The answer options ranged on a 5-point Likert scale from 1 to 5 and were classified as follows: 1 = "I absolutely don't agree," 2 = "I don't agree," 3 = "Neutral," 4 = "I agree," 5 = "I absolutely agree."

Statistical analyses

All statistical comparisons were performed between each modified facial image and its respective unmodified (baseline) image to assess the effect of the specific regional alterations. The Wilcoxon-signed rank test was used to compare the rating of the visualizations with the baseline image. All calculations were performed using SPSS Statistics 27 (IBM, Armonk, NY, USA) and the differences were considered statistically significant at a probability level of $\leq$ 0.05 to guide conclusions. Results are presented as mean and the respective 1x standard deviation to increase readability despite the ordinal data format. All statistical testing was conducted according to the respective data format (non-parametric).

Results

General description

This study included a total of 50 volunteers with a mean age of 39.50 (14.9) years [range: 18-69 year]; among them 30 (60%) were women and 20 (40%) were men. All participants were of Polish Caucasian ethnic origin and completed the survey and eye-tracking component of the study.

Neutral face

When survey respondents were asked, independent of their gender, to rate the non-modified image for attractiveness, the rating for the female image was 3.92 (1.0) and 3.62 (1.2) for the male image. The unattractiveness score was (female/male image) 1.74 (0.8)/1.92 (0.8), whereas the femininity score was 4.04 (1.1)/1.78 (0.8) and masculinity score was 1.52 (0.7)/3.92 (1.1), respectively.

Eye modification

When the female and male images were modified by increasing their lateral canthal angle (eye modification), the survey responses were (female/male image): attractiveness: 3.18 (1.1) ($p < 0.001$)/2.68 (1.1) ($p < 0.001$); unattractiveness: 2.46 (1.2) ($p = 0.001$)/2.82 (1.1) ($p < 0.001$); femininity: 3.80 (1.0) ($p = 0.040$)/1.94 (1.0) ($p = 0.444$); and masculinity: 1.52 (0.7) ($p = 1.00$)/3.60 (1.0) ($p = 0.040$).

When comparing the eye-tracking responses based on the total fixation duration for each of the modified facial regions (periorbital, perioral, and cheeks), the perioral region showed shorter fixations for female ($p = 0.009$) and male ($p = 0.022$) images, while the periorbital region displayed longer fixations for male images ($p = 0.014$), a statistically significant difference when compared to the non-modified full-face images.

Cheek modification

When the female and male images were modified by increasing their cheek volume (cheek modification), the survey responses were (female/male image): attractiveness: 3.74 (1.2) ($p = 0.194$)/3.16 (1.2) ($p = 0.017$); unattractiveness: 1.90 (1.0) ($p = 0.295$)/2.46 (1.1) ($p = 0.004$); femininity: 4.16 (1.0) ($p = 0.243$)/2.14 (1.1) ($p = 0.030$); and masculinity: 1.56 (0.8) ($p = 0.926$)/3.36 (1.2) ($p = 0.001$).

When comparing the eye-tracking responses based on the total fixation duration for each of the modified facial regions, the perioral region (shorter; $p = 0.001$) for the female images and cheek region (longer; $p = 0.003$) for the males images displayed a statistically significant difference when compared to the non-modified full-face images.

Lip modification

When the female and male images were modified by increasing their lip volume (lip modification), the survey responses were (female/male image): attractiveness: 4.04 (1.0) ($p = 0.292$)/3.38 (1.2) ($p = 0.070$); unattractiveness: 1.78 (0.9) ($p = 0.928$)/2.10 (1.0) ($p = 0.128$); femininity: 4.04 (1.2) ($p = 0.888$)/1.88 (0.9) ($p = 0.607$); and masculinity: 1.36 (0.5) ($p = 0.059$)/ 3.78 (1.1) ($p = 0.261$).

When comparing the eye-tracking-responses based on the total fixation duration for each of the modified facial regions, the perioral region showed longer fixations for the male images ($p = 0.013$) and the periorbital region showed longer fixations for the female images ($p = 0.007$), displaying a statistically significant difference when compared to the non-modified full-face images.

Lip-cheek modification

When the female and male images were modified by increasing their lip and their cheek volume (lip-cheek modification), the survey responses were (female/male image): attractiveness: 3.78 (1.1) ($p = 0.350$)/2.92 (1.2) ($p < 0.001$); unattractiveness: 1.92 (0.8) ($p = 0.138$)/2.70 (1.2) ($p < 0.001$); femininity: 4.02 (1.0) ($p = 0.826$)/2.34 (1.1) ($p = 0.002$); and masculinity: 1.60 (0.7) ($p = 0.412$)/3.20 (1.1) ($p < 0.001$).

When comparing the eye-tracking responses based on the total fixation duration for each of the modified facial regions, the cheek region showed longer fixations ($p = 0.010$) and periorbital region showed shorter fixations ($p = 0.040$) for the male images, displaying a statistically significant difference when compared to the non-modified full-face images.

Lip-eye modification

When the female and male images were modified by increasing their lip volume and their lateral canthal angle (lip-eye modification), the survey responses were (female/male image): attractiveness: 2.94 (1.2) ($p < 0.001$)/2.56 (1.1) ($p < 0.001$); unattractiveness: 2.60 (1.0) ($p < 0.001$)/2.88 (1.2) ($p < 0.001$); femininity: 3.60 (1.1) ($p < 0.001$)/2.38 (1.1) ($p = 0.003$); and masculinity: 1.76 (0.8) ($p = 0.011$)/3.02 (1.0) ($p < 0.001$).

When comparing the eye-tracking- responses based on the total fixation duration for each of the modified facial regions, the perioral region showed longer fixations for male images ($p = 0.041$), displaying a statistically significant difference when compared to the non-modified full-face images.

Cheek-eye modification

When the female and male images were modified by increasing their cheek volume and their lateral canthal angle (cheek-eye modification), the survey responses were (female/male image): attractiveness: 2.92 (1.1) ($p < 0.001$)/ 2.26 (1.0) ($p < 0.001$); unattractiveness: 2.54 (1.0) ($p < 0.001$)/3.28 (1.2) ($p < 0.001$); femininity: 3.58 (1.0) ($p < 0.001$)/2.24 (1.1) ($p = 0.010$); and masculinity: 1.66 (0.7) ($p = 0.108$)/3.16 (1.0) ($p < 0.001$).

When comparing the eye-tracking responses based on the total fixation duration for each of the modified facial regions, the perioral region showed shorter fixations for female images ($p = 0.008$), while the cheek region displayed longer fixations for male images ($p = 0.004$), a statistically significant difference when compared to the non-modified full-face images.

Lip-cheek-eye modification

When the female and male images were modified by increasing their lip volume and cheek volume and their lateral canthal angle (cheek-eye modification), the survey responses were (female/male image): attractiveness: 2.70 (1.2) ($p < 0.001$)/2.32 (1.1) ($p < 0.001$); unattractiveness: 2.92 (1.3) ($p < 0.001$)/3.28 (1.2) ($p < 0.001$); femininity: 3.48 (1.1) ($p < 0.001$)/2.52 (1.1) ($p < 0.001$); and masculinity: 1.96 (1.0) ($p = 0.003$)/2.88 (1.1) ($p < 0.001$).

When comparing the eye-tracking-responses based on the total fixation duration for each of the modified facial regions, the perioral region showed shorter fixations ($p = 0.033$), and the periorbital region displayed longer fixations ($p = 0.034$) for female images, a statistically significant difference when compared to the non-modified full-face images.

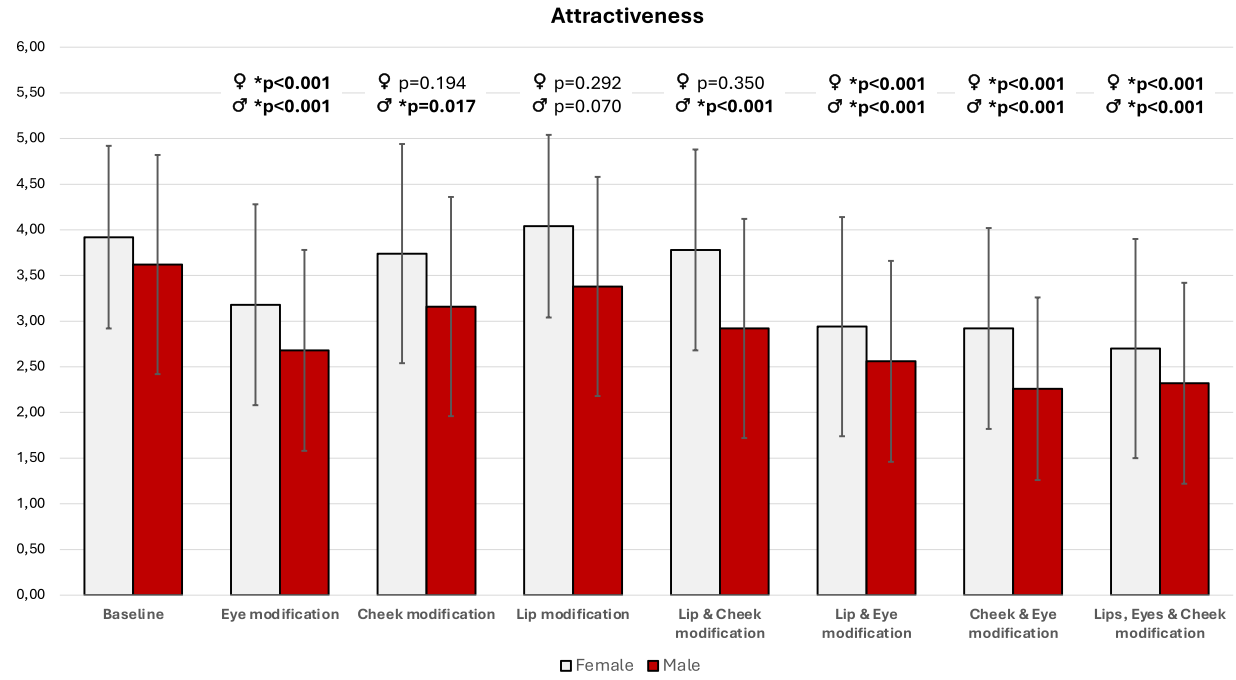

Figure 3 Paired bar graph illustrating the average attractiveness ratings for male and female models with different facial modifications, individually and in combination. P values indicate comparisons with the baseline, with asterisks and bold text highlighting statistically significant differences.

Discussion

This study aimed to examine the influence of overly volumized facial regions on the perceptions of attractiveness, femininity, and masculinity in male and female faces, using voluntary survey responses and involuntary eye-tracking analyses to understand the changes linked to FOS. The results revealed that in females, only the increase in lip volume resulted in an increased rating of attractiveness (baseline: 3.92 *vs.* lip modification: 4.04), whereas all other individual modifications (cheeks and eye) or their combinations resulted in a decrease in attractiveness (Figure 3, Table 1). The biggest negative impact on attractiveness was from the eye modification which reduced the score significantly on an individual level (3.18 with $p < 0.001$) and when combined with the lip modification (2.94 with $p < 0.001$), cheek modification (2.92 with $p < 0.001$), or lips and cheek modifications (2.70 with $p < 0.001$); the latter combination (modification of lips, cheek, and eyes) resulted in the lowest attractiveness score for females. For males, each facial modification led to a decrease in attractiveness for all modifications except for the lips ($p = 0.070$) showing a significant reduction when compared to the unmodified image ($p \leq 0.017$.) All modifications, except lip enhancements, reduced the attractiveness. Increased lip volume improved female attractiveness, likely due to the lips' association with fertility and sexuality.[14,15]

When investigating the unattractiveness rating, an identical inverse relationship was observed with the highest ratings for those modifications that included the eye region as an individual region or in combination with lips and cheeks.

When participants were asked to rate the degree of femininity of female images, it was revealed that none of the performed digital facial modifications increased femininity to a significant degree. All combined facial modifications, other than cheek modification, lip modification, and cheek and lip modification, resulted in a statistically significant reduction of the femininity scoring when compared to baseline with all $p < 0.001$. When evaluating the male facial images for their femininity rating, it was revealed that all modifications increased femininity with the highest scores observed for the combined facial regional changes with all $p \leq 0.010$. The highest increase in femininity of a male image following an individual change was induced by the cheek modification (2.14 with $p = 0.030$), indicating that the cheek region has a high impact on the perception of femininity.

When analyzing the masculinity rating of male facial images, the results indicated that all modifications decreased the perception of masculinity. The greatest negative impact was observed for the cheek modification as an individual modification (baseline *vs.* cheek modification: 3.92 *vs.* 3.36 with $p < 0.001$).

The study showed that attractiveness, unattractiveness, femininity, and masculinity are distinct and independent domains. Increased attractiveness does not correlate with increased femininity or masculinity. Interestingly, changes in specific facial regions can enhance individual domains—for instance, increased cheek volume boosted femininity in male and female faces but not the attractiveness. On the contrary, cheek modification increased the perception of unattractiveness in female and male images. The lip

Table 1 Average ratings of attractiveness, unattractiveness, femininity, and masculinity for individual facial modifications (eyes, cheeks, and lips) and their combined alterations.

	Baseline (B)		Eye modification (E)		*p value (B vs. E)*	Cheek modification (C)		*p value (B vs. C)*	Lip modification (L)		*p value (B vs. L)*	Lip and Cheek modification (LC)		*p value (B vs. LC)*	Lip and Eye modification (LE)		*p value (B vs. LE)*	Cheek and Eye modification (CE)		*p value (B vs. CE)*	Lips, Eyes, and Cheek modification (LEC)		*p value (B vs. LEC)*
	Female	Male	Female	Male		Female	Male		Female	Male		Female	Male		Female	Male		Female	Male		Female	Male	
Attractiveness	3.92 (1.0)	3.62 (1.2)	**3.18 (1.1)**	**2.68 (1.1)**	**Both < 0.001**	3.74 (1.2)	**3.16 (1.2)**	Female: 0.194 **male: 0.017**	4.04 (1.0)	3.38 (1.2)	Female: 0.292 male: 0.070	3.78 (1.1)	**2.92 (1.2)**	Female: 0.350 **male: < 0.001**	**2.94 (1.2)**	**2.56 (1.1)**	**Both < 0.001**	**2.92 (1.1)**	**2.26 (1.0)**	**Both < 0.001**	**2.70 (1.2)**	**2.32 (1.1)**	**Both < 0.001**
Unattractiveness	1.74 (0.8)	1.92 (0.8)	**2.46 (1.2)**	**2.82 (1.1)**	**Female: 0.001 male: < 0.001**	1.90 (1.0)	**2.46 (1.1)**	Female: 0.295 **male: 0.004**	1.78 (0.9)	2.10 (1.0)	Female: 0.928 male: 0.128	1.92 (0.8)	**2.70 (1.2)**	Female: 0.138 **male: < 0.001**	**2.60 (1.0)**	**2.88 (1.2)**	**Both < 0.001**	**2.54 (1.0)**	**3.28 (1.2)**	**Both < 0.001**	**2.92 (1.3)**	**3.28 (1.2)**	**Both < 0.001**
Femininity	4.04 (1.1)	1.78 (0.8)	**3.80 (1.0)**	1.94 (1.0)	**Female: 0.040** male: 0.444	4.16 (1.0)	**2.14 (1.1)**	Female: 0.243 **male: 0.030**	4.04 (1.2)	1.88 (0.9)	Female: 0.888 male: 0.607	4.02 (1.0)	**2.34 (1.1)**	Female: 0.826 **male: 0.002**	**3.60 (1.1)**	**2.38 (1.1)**	**Female: < 0.001 male: 0.003**	**3.58 (1.0)**	**2.24 (1.1)**	**Female: < 0.001 male: 0.010**	**3.48 (1.1)**	**2.52 (1.1)**	**Both < 0.001**
Masculinity	1.52 (0.7)	3.92 (1.1)	1.52 (0.7)	**3.60 (1.0)**	Female: 1.000 **male: 0.040**	1.56 (0.8)	**3.36 (1.2)**	Female: 0.926 **male: 0.001**	1.36 (0.5)	3.78 (1.1)	Female: 0.059 male: 0.261	1.60 (0.7)	**3.20 (1.1)**	Female: 0.412 **male: < 0.001**	**1.76 (0.8)**	**3.02 (1.0)**	**Female: 0.011 male: < 0.001**	1.66 (0.7)	**3.16 (1.0)**	Female: 0.108 **male: < 0.001**	**1.96 (1.0)**	**2.88 (1.1)**	**Female: 0.003 male: < 0.001**

Bold value indicates significance level ($p < 0.05$).

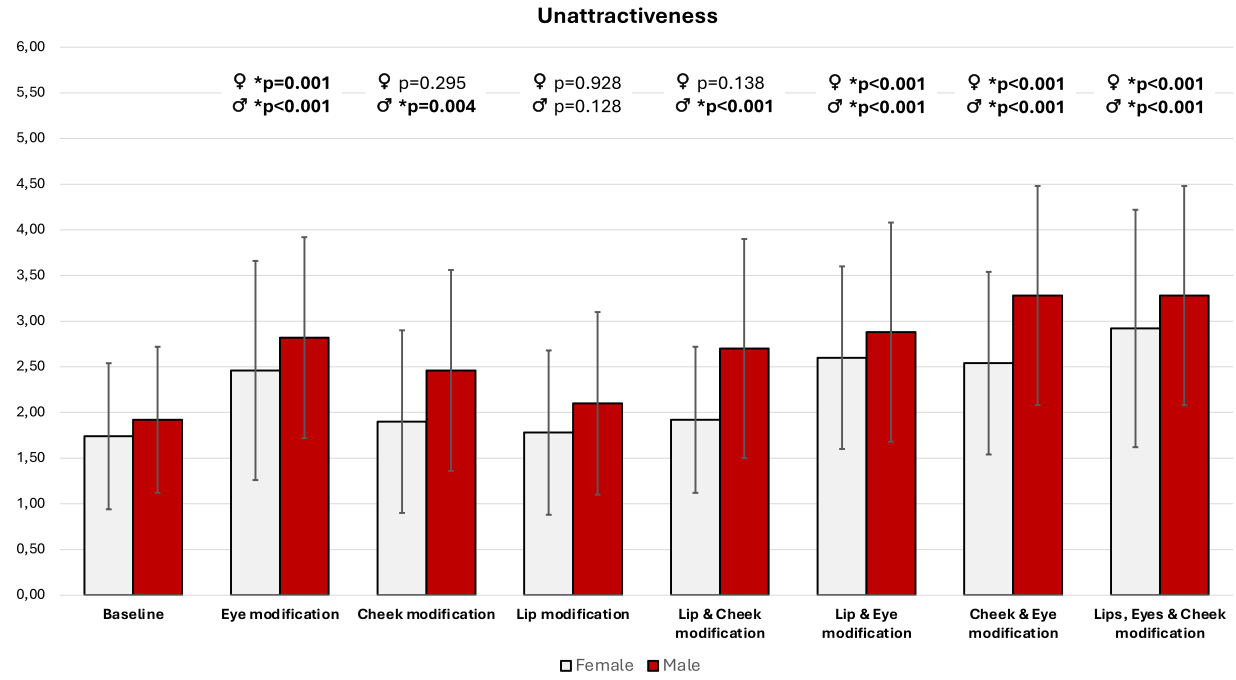

Figure 4 Paired bar graph illustrating the average ratings for unattractiveness in male and female models with different facial modifications, individually and in combination. P values indicate comparisons with the baseline, with asterisks and bold text highlighting statistically significant differences.

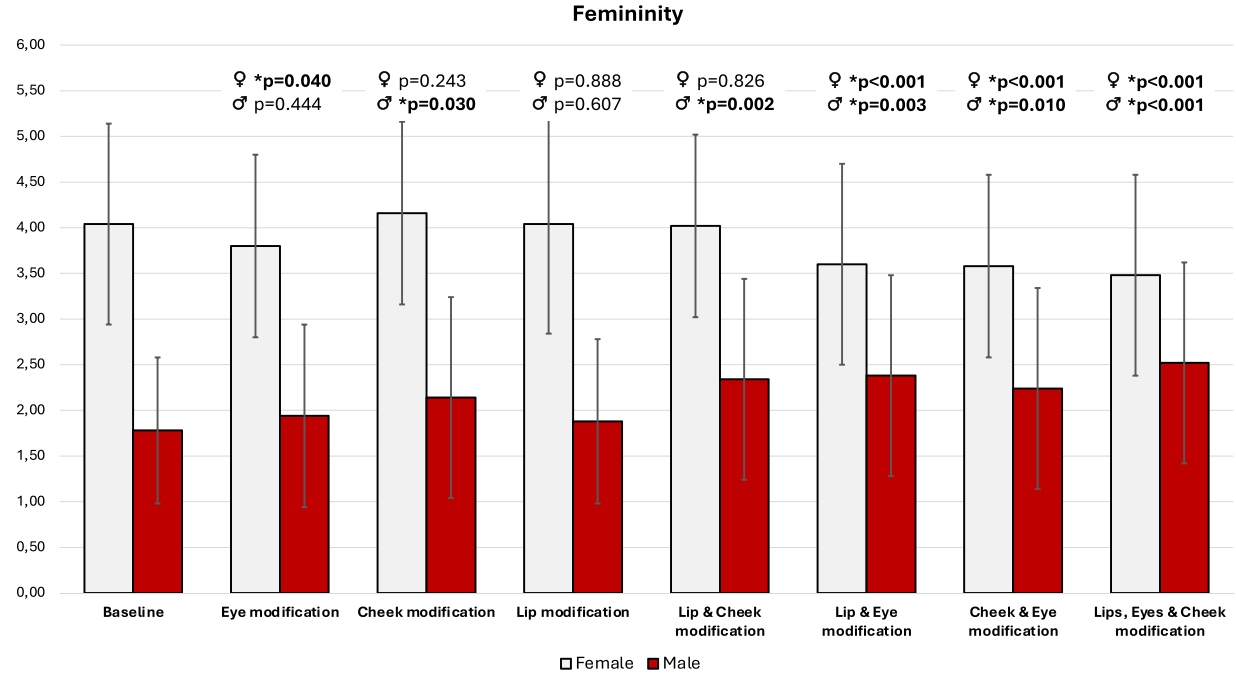

Figure 5 Paired bar graph illustrating the average ratings for femininity in male and female models for different facial modifications, individually and in combination. P values indicate comparisons with the baseline, with asterisks and bold text highlighting statistically significant differences.

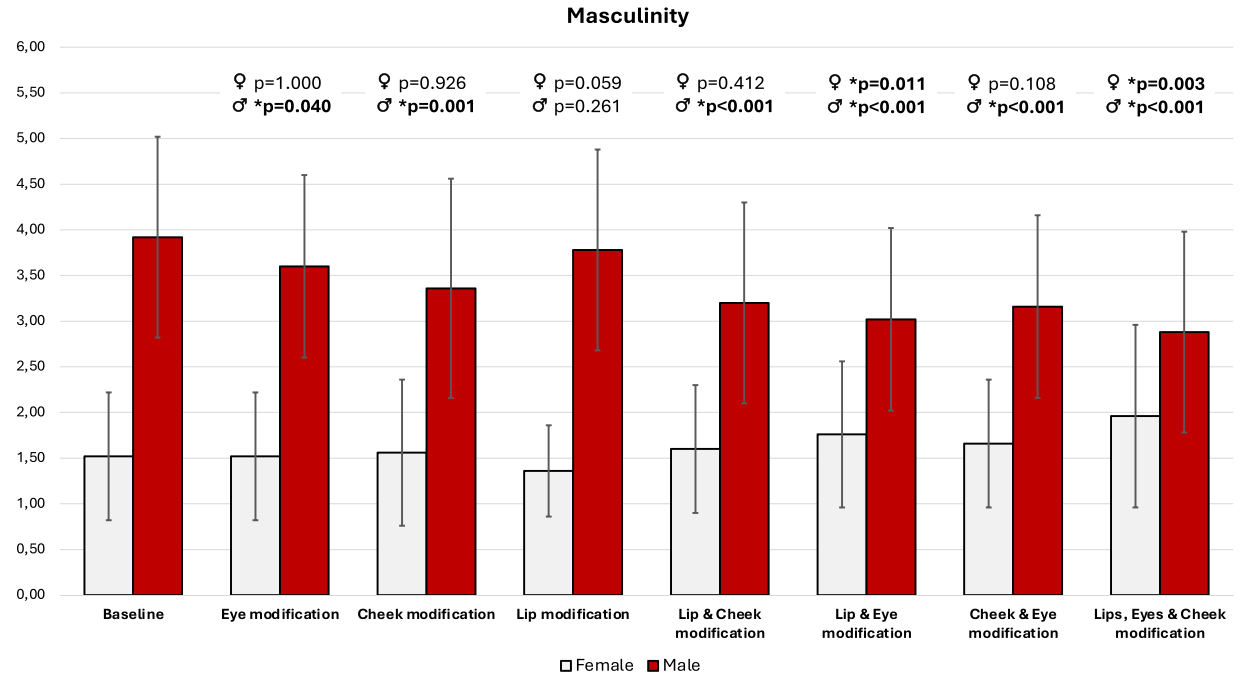

Figure 6 Paired bar graph illustrating the average ratings for masculinity in male and female models with different facial modifications, individually and in combination. P values indicate comparisons with the baseline, with asterisks and bold text highlighting statistically significant differences.

modification increased the attractiveness in females (but not in males) and decreased marginal femininity when compared to the baseline.

The study found that combined facial changes had a greater negative impact on the evaluated domains than individual changes. Attractiveness ratings dropped from 3.77 (baseline) to 3.36 (one change), 2.83 (2 changes), and 2.43 (3 changes). Combined changes significantly reduced the perceptions across domains, while individual changes were less disruptive and often remained within the normal limits, suggesting that multiple alterations create an aesthetic overload. Among the various facial regions that were modified and investigated, the eye modifications appeared to have the most negative impact on attractiveness, unattractiveness, and femininity; however, they had a less negative impact on the perception of masculinity in male images. The latter finding is curious and could most likely be related to the perception of suspiciousness or to that of an evil person or villain.[16].

The combination of survey results and eye-tracking analyses revealed that modifying a facial region increased the fixation time on the altered area while decreasing attention to others. This relationship supports the internal representation of the beauty theory, which suggests that individuals have an internal beauty blueprint. Features that do not align with this standard, considered as unattractive, require longer viewing times to process compared to those within the expected norms.[10,12] (Table 2).

The results obtained can provide insight into the perception of FOS. It is important to understand how each overfilled region might affect perception to understand and guide treatment accordingly. Even though some patients may perceive a specific volume increase as being attractive, the healthcare provider needs to understand and communicate the effects on other domains such as femininity or masculinity.

This study has some limitations: The images and sample were exclusively of Caucasian ethnicity, highlighting the need for future cross-ethnic studies. Although aesthetic perceptions may be influenced by cultural factors, previous studies suggest that certain universal aesthetic principles exist across populations.[17–19] This strengthens the relevance of our findings while highlighting the need for continued cross-ethnic research, particularly because our images and sample consisted exclusively of Caucasian individuals. Second, participants' medical backgrounds were evaluated only in terms of yes/no exposure to the medical field, without assessing its detailed influence owing to the complexity of the analyses and impact on group size. Furthermore, the modifications in this study reflect the co-authors' experience in aesthetic medicine. Other facial areas, such as the temples, forehead, chin, and nose, were not addressed, and different results may arise with more or less drastic modifications. The modifications in this study were based on the available literature and authors' experience, which can be considered a limitation. Modifications of areas such as the forehead, chin, nose, or jawline were excluded owing to the limitations of frontal imaging and complexity in altering these features. Future research with side-profile images could address these challenges more effectively. Additionally, the relatively small sample size (n=50) of this study may introduce an overestimation bias and increase the risk of type I or II errors; however, the study was exploratory in nature and aimed to capture subjective opinions without a predefined effect size.

Table 2 Average total fixation duration (in seconds) measured through eye-tracking analysis across 3 facial regions—perioral, periorbital, and cheeks—corresponding to individual facial modifications (eyes, cheeks, and lips) and their combined alterations.

	Baseline		Eye modification		*p value (B vs. E)*	Cheek modification		*p value (B vs. C)*	Lip modification		*p value (B vs. L)*	Lip and Cheek modification		*p value (B vs. LC)*	Lip and Eye modification		*p value (B vs. LE)*	Cheek and Eye modification		*p value (B vs. CE)*	Lips, Eyes, and Cheek modification		*p value (B vs. LEC)*
	Female	Male	Female	Male		Female	Male		Female	Male		Female	Male		Female	Male		Female	Male		Female	Male	
Perioral	1.22 (0.7)	0.81 (0.4)	**0.86** (**0.4**)	**0.65** (**0.3**)	**Female: 0.009 male: 0.022**	**0.80** (**0.5**)	0.83 (0.5)	**Female: 0.001** male: 0.866	0.96 (0.6)	**1.09** (**0.8**)	Female: 0.051 **male: 0.013**	1.14 (0.6)	0.91 (0.6)	Female: 0.492 male: 0.688	0.99 (0.6)	**1.03** (**0.6**)	Female: 0.140 **male: 0.041**	**0.90** (**0.7**)	0.73 (0.5)	**Female: 0.008** male: 0.136	**0.84** (**0.5**)	0.80 (0.7)	**Female: 0.033** male: 0.524
Periorbital	2.67 (1.3)	2.72 (1.0)	2.94 (1.3)	**3.16** (**1.0**)	female: 0.228 **male: 0.014**	2.93 (1.3)	2.53 (1.5)	Female: 0.095 male: 0.226	**3.20** (**1.1**)	2.52 (1.1)	**Female: 0.007** male: 0.299	2.73 (1.0)	**2.30** (**1.4**)	Female: 0.395 **male: 0.040**	2.71 (1.3)	2.92 (1.1)	Female: 0.532 male: 0.257	2.79 (1.3)	2.56 (1.2)	Female: 0.277 male: 0.484	**3.06** (**1.2**)	2.94 (1.2)	**Female: 0.034** male: 0.367
Cheeks	0.62 (1.0)	0.34 (0.2)	0.72 (0.6)	0.47 (0.4)	Female: 0.586 male: 0.575	0.76 (0.8)	**1.0** (**0.8**)	Female: 0.627 **male: 0.003**	0.27 (0.2)	0.61 (0.4)	Female: 0.299 male: 0.260	0.65 (0.7)	**1.02** (**0.8**)	Female: 0.532 **male: 0.010**	0.43 (0.4)	0.52 (0.5)	Female: 0.748 male: 0.959	0.68 (0.7)	**1.02** (**0.9**)	Female: 0.396 **male: 0.004**	0.72 (0.6)	0.71 (0.6)	Female: 0.469 male: 0.133

Bold value indicates significance level ($p < 0.05$).

Conclusion

This study highlights the complex relationship between facial aesthetic modifications and perceptions of attractiveness, femininity, and masculinity. Although certain individual facial modifications, such as lip enhancement in females, can increase attractiveness, most alterations, especially those involving the eyes or combined modifications, tend to decrease attractiveness and alter the perceptions of femininity and masculinity. Our findings clearly highlight the necessity for a cautious and individualized approach to facial volumization, particularly when addressing multiple regions in a single treatment session. The data demonstrate that combined modifications significantly increase the risk of FOS, which was consistently associated with decreased attractiveness ratings. Further research across different ethnic backgrounds and with larger sample sizes is required to validate these findings and enhance our understanding of the psychological and social impacts of aesthetic treatments.

Ethical approval

Bioethical Committee of the Medical University of Lodz (RNN/217/22/KE).

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Conflicts of interests

None declared.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.bjps.2025.04.027.

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