applied sciences

MDPI

Article

Esthetic Perceptions Associated with Gingival Color Changes in Broad Smiles

Manuel Antonio Sánchez De Martín *, Adrián Curto Aguilera, Ana María Martín Casado and Cristina Gómez-Polo

Department of Surgery, Faculty of Medicine, University of Salamanca, 37007 Salamanca, Spain; adrian_odonto@usal.es (A.C.A.); ammc@usal.es (A.M.M.C.); crisgodent@usal.es (C.G.-P.)
* Correspondence: manuelsm@usal.es

Abstract

Little is known about how controlled changes in gingival color affect the esthetic perception of broad smiles. This study evaluated how gingival color modifications affected esthetic ratings and whether responses varied by evaluator gender and age. Two photographs of broad smiles (one male and one female model) were digitally modified to create four versions per model: natural gingival color, increased L* (lighter gingiva), increased a* (redder gingiva), and either increased b* (more yellowish gingiva) in the female model or decreased L* (darker gingiva) in the male model. Two hundred participants rated the eight images on a 0–10 scale. Paired-samples *t*-tests and Cohen's *d* were used. For both models, images with natural or lighter gingiva received higher ratings than the other versions. Redder gingiva received significantly lower ratings than the original, with a larger effect in the male model ($d = 0.94$) than in the female model ($d = 0.33$). Darker (male) and more yellowish (female) gingiva also received lower ratings ($d = 0.90$ and $d = 0.88$, respectively). In descriptive subgroup analyses, unfavorable color changes tended to receive lower ratings among female evaluators and participants younger than 60 years; however, between-group differences were not formally tested. Gingival color significantly influenced the esthetic perception of the two broad-smile photographs evaluated.

Keywords: gingival esthetic perceptions; gingival appearance; gingival color; broad smiles

1. Introduction

Social media has been shown to influence how people perceive smiles and their interest in dental esthetics [1,2]. The smile is also a fundamental means of communication and emotional expression [3,4], and several studies have examined how smile esthetics influence perceptions of facial attractiveness [5].

It is well documented that the importance of beauty extends beyond purely esthetic considerations [6–10]. An attractive smile is often associated with desirable personal characteristics and success [6,11,12]; in other words, a beautiful smile leads observers to infer a range of positive psychosocial and personal traits [7,9]. More generally, physically attractive individuals tend to be perceived as more sociable, socially skilled, popular, and mentally healthy than less attractive individuals, although the strength of this effect varies across trait domains [13,14]. Beauty, therefore, has genuine social value [13–15].

A smile is typically considered esthetically pleasing when the teeth (white esthetics) and the gingiva (pink esthetics) are in harmony [16–18]. There is consensus within the scientific community that dental (white) esthetics has been studied far more extensively,

Check for updates

Academic Editor: Iole Vozza

Received: 31 August 2026
Revised: 12 October 2026
Accepted: 17 October 2026
Published: 23 October 2026

Copyright: © 2026 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license.

focusing on aspects such as proportion [17], symmetry, and color [11,19–22], whereas gingival (pink) esthetics remains relatively underexplored [23–25].

This imbalance is reflected in the market: a wide range of tooth shades is available, whereas manufacturers offer only a narrow palette of gingival shades. Moreover, much of the literature on gingival display has focused on excessive gingival display rather than on gingival tissue color variation.

Terminology concerning gingival display varies. In this study, the term broad smile is used descriptively for a smile with sufficient visible gingiva for gingival color to contribute to the overall smile image; it is not used as a synonym for a gummy smile. A gummy smile, or excessive gingival display, refers to maxillary gingival exposure considered excessive, with thresholds ranging from more than 2 mm to more than 3–4 mm proposed in the literature [26–29]. Excessive gingival display may result from vertical maxillary excess, a short or hypermobile upper lip, or altered passive eruption [30,31], and treatment may include periodontal or crown-lengthening surgery, orthognathic surgery, botulinum toxin, lip-repositioning or laser-assisted procedures, and multidisciplinary approaches [32–44].

Gingival color is a highly complex element of the smile [25,45], and achieving optimal esthetic outcomes in both direct and indirect restorative procedures requires a personalized approach. Gingival tissue exhibits substantial regional variation in color, which is influenced by factors such as age, gender, and skin tone [46,47].

Gingival color also has clinical relevance: gingival pigmentation has been associated with serum ferritin levels in patients with thalassemia [48], and changes in gingival color accompany inflammation and its response to periodontal treatment [49,50].

Tooth color, particularly lightness, is especially relevant to smile esthetics [51]. Lighter tooth shades (with greater whiteness) are generally perceived as more esthetic and harmonious [9,10,51–55]. However, this relationship cannot be directly extrapolated to gingival color, and it remains unclear whether lighter gingiva is perceived more favorably.

The extent of gingival display during smiling plays an important role in esthetic perception. Excessive display is generally regarded as unattractive [29,56], although preferences vary, and displays close to the gingival margin have been rated most favorably [57]. Excessive gingival display has been estimated to affect approximately 10% of individuals aged 20–30 years [26,58] and is more common in women than in men [59–62], and gingival display during smiling tends to decrease with age [26,63]. It has also been suggested that the increasing use of dermal fillers to correct lip sagging may affect gingival display, reflecting the growing social emphasis on gingival esthetics [64].

The prevalence of visible gingiva during smiling, together with the established importance of color in dental esthetics [65,66], supports investigating how gingival color contributes to smile perception [67–70]. Gingival color perception is not unexplored: perceptibility and acceptability thresholds have been reported [71], and recent work has examined esthetic preferences for gingival–dental color combinations and associations with participant age and sex [72]. However, the specific effect of controlled modifications of individual CIELAB gingival color coordinates in broad-smile photographs has received little attention.

Therefore, this study used photographs of two broad-smile models (one female and one male), each digitally modified to produce three additional color variations, to (1) describe the ratings assigned to the four smile images of each model and assess the effect of the color modifications relative to the original smile, and (2) descriptively explore whether these effects varied by evaluator gender and age. The null hypothesis for the primary paired comparisons was that controlled gingival color modifications would not affect the esthetic ratings of the tested broad-smile photographs. Analyses by evaluator gender and age were considered exploratory.

2. Materials and Methods

2.1. Data Collection

All participants ($n = 200$) voluntarily agreed to take part in the study, provided written informed consent, and passed the Ishihara color vision test [73], a pseudoisochromatic plate-based screening test used primarily to identify red–green color vision deficiencies. Each participant reported perceiving color differences among the eight images before scoring them. One of 23 trained interviewers verbally explained the study procedures to each participant. The interviewers were all final-year dental students from the University of Salamanca and had received standardized instructions to ensure uniform data collection. Each interviewer was given two printed photographic series, each containing four images (Figures 1 and 2), showing the broad smiles of one female and one male model, digitally edited to produce various gingival color modifications. The interviewers conducted the surveys in their respective regions across 10 autonomous communities in Spain.

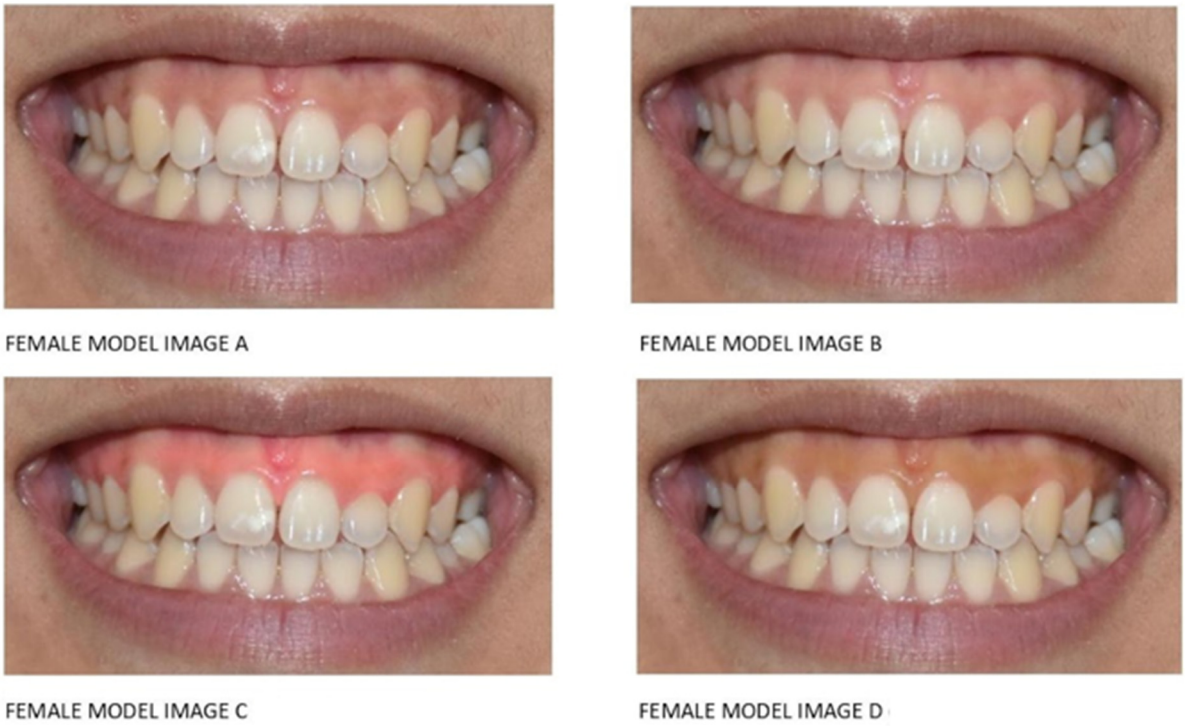


Figure 1. Images of the female model presented to participants for rating on a 0–10 scale: (**A**) original; (**B**) L* increased by 3 units (lighter gingiva); (**C**) a* increased by 10 units (redder gingiva); (**D**) b* increased by 9 units (more yellowish gingiva).

Lay participants were required to be over 18 years of age and to have no cognitive or visual impairments. They also had to confirm that they perceived color differences in the gingival tissue among the images presented.

A database was created to compile participants' age, gender, and esthetic ratings for the eight images (Figures 1 and 2). Questionnaires with more than one missing response were excluded. Of the 234 surveys initially collected, 200 valid responses remained after this criterion was applied.

The sample size required to detect a significant difference in mean scores between the reference image (A) and each modified image (B, C, and D) using a paired-samples *t*-test was calculated using the following formula:

$$n = \left(\frac{\left(z_{\frac{\alpha}{2}} + z_{\beta} \right) \sigma_d}{\Delta} \right)^2$$

Assuming a two-sided significance level of 5% ($\alpha = 0.05$; $z_{\alpha/2} = 1.96$), a statistical power of 80% ($1 - \beta = 0.80$; $z_{\beta} = 0.84$), a standard deviation of the differences of 2.5 ($\sigma_d \approx 2.5$), and a minimum detectable mean difference of 0.5 points ($\Delta = 0.5$), this normal approximation gave an estimated sample size of 196 participants. The standard deviation of the differences was estimated from a pilot sample of 30 participants (who were subsequently included in the final study sample). The largest of the six standard deviations of score differences was selected, based on comparisons between Images A and B, A and C, and A and D for both the female and male models.



Figure 2. Images of the male model presented to participants for rating on a 0–10 scale: (**A**) original; (**B**) L* increased by 3 units (lighter gingiva); (**C**) a* increased by 10 units (redder gingiva); (**D**) L* decreased by 9 units (darker gingiva).

Allowing for a 15% rate of nonresponse or invalid questionnaires, the adjusted sample size was calculated as follows:

$$n_{adjusted} = \frac{n}{1 - nonresponse\ rate}$$

This yielded an adjusted sample size of 231 participants (231 pairs of scores).

2.2. Images

Two models were selected, one female and one male, both of whom displayed a natural broad smile with more than 2–3 mm of visible gingival tissue, providing sufficient gingival exposure for assessment of gingival color [26]. This descriptive study criterion was not intended as a diagnosis of gummy smile or excessive gingival display. Both models had aligned, symmetrical natural teeth and excellent dental and gingival health (Figures 1 and 2). The male model was a 26-year-old Caucasian man, and the female model a 20-year-old Caucasian woman.

Standardized photographs of both models were taken by a professional photographer in the same studio, using T8 fluorescent tubes (TLD 865) to simulate daylight. A Nikon D7200 camera equipped with a 51-point Multi-CAM 3500DX II autofocus system, an Expeed 4 processor, and an ISO sensitivity range of 100–25,600 was used at a fixed distance.

The photographic protocol, based on recommendations for clinical photography [74], included a neutral gray background and a ring flash allowing a minimum aperture of f/16. The camera was positioned at the same height as the models, who held their heads straight. The photographs were taken at a distance of one meter and subsequently cropped.

Controlled modifications were applied to the CIELAB color coordinates of the images using Adobe Photoshop CS5 (update 12.0.4), ensuring that the changes remained perceptible to the human eye [71]. Before the main study, the perceptibility of these color modifications was verified in the previously described pilot sample of 30 participants, all of whom had normal Ishihara test results. This sample was also used for the sample size calculation and subsequently included in the final study sample. All 30 participants reported noticing gingival color differences among the broad-smile images of both the female and male models.

The CIELAB system is a color space in which color is expressed as Cartesian coordinates along three axes (L*, a*, and b*) [75]. The L* coordinate describes an object's lightness, ranging from black (0) to white (100). Changes in lightness are commonly used to assess the outcomes of tooth whitening [76]. The a* coordinate describes an object's position on an axis from red (positive) to green (negative), while the b* coordinate describes its position on an axis from yellow (positive) to blue (negative).

The original broad-smile images of the female and male models (Image A) were edited to modify gingival color and generate three additional versions of each (Images B, C, and D), yielding a total of eight images (Figures 1 and 2).

For the female model, gingival color was modified as follows: in Image B, L* was increased by 3 units to make the gingiva lighter; in Image C, a* was increased by 10 units to make the gingiva redder; and in Image D, b* was increased by 9 units to make the gingiva more yellowish. Similarly, for the male model, L* was increased by 3 units in Image B to make the gingiva lighter, and a* was increased by 10 units in Image C to make the gingiva redder. In Image D, L* was decreased by 9 units to make the gingiva darker.

The modifications evaluated were therefore (1) increased lightness (L*) in both models; (2) increased a* (redness) in both models; (3) increased b* (yellowness) in the female model (Image D); and (4) decreased lightness (L*) in the male model (Image D).

The four female images were presented simultaneously on a single sheet, arranged as shown in Figure 1, and participants were asked to score them. Several minutes later, a single sheet displaying the four male images, arranged as shown in Figure 2, was presented, and participants scored these images in the same way.

2.3. Statistical Analysis

Statistical analyses were performed using SPSS Statistics software, version 28.0. The variables examined were gender, age, and the ratings assigned to the eight images. Two-sided paired-samples *t*-tests were performed to compare the rating of the original image (A) with that of each modified image (B, C, and D). These analyses were repeated separately by evaluator gender and age group (26 years or younger, 27 to 59 years, and 60 years or older); differences between subgroups were described but not tested formally. Effect sizes were calculated as Cohen's *d* for paired samples (d_z), that is, the mean difference (Image A minus the modified image) divided by the standard deviation of the differences, so that positive values indicate lower ratings for the modified image. Effect sizes were interpreted according to Cohen's guidelines on the basis of their absolute values [77]: $|d| < 0.2$,

negligible; $0.2 \leq |d| < 0.5$, small; $0.5 \leq |d| < 0.8$, medium; and $|d| \geq 0.8$, large. Statistical significance was set at $p < 0.05$.

3. Results

The sample comprised 123 female (61.5%) and 77 male (38.5%) evaluators. Of these, 69 (34.5%) were 26 years or younger, 107 (53.5%) were between 27 and 59 years old, and 24 (12.0%) were 60 years or older.

3.1. Description of Scores Assigned to the Smiles

Table 1 presents the means, standard deviations, and coefficients of variation for the ratings assigned to each model's four smile images by the total sample ($n = 200$).

Table 1. Descriptive statistics of the smile scores for each model.

Model/Image	Mean	Standard Deviation	Coefficient of Variation (%)
Female model			
Image A	6.8	1.5	22.4
Image B	7.2	1.4	19.9
Image C	5.9	2.2	38.2
Image D	4.7	2.2	46.7
Male model			
Image A	7.3	1.5	21.0
Image B	7.2	1.7	23.5
Image C	4.8	2.1	44.8
Image D	5.1	2.1	40.9

For the female model, Image B (lighter than the original) received the highest mean score, at 7.2 points, followed by Image A (original), at 6.8 points. The lowest-rated images were Image C (redder than the original), at 5.9 points, and Image D (more yellowish than the original), at 4.7 points (Table 1).

For the male model, Image A (original) received the highest mean score, at 7.3 points, followed closely by Image B (lighter than the original), at 7.2 points. The lowest mean scores were assigned to Image D (darker than the original), at 5.1 points, and Image C (redder than the original), at 4.8 points (Table 1).

For both models, ratings for Images A and B had lower coefficients of variation than those for Images C and D, indicating less relative variability and therefore greater consensus among evaluators. Nevertheless, outliers were present in the ratings of Images A and B for both models. For the female model, there were 2 low outliers for Image A and 3 high and 10 low outliers (4 of them extreme) for Image B (Figure 3). For the male model, there were 2 low outliers each for Images A and B (Figure 4).

3.2. Effect of Gingival Color Modifications on Esthetic Ratings ($n = 200$)

Table 2 presents the test statistics, effect sizes, and associated p-values for comparisons of the mean score for the original image (Image A) with those for each of the three modified images, for both models in the total sample.

From an esthetic perspective:

(1) An increase in lightness (3 units of L*) was rated positively only in the female model ($p = 0.002$), with a small effect size ($d = -0.2$); (2) an increase in a* (10 units) was rated negatively in both models, with a small effect size in the female model ($d = 0.3$) and a large effect size in the male model ($d = 0.9$); (3) an increase in b* (9 units) was rated negatively in the female model, with a large effect size ($d = 0.9$); and (4) a decrease in

lightness (9 units of L*) was rated negatively in the male model, with a large effect size ($d = 0.9$).

In the female model, the increase in b* was the only change with a large effect on esthetic evaluation: more yellowish gingiva was perceived negatively.

In the male model, both the increase in a* and the decrease in L* had large negative effects on the esthetic evaluation of the smile. Notably, the increase in a* produced only a small effect in the female model, compared with the large effect observed in the male model.

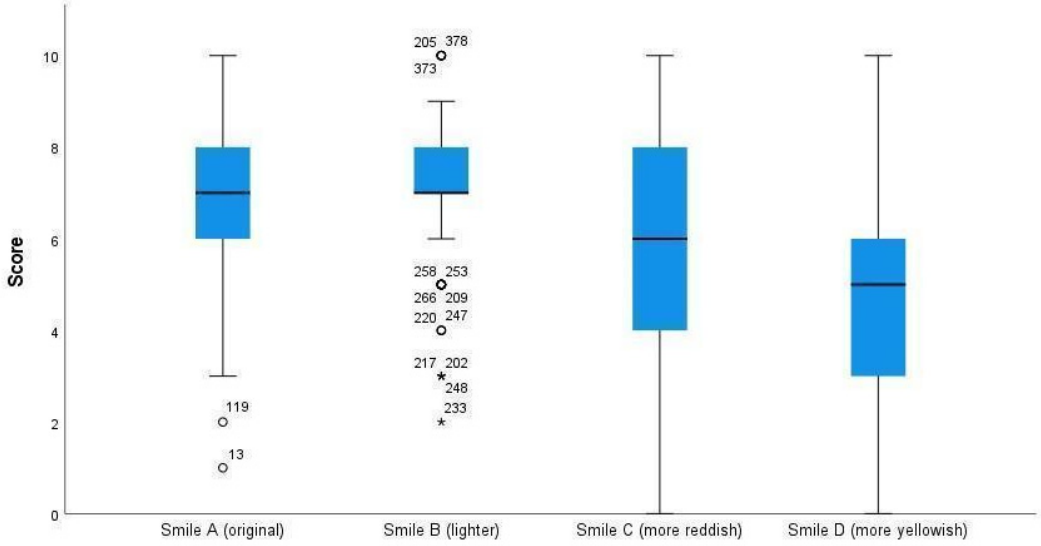


Figure 3. Boxplots of esthetic ratings (0–10) for Images A–D of the female model ($n = 200$). Boxes show the interquartile range and median; whiskers extend to the most extreme values within 1.5 times the interquartile range; circles and asterisks indicate outliers and extreme values, respectively, labeled with case numbers (SPSS default settings).

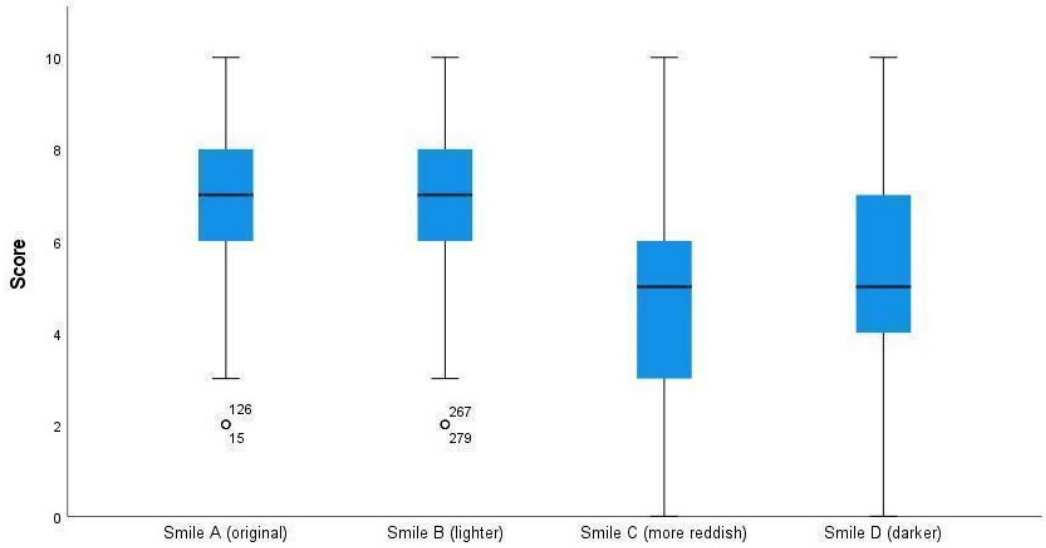


Figure 4. Boxplots of esthetic ratings (0–10) for Images A–D of the male model ($n = 200$). Boxes show the interquartile range and median; whiskers extend to the most extreme values within 1.5 times the interquartile range; circles indicate outliers, labeled with case numbers (SPSS default settings).

Table 2. Comparisons between the original image (A) and each modified image for both models ($n = 200$).

Model/Comparison	Mean Scores (A vs. Modified)	*t*	Cohen's *d*	*p*
Female model				
Image A–Image B (lighter)	6.8 vs. 7.2	−3.1	−0.2	0.002
Image A–Image C (more reddish)	6.8 vs. 5.9	4.7	0.3	<0.001
Image A–Image D (more yellowish)	6.8 vs. 4.7	12.4	0.9	<0.001
Male model				
Image A–Image B (lighter)	7.3 vs. 7.2	0.6	0.0	0.565
Image A–Image C (more reddish)	7.3 vs. 4.8	13.2	0.9	<0.001
Image A–Image D (darker)	7.3 vs. 5.1	12.8	0.9	<0.001

3.3. Effect of Gingival Color Modifications on Esthetic Ratings by Evaluator Gender

Table 3 presents the results of comparisons of the mean score for the original image with those for each of the three modified images, by evaluator gender.

Table 3. Test statistics, effect sizes, and *p*-values for the comparisons between the scores for the original image and each of the other three images, by smile model and evaluator gender.

Evaluator Group/Model/Comparison	Mean Scores (A vs. Modified)	*t*	Cohen's *d*	*p*
Female evaluators ($n = 123$)				
Female model				
Image A–Image B (lighter)	6.7 vs. 7.2	−1.5	−0.1	0.145
Image A–Image C (more reddish)	6.7 vs. 5.6	5.4	0.5	<0.001
Image A–Image D (more yellowish)	6.7 vs. 4.5	10.9	1.0	<0.001
Male model				
Image A–Image B (lighter)	7.4 vs. 7.0	2.0	0.2	0.052
Image A–Image C (more reddish)	7.4 vs. 4.5	11.8	1.1	<0.001
Image A–Image D (darker)	7.4 vs. 5.0	10.5	0.9	<0.001
Male evaluators ($n = 77$)				
Female model				
Image A–Image B (lighter)	6.8 vs. 7.2	−3.0	−0.3	0.003
Image A–Image C (more reddish)	6.8 vs. 6.2	0.9	0.1	0.378
Image A–Image D (more yellowish)	6.8 vs. 4.9	6.3	0.7	<0.001
Male model				
Image A–Image B (lighter)	7.0 vs. 7.3	−1.4	−0.2	0.168
Image A–Image C (more reddish)	7.0 vs. 5.1	6.5	0.7	<0.001
Image A–Image D (darker)	7.0 vs. 5.1	7.3	0.8	<0.001

The subgroup results were descriptive. The increase in a* showed larger within-group effect sizes among female than male evaluators for both models (Cohen's d = 0.5 and 1.1 for the female and male models, respectively, among female evaluators vs. 0.1 and 0.7 among male evaluators), with the largest effect observed in the male model. Among male evaluators, the effect of this change on the female model was not significant ($p = 0.378$). The increase in b* showed a larger negative effect size among female than male evaluators for the female model (d = 1.0 vs. 0.7), and the decrease in L* showed a slightly larger negative effect size among female than male evaluators for the male model (d = 0.9 vs. 0.8). Overall, several unfavorable modifications showed larger effect sizes among female evaluators; however, no direct interaction test between evaluator gender and image condition was performed. By contrast, the lighter image was rated significantly higher than the original only by male evaluators, and only for the female model ($p = 0.003$).

3.4. Effect of Gingival Color Modifications on Esthetic Ratings by Evaluator Age Group

Table 4 presents the test statistics, effect sizes, and associated *p*-values for comparisons of the mean score for the original image with those for each of the three modified images within each age group.

Table 4. Results of the comparisons between the original image and each of the other three images, by smile model and evaluator age group.

Evaluator Group/Model/Comparison	Mean Scores (A vs. Modified)	*t*	Cohen's *d*	*p*
Evaluators aged 26 or younger ($n = 69$)				
Female model				
Image A–Image B (lighter)	6.5 vs. 7.0	−2.4	−0.3	0.017
Image A–Image C (more reddish)	6.5 vs. 6.0	1.2	0.1	0.244
Image A–Image D (more yellowish)	6.5 vs. 4.0	8.1	1.0	<0.001
Male model				
Image A–Image B (lighter)	7.1 vs. 6.8	1.0	0.1	0.310
Image A–Image C (more reddish)	7.1 vs. 4.3	9.5	1.1	<0.001
Image A–Image D (darker)	7.1 vs. 4.6	8.1	1.0	<0.001
Evaluators aged 27 to 59 ($n = 107$)				
Female model				
Image A–Image B (lighter)	7.1 vs. 7.3	−1.0	−0.1	0.303
Image A–Image C (more reddish)	7.1 vs. 5.7	5.7	0.6	<0.001
Image A–Image D (more yellowish)	7.1 vs. 4.9	9.7	0.9	<0.001
Male model				
Image A–Image B (lighter)	7.4 vs. 7.1	1.1	0.1	0.282
Image A–Image C (more reddish)	7.4 vs. 4.9	9.5	0.9	<0.001
Image A–Image D (darker)	7.4 vs. 5.1	10.3	1.0	<0.001
Evaluators aged 60 or older ($n = 24$)				
Female model				
Image A–Image B (lighter)	6.2 vs. 7.4	−2.2	−0.4	0.039
Image A–Image C (more reddish)	6.2 vs. 5.8	0.6	0.1	0.566
Image A–Image D (more yellowish)	6.2 vs. 5.4	1.9	0.4	0.071
Male model				
Image A–Image B (lighter)	6.7 vs. 7.8	−3.0	−0.6	0.006
Image A–Image C (more reddish)	6.7 vs. 5.3	2.5	0.5	0.020
Image A–Image D (darker)	6.7 vs. 6.0	1.8	0.4	0.092

Descriptively, the increase in a* had a large negative effect on ratings of the male model among evaluators aged 26 years or younger and those aged 27 to 59 years (Cohen's d = 1.1 and 0.9, respectively) and a medium effect among those aged 60 years or older (d = 0.5). For the female model, this increase had a significant, medium effect only among evaluators aged 27 to 59 years (d = 0.6). The increase in b* had a large negative effect on ratings of the female model among evaluators aged 26 years or younger and those aged 27 to 59 years (d = 1.0 and 0.9, respectively), whereas among those aged 60 years or older the effect was small and nonsignificant (d = 0.4, $p = 0.071$). Similarly, the decrease in L* had a large negative effect on ratings of the male model among evaluators aged 26 years or younger and those aged 27 to 59 years (d = 1.0 in both cases), but only a small, nonsignificant effect among those aged 60 years or older (d = 0.4, $p = 0.092$). Conversely, evaluators aged 60 years or older showed the strongest within-group preference for the lighter images, rating them significantly higher than the originals for both models (d = −0.4 and −0.6). These subgroup patterns should not be interpreted as statistically established differences between age groups because no direct interaction tests were performed.

4. Discussion

Scholarly interest in gingival esthetics has increased markedly in recent years. Research has focused on aspects such as the characterization of healthy gingival color [25,46,78–81] and color changes during inflammation [49,50]. Other key areas of study include the development and evaluation of ceramic materials [82] and gingival composite resins [83,84], and the use of gingiva-colored resins in removable prostheses that combine gingival and dental components [85,86].

Previous studies have shown that laypersons rate digitally altered smiles with altered gingival characteristics less favorably [87,88]. Gingiva-specific perceptibility and acceptability thresholds [71] and esthetic preferences for gingival–dental color combinations [72] provide additional relevant context. The present study addresses a narrower question: the effect of controlled modifications of individual CIELAB coordinates on the esthetic perception of two broad-smile photographs. The primary paired comparisons showed that several gingival color modifications significantly changed esthetic ratings. In the female model, the most notable effect was associated with the increase in b* (more yellowish gingiva), whereas in the male model, the greatest effects were associated with the increase in a* (redder gingiva) and the decrease in L* (darker gingiva). Descriptive subgroup analyses suggested different response patterns by evaluator gender and age, but between-group differences were not formally tested and should not be interpreted as inferential findings.

As noted above, extensive research on teeth has shown that greater lightness is associated with greater esthetic appeal and more favorable psychosocial attributions. However, gingival color has been less extensively explored from an esthetic standpoint. This study should therefore be regarded as exploratory and as providing stimulus-specific data for future research on esthetic perceptions of gingival color. Only one female and one male photographic model were used, so model identity is inseparable from sex, age, baseline gingival color, tooth appearance, lip characteristics, and other individual features. The image composition also differed between models, with mandibular tooth display visible in the female series but not to the same extent in the male series. Consequently, differences between the two photographic series cannot be generalized as differences between female and male smiles. Because both models' smiles were natural rather than digitally standardized, individual smile features, such as tooth color and size, tooth display, lip size and position, and the presence of upper-lip hair, may have influenced the scores assigned to each image. Smile perception is holistic, involving a complex interplay of multiple factors, and gingival color is only one component of this multifaceted visual context [64].

The study of esthetics has inherent limitations, as esthetic judgments are highly subjective and vary between individuals, within the same observer over time, and across cultures. Cultural background shapes esthetic standards: for example, when evaluating the same digitally modified smiles, American laypersons were more tolerant than Iranian laypersons of variations in features such as gingival display and buccal corridors [89]. Such cultural differences suggest that our results might differ in other cultural contexts. Perceptions of smile esthetics have also been found to differ between dental professionals and laypersons [57] and by educational level [90], indicating that education and background affect these judgments. Future research should therefore consider larger samples that account for these potential influences.

In addition, the survey format introduces variables such as evaluators' mood at the time of data collection, their interest in the subject (gingival esthetics), and individual differences in color discrimination ability. Personality traits are another relevant factor, particularly the Openness factor, which has been linked to sensitivity to art and esthetics [51].

The study also has methodological limitations. Although the color modifications were experimentally controlled within evaluators, the associations with evaluator gender and age

are observational and cannot be interpreted as causal. The generalizability of the findings is limited by the composition of the sample and by the nonprobabilistic sampling method, which may have introduced selection bias. The 30-participant pilot was subsequently included in the final study sample, which should be considered when interpreting the sample-size planning. In addition, participants evaluated printed photographs in different regions, and ambient illumination and viewing distance were not standardized across all assessment settings; printer, paper, and color-management characteristics were not documented in the protocol. These factors may have introduced variability in the color stimuli perceived by participants. The Ishihara test primarily screens for red–green color vision deficiencies and does not provide a comprehensive assessment of all color vision defects; its field administration across multiple sites is an additional methodological consideration.

Several aspects of the design and analysis also warrant caution. The female images were always presented before the male images, and the four images of each model were displayed together in a fixed arrangement, so order, position, anchoring, contrast, and direct-comparison effects cannot be ruled out. Future studies should randomize both the order of the photographic series and the position of images within each series. Because the fourth modification differed between the models (increased b* in the female model and decreased L* in the male model), the effects of yellowing and darkening are each confounded with model identity and cannot be compared directly. The subgroup analyses involved multiple comparisons without correction, and the oldest group included only 24 evaluators, which limits precision; nonsignificant results in this group should therefore not be interpreted as evidence of tolerance. Finally, evaluators were recruited by 23 interviewers in different regions, and possible clustering by interviewer or region was not assessed.

Direct comparison with previous research is limited by methodological differences. Gingiva-specific perceptibility and acceptability thresholds [71] and studies of gingival–dental shade-combination preferences [72] address outcomes that differ from attractiveness ratings of digitally modified broad-smile photographs. Our results can also be related to the assessment of soft tissue around implant-supported restorations, in which gingival color is considered one of the key components of pink esthetics [18].

Our results are also consistent with previous research showing that laypersons perceive pigmented gingiva, which makes the smile appear darker, as less esthetically pleasing [87,88]. Inflammatory conditions such as gingivitis and periodontitis are associated with redder gingival hues [50,91,92], which, in light of our findings, may also reduce the esthetic appeal of the smile.

Physiological gingival pigmentation is a normal variation, but it can be an esthetic concern for some individuals, and laypersons readily perceive gingival color changes caused by pigmentation or inflammation and rate them as unattractive [87,93]. Smoking is a recognized cause of gingival pigmentation, as components of tobacco smoke such as nicotine and benzopyrene stimulate melanin production in gingival tissue [93]. It would therefore be worth investigating whether smokers are more tolerant of reduced gingival lightness.

A potential source of bias in our study is the shared ethnic background of the models and the surveyed population, all of whom were Caucasian. The reported prevalence of gingival pigmentation varies widely, from 0% to 89%, depending on ethnic background, geographic location, and smoking habits [93], and gingival pigmentation has been associated with skin color [68,94]. This variation probably reflects genetic and ethnic factors as well as differences in smoking habits and study methods.

Future studies should examine whether darker gingiva is perceived as more esthetically acceptable in populations with naturally pigmented gingiva than in populations in which lighter gingiva predominates [67–70]. Future research should also standardize the esthetic

features of the smile models to control for variability between the male and female models, although this would sacrifice some of the authenticity of natural smiles.

Esthetic perceptions of broad smiles with gingival color modifications may also vary by individuals' age, educational level, social status, and ethnic origin. While these factors are known to influence perceptions of dental esthetics [55,90,95–97], their effect on perceptions of gingival color has received little attention and warrants further investigation. The present study collected data across a large part of the country (10 of the 17 autonomous communities), with a sample size calculated for the main paired comparisons.

Given the scarcity of studies specifically addressing gingival color, we compared our findings with those of studies on tooth color. However, these studies typically use different methodologies, often assessing esthetic perception after tooth whitening rather than after digital modification of color coordinates, as in this study. Some have examined social perceptions in relation to tooth color [9]; for example, faces with digitally whitened teeth have been judged more favorably than those with natural or darkened teeth [10], although not all studies have found an effect of tooth color on attractiveness ratings [98]. These findings, together with those of the present study, highlight the importance of lightness in the esthetic perception of a smile. They also underline the need to establish esthetic acceptability thresholds for changes in gingival color, building on the perceptibility and acceptability thresholds already reported for gingiva [71].

Dunn et al. [65], who asked 297 participants to rank standardized photographs of eight male and eight female smiles, likewise identified tooth color as an important determinant of perceived dental attractiveness. Sabherwal et al. [66] modified facial skin color and tooth shade value in a smile photograph and found that men gave lower attractiveness ratings than women for most tooth shade values and that ratings increased with evaluator age. These studies provide useful demographic context, but direct comparison with the present subgroup patterns should be made cautiously because the current analyses did not formally test interactions between image condition and evaluator gender or age.

In this study, the color changes were applied uniformly across the entire visible gingival area. Future research should examine the effects of such changes in different anatomical regions of gingival tissue, such as the papillae and the middle of the attached gingiva, given that natural gingival color varies between these regions [99]. Furthermore, technical limitations of the software prevented the same set of color coordinate modifications from being applied to both models. In addition, the edited images were not compared with the actual color coordinates of inflamed, reddened gingiva (Image C) or of gingiva with melanin hyperpigmentation (Image D in the male model). Although gingival color has been measured in health and in response to periodontal treatment [50], no universally accepted coordinate ranges have been established for these conditions, so these images should be regarded as approximations.

The analysis of increases in lightness and in a* (redness) in both models was based on the expectation that these coordinates would have the greatest influence. Tooth color is an important determinant of satisfaction with dental appearance [97], but the esthetic effect of gingival lightness has received little attention. Clinical assessments of gingival inflammation include redness [91,92,100,101], but these studies do not assess esthetic preferences.

Darkening was applied to the male model and increased yellowness to the female model. Men and women differ in some aspects of color perception and color naming [102–105], but both female and male evaluators rated both models; as noted above, this design means that the effects of darkening and yellowing are each confounded with model identity. Clinically, changes in gingival color have been associated with dental plaque-induced gingival inflammation [106] and with the oral adverse effects of certain medications, which include gingival discoloration and enlargement [107–110].

To promote consistency, both models had similar characteristics, including aligned and leveled teeth, healthy gingiva, and a thin gingival biotype. The influence of gingival biotype on color perception should also be assessed, as gingival thickness varies with age, gender, and arch location [111], and thinner tissue is more translucent, which may affect its color.

The study involved training 23 interviewers, each responsible for collecting at least 10 surveys. This approach ensured that each participant received clear instructions and that any questions could be answered promptly, while also enabling the study to achieve a substantial sample size. The interviewers collected data in 10 autonomous communities to broaden the geographic coverage of the sample.

Although this study yielded statistically significant results, future research could benefit from longitudinal designs with larger samples and consideration of variables beyond age and gender that may influence the esthetic perception of gingival color in broad smiles, such as culture, socioeconomic status, and the ethnic background of the models.

5. Conclusions

In the two broad-smile photographs evaluated under the study conditions, gingival color modifications were associated with differences in esthetic ratings. Redder gingiva was rated less favorably in both models, whereas more yellowish gingiva in the female model and darker gingiva in the male model also received lower ratings. Increased lightness produced a small favorable effect in the female model and no significant effect in the male model.

Descriptive subgroup analyses showed different patterns of response by evaluator gender and age; however, because between-group interactions were not formally tested, these observations should not be interpreted as statistically established demographic effects. The findings should therefore be restricted to the two photographic stimuli evaluated and regarded as exploratory.

Author Contributions: Conceptualization, C.G.-P.; methodology, M.A.S.D.M.; investigation, M.A.S.D.M.; formal analysis, A.M.M.C.; data curation, A.M.M.C.; visualization, A.M.M.C.; writing—original draft preparation, M.A.S.D.M.; writing—review and editing, A.C.A.; supervision, C.G.-P.; project administration, C.G.-P. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the University of Salamanca (protocol code 1102, date of approval 17 January 2024).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study. Written informed consent for the publication of their photographs was obtained from both the female and male models.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Čalušić Šarac, M.; Jakovac, M. The influence of social network content on the perception of smiles—A randomized controlled trial. *Dent. J.* **2022**, *10*, 168. [CrossRef]
2. Baik, K.M.; Anbar, G.; Alshaikh, A.; Banjar, A. Effect of social media on patient's perception of dental aesthetics in Saudi Arabia. *Int. J. Dent.* **2022**, *2022*, 4794497. [CrossRef]
3. Graziano, M.S.A. The origin of smiling, laughing, and crying: The defensive mimic theory. *Evol. Hum. Sci.* **2022**, *4*, e10. [CrossRef]
4. Heerey, E.A.; Gilder, T.S.E. The subjective value of a smile alters social behaviour. *PLoS ONE* **2019**, *14*, e0225284. [CrossRef]
5. Batwa, W. The influence of the smile on the perceived facial type esthetics. *Biomed. Res. Int.* **2018**, *2018*, 3562916. [CrossRef]

6. Gómez-Polo, C.; Montero, J.; Santos Marino, J.; Galindo, M.P.; Vicente, M.P. Application of the Social Appeal Scale to a selected Spanish population. *Int. J. Prosthodont.* **2016**, *29*, 59–62. [CrossRef]
7. Newton, J.T.; Prabhu, N.; Robinson, P.G. The impact of dental appearance on the appraisal of personal characteristics. *Int. J. Prosthodont.* **2003**, *16*, 429–434.
8. Jeremiah, H.G.; Bister, D.; Newton, J.T. Social perceptions of adults wearing orthodontic appliances: A cross-sectional study. *Eur. J. Orthod.* **2011**, *33*, 476–482. [CrossRef]
9. Montero, J.; Gómez-Polo, C.; Santos, J.A.; Portillo, M.; Lorenzo, M.C.; Albaladejo, A. Contributions of dental colour to the physical attractiveness stereotype. *J. Oral Rehabil.* **2014**, *41*, 768–782. [CrossRef]
10. Newton, J.T.; Subramanian, S.S.; Westland, S.; Gupta, A.K.; Luo, W.; Joiner, A. The impact of tooth colour on the perceptions of age and social judgements. *J. Dent.* **2021**, *112*, 103771. [CrossRef]
11. Eli, I.; Bar-Tal, Y.; Kostovetzki, I. At first glance: Social meanings of dental appearance. *J. Public Health Dent.* **2001**, *61*, 150–154. [CrossRef]
12. Cunningham, S.J. The psychology of facial appearance. *Dent. Update* **1999**, *26*, 438–443. [CrossRef]
13. Feingold, A. Good-looking people are not what we think. *Psychol. Bull.* **1992**, *111*, 304–341. [CrossRef]
14. Eagly, A.H.; Ashmore, R.D.; Makhijani, M.G.; Longo, L.C. What is beautiful is good, but...: A meta-analytic review of research on the physical attractiveness stereotype. *Psychol. Bull.* **1991**, *110*, 109–128. [CrossRef]
15. Davis, L.G.; Ashworth, P.D.; Spriggs, L.S. Psychological effects of aesthetic dental treatment. *J. Dent.* **1998**, *26*, 547–554. [CrossRef]
16. Van der Geld, P.; Oosterveld, P.; Van Heck, G.; Kuijpers-Jagtman, A.M. Smile attractiveness. Self-perception and influence on personality. *Angle Orthod.* **2007**, *77*, 759–765.
17. Duarte, S., Jr.; Schnider, P.; Lorezon, A.P. The importance of width/length ratios of maxillary anterior permanent teeth in esthetic rehabilitation. *Eur. J. Esthet. Dent.* **2008**, *3*, 224–234.
18. Fürhauser, R.; Florescu, D.; Benesch, T.; Haas, R.; Mailath, G.; Watzek, G. Evaluation of soft tissue around single-tooth implant crowns: The pink esthetic score. *Clin. Oral Implants Res.* **2005**, *16*, 639–644. [CrossRef]
19. Samorodnitzky-Naveh, G.R.; Geiger, S.B.; Levin, L. Patients' satisfaction with dental esthetics. *J. Am. Dent. Assoc.* **2007**, *138*, 805–808. [CrossRef]
20. Lajnert, V.; Pavičić, D.K.; Gržić, R.; Kovač, Z.; Pahor, D.; Kuis, D.; Simonić-Kocijan, S.; Antonić, R.; Bakarčić, D. Influences of age and maxillary anterior teeth status on patient's satisfaction with dental appearance and tooth colour. *Gerodontology* **2012**, *29*, e674–e679. [CrossRef]
21. Kershaw, S.; Newton, J.T.; Williams, D.M. The influence of tooth colour on the perceptions of personal characteristics among female dental patients: Comparisons of unmodified, decayed and "whitened" teeth. *Br. Dent. J.* **2008**, *204*, E9. [CrossRef]
22. Shaw, W.C.; Rees, G.; Dawe, M.; Charles, C.R. The influence of dentofacial appearance on the social attractiveness of young adults. *Am. J. Orthod.* **1985**, *87*, 21–26. [CrossRef]
23. Bayindir, F.; Bayindir, Y.Z.; Gozalo-Diaz, D.J.; Wee, A.G. Coverage error of gingival shade guide systems in measuring color of attached anterior gingiva. *J. Prosthet. Dent.* **2009**, *101*, 46–53. [CrossRef]
24. Ito, M.; Marx, D.B.; Cheng, A.C.; Wee, A.G. Proposed shade guide for attached gingiva—A pilot study. *J. Prosthodont.* **2015**, *24*, 182–187. [CrossRef]
25. Gómez-Polo, C.; Montero, J.; Gómez-Polo, M.; Martín Casado, A.M. Clinical study on natural gingival color. *Odontology* **2019**, *107*, 80–89. [CrossRef]
26. Brizuela, M.; Ines, D. Excessive Gingival Display. In *StatPearls*; StatPearls Publishing: Treasure Island, FL, USA, 2024.
27. Polo, M. Botulinum toxin and smile design. *Dent. Clin. N. Am.* **2022**, *66*, 419–429. [CrossRef]
28. Horn, R.O.R.; Elias, C.N.; Joly, J.C. A lip repositioning technique using polyester threads for gummy smile treatment. *Int. J. Dent.* **2022**, *2022*, 3972150. [CrossRef]
29. Dym, H.; Pierre, R., II. Diagnosis and treatment approaches to a "gummy smile". *Dent. Clin. N. Am.* **2020**, *64*, 341–349. [CrossRef]
30. Alammar, A.M.; Heshmeh, O.A. Lip repositioning with a myotomy of the elevator muscles for the management of a gummy smile. *Dent. Med. Probl.* **2018**, *55*, 241–246. [CrossRef]
31. Tatakis, D.N.; Silva, C.O. Contemporary treatment techniques for excessive gingival display caused by altered passive eruption or lip hypermobility. *J. Dent.* **2023**, *138*, 104711. [CrossRef]
32. Monnet-Corti, V.; Antezack, A.; Pignoly, M. Comment parfaire l'esthétique du sourire: Toujours en rose! [Perfecting smile esthetics: Keep it pink!]. *Orthod. Fr.* **2018**, *89*, 71–80. [CrossRef]
33. Khojasteh, A.; Mohaghegh, S. Orthognathic surgery for management of gummy smile. *Dent. Clin. N. Am.* **2022**, *66*, 385–398. [CrossRef]
34. Rojo-Sanchis, C.; Montiel-Company, J.M.; Tarazona-Álvarez, B.; Haas-Junior, O.L.; Peiró-Guijarro, M.A.; Paredes-Gallardo, V.; Guijarro-Martínez, R. Non-surgical management of the gingival smile with botulinum toxin A—A systematic review and meta-analysis. *J. Clin. Med.* **2023**, *12*, 1433. [CrossRef]

35. Fatani, B. An approach for gummy smile treatment using botulinum toxin A: A narrative review of the literature. *Cureus* **2023**, *15*, e34032. [CrossRef]
36. Duruel, O.; Ataman-Duruel, E.T.; Berker, E.; Tözüm, T.F. Treatment of various types of gummy smile with botulinum toxin-A. *J. Craniofac. Surg.* **2019**, *30*, 876–878. [CrossRef]
37. Adel, N. A standardized technique for gummy smile treatment using repeated botulinum toxins: A 1-year follow-up study. *Plast. Reconstr. Surg. Glob. Open* **2022**, *10*, e4281. [CrossRef]
38. Al-Fouzan, A.F.; Mokeem, L.S.; Al-Saqat, R.T.; Alfalah, M.A.; Alharbi, M.A.; Al-Samary, A.E. Botulinum toxin for the treatment of gummy smile. *J. Contemp. Dent. Pract.* **2017**, *18*, 474–478. [CrossRef]
39. Yagiz, O.; Yavuz, G.Y.; Keskinruzgar, A.; Acibadem, E. Analyses of YouTube videos on Botox treatment of gummy smile. *J. Craniofac. Surg.* **2022**, *33*, e433–e438. [CrossRef]
40. Capodiferro, S.; Kazakova, R. Laser-assisted gingivectomy to treat gummy smile. *Dent. Clin. N. Am.* **2022**, *66*, 399–417. [CrossRef]
41. Mossaad, A.M.; Abdelrahman, M.A.; Kotb, A.M.; Alolayan, A.B.; Elsayed, S.A. Gummy smile management using diode laser gingivectomy versus botulinum toxin injection—A prospective study. *Ann. Maxillofac. Surg.* **2021**, *11*, 70–74. [CrossRef]
42. Borham, E.; Abuel-Ela, H.A.; Mohamed, I.S.; Fouad, Y.A. Treatment of excessive gingival display using conventional esthetic crown lengthening versus computer-guided esthetic crown lengthening: A randomized clinical trial. *BMC Oral Health* **2024**, *24*, 317. [CrossRef]
43. Nourah, D. Digital smile makeover: A multidisciplinary team approach. *Eur. J. Dent.* **2023**, *17*, 1349–1355. [CrossRef]
44. Gomes, G.H.; Corbellini, A.O.; Rotta, W.G.; Martos, J.; Boeira, G.F. Interdisciplinary esthetic approach in clinical dental rehabilitation. *J. Conserv. Dent.* **2021**, *24*, 519–523. [CrossRef]
45. Koppolu, P.; Almutairi, H.; Al Yousef, S.; Ansary, N.; Noushad, M.; Vishal, M.B.; Swapna, L.A.; Alsuwayyigh, N.; Albalawi, M.; Shrivastava, D.; et al. Relationship of skin complexion with gingival tissue color and hyperpigmentation: A multi-ethnic comparative study. *BMC Oral Health* **2024**, *24*, 451. [CrossRef]
46. Naranjo, M.J.; Gómez-Polo, M.; Gómez-Polo, C.; Celemin-Viñuela, A. Study of attached gingiva space color according to gender and age in Caucasian population. *J. Esthet. Restor. Dent.* **2023**, *35*, 834–841. [CrossRef]
47. Verma, J.; Ahuja, A.; Ahuja, V.; Thosar, N.R. Reconnoitering the association of gingival melanin pigmentation with skin color, age, and sex in pre-school children of Hazaribag: A cross-sectional study. *Cureus* **2022**, *14*, e30699. [CrossRef]
48. Gajjar, S.; Kaur, H.; Girdhar, G.; Kaur, A.; Patel, C.; Mehta, R.; Bhakkand, S.; Hirani, T.; Joshi, S.; Irfan, M.; et al. Identifying gingival pigmentation patterns and skin color and its co-relation with serum ferritin levels in thalassemic patients. *Cureus* **2022**, *14*, e28015. [CrossRef]
49. Wilson, T.G.; Harrel, S.K.; Nunn, M.E.; Francis, B.; Webb, K. The relationship between the presence of tooth-borne subgingival deposits and inflammation found with a dental endoscope. *J. Periodontol.* **2008**, *79*, 2029–2035. [CrossRef]
50. Mayer, Y.; Ginesin, O.; Machtei, E.E. Photometric CIELAB analysis of the gingiva: A novel approach to assess response to periodontal therapy. *J. Periodontol.* **2017**, *88*, 854–859. [CrossRef]
51. Montero, J.; Gómez-Polo, C.; Rosel, E.; Barrios, R.; Albaladejo, A.; López-Valverde, A. The role of personality traits in self-rated oral health and preferences for different types of flawed smiles. *J. Oral Rehabil.* **2016**, *43*, 39–50. [CrossRef]
52. Joiner, A.; Luo, W. Tooth colour and whiteness: A review. *J. Dent.* **2017**, *67S*, S3–S10. [CrossRef]
53. Estay, J.; Angel, P.; Bersezio, C.; Tonetto, M.; Jorquera, G.; Peña, M.; Fernández, E. The change of teeth color, whiteness variations and its psychosocial and self-perception effects when using low vs. high concentration bleaching gels: A one-year follow-up. *BMC Oral Health* **2020**, *20*, 255. [CrossRef]
54. Vallittu, P.K.; Vallittu, A.S.J.; Lassila, V.P. Dental aesthetics—A survey of attitudes in different groups of patients. *J. Dent.* **1996**, *24*, 335–338. [CrossRef]
55. Ajayi, D.M.; Gbadebo, S.O.; Adebayo, G.E. Perception about tooth colour and appearance among patients seen in a tertiary hospital, South-West, Nigeria. *Pan Afr. Med. J.* **2021**, *38*, 38. [CrossRef]
56. Allen, E.P. Use of mucogingival surgical procedures to enhance esthetics. *Dent. Clin. N. Am.* **1988**, *32*, 307–330. [CrossRef]
57. Negruțiu, B.M.; Moldovan, A.F.; Staniș, C.E.; Pusta, C.T.J.; Moca, A.E.; Vaida, L.L.; Romanec, C.; Luchian, I.; Zetu, I.N.; Todor, B.I. The influence of gingival exposure on smile attractiveness as perceived by dentists and laypersons. *Medicina* **2022**, *58*, 1265. [CrossRef]
58. Silberberg, N.; Goldstein, M.; Smidt, A. Excessive gingival display: Etiology, diagnosis, and treatment modalities. *Quintessence Int.* **2009**, *40*, 809–818.
59. Peck, S.; Peck, L.; Kataja, M. The gingival smile line. *Angle Orthod.* **1992**, *62*, 91–100.
60. Tjan, A.H.; Miller, G.D.; The, J.G. Some esthetic factors in a smile. *J. Prosthet. Dent.* **1984**, *51*, 24–28. [CrossRef]
61. Çetin, M.B.; Sezgin, Y.; Akıncı, S.; Bakırarar, B. Evaluating the impacts of some etiologically relevant factors on excessive gingival display. *Int. J. Periodontics Restor. Dent.* **2021**, *41*, e73–e80. [CrossRef]
62. Tatakis, D.N.; Paramitha, V.; Lu, W.E.; Guo, X. Upper lip characteristics and associated excessive gingival display etiologies in adults: Race and sex differences. *J. Periodontol.* **2024**, *95*, 74–83. [CrossRef]

63. Chetan, P.; Tandon, P.; Singh, G.K.; Nagar, A.; Prasad, V.; Chugh, V.K. Dynamics of a smile in different age groups. *Angle Orthod.* **2013**, *83*, 90–96. [CrossRef]
64. Gómez-Polo, C.; Sánchez de Martín, M.A.; Curto, A.; Montero, J.; Martín Casado, A.M. Validation of a new questionnaire for assessing the psychosocial impact of gingival aesthetics (PIGAQ). *J. Clin. Periodontol.* **2025**, *52*, 399–407. [CrossRef]
65. Dunn, W.J.; Murchison, D.F.; Broome, J.C. Esthetics: Patients' perceptions of dental attractiveness. *J. Prosthodont.* **1996**, *5*, 166–171. [CrossRef]
66. Sabherwal, R.S.; Gonzalez, J.; Naini, F.B. Assessing the influence of skin color and tooth shade value on perceived smile attractiveness. *J. Am. Dent. Assoc.* **2009**, *140*, 696–705. [CrossRef]
67. Masilana, A.; Khammissa, R.A.G.; Lemmer, J.; Feller, L. Physiological oral melanin pigmentation in a South African sample: A clinical study. *J. Investig. Clin. Dent.* **2017**, *8*, e12258. [CrossRef]
68. Ponnaiyan, D.; Jegadeesan, V.; Perumal, G.; Anusha, A. Correlating skin color with gingival pigmentation patterns in South Indians—A cross-sectional study. *Oral Health Dent. Manag.* **2014**, *13*, 132–136.
69. Longo, B.C.; Rocha, T.T.C.; Santin, G.C.; Tatakis, D.N.; Silva, C.O. Gingival pigmentation: Concurrent assessment of distribution, intensity, and extent in a black population. *J. Esthet. Restor. Dent.* **2022**, *34*, 897–906. [CrossRef]
70. Gorsky, M.; Buchner, A.; Fundoianu-Dayan, D.; Aviv, I. Physiologic pigmentation of the gingiva in Israeli Jews of different ethnic origin. *Oral Surg. Oral Med. Oral Pathol.* **1984**, *58*, 506–509. [CrossRef]
71. Pérez, M.M.; Carrillo-Perez, F.; Tejada-Casado, M.; Ruiz-López, J.; Benavides-Reyes, C.; Herrera, L.J. CIEDE2000 lightness, chroma and hue human gingiva thresholds. *J. Dent.* **2022**, *124*, 104213. [CrossRef]
72. Gómez Polo, C.; Martín Casado, A.M. Analysis of aesthetic preferences regarding gingival–dental color combinations. *J. Esthet. Restor. Dent.* **2025**, *37*, 2060–2071. [CrossRef]
73. Birch, J. Identification of red–green colour deficiency: Sensitivity of the Ishihara and American Optical Company (Hardy, Rand and Rittler) pseudo-isochromatic plates to identify slight anomalous trichromatism. *Ophthalmic Physiol. Opt.* **2010**, *30*, 667–671. [CrossRef]
74. Sandler, J.; Murray, A. Clinical photography in orthodontics. *J. Clin. Orthod.* **1997**, *31*, 729–739.
75. CIE (Commission Internationale de l'Éclairage). *Colorimetry*, 4th ed.; CIE 015:2018; CIE: Vienna, Austria, 2018. [CrossRef]
76. Carey, C.M. Tooth whitening: What we now know. *J. Evid. Based Dent. Pract.* **2014**, *14*, 70–76. [CrossRef]
77. Cohen, J. *Statistical Power Analysis for the Behavioral Sciences*, 2nd ed.; Lawrence Erlbaum Associates: Hillsdale, NJ, USA, 1988.
78. Gómez-Polo, C.; Montero, J.; Gómez-Polo, M.; Martín Casado, A.M. Chromatic compatibility of two gingival shade guides with human keratinized gingiva. *Int. J. Prosthodont.* **2023**, *36*, 20–29. [CrossRef]
79. Gómez-Polo, C.; Montero, J.; Martín Casado, A.M. Explaining the colour of natural healthy gingiva. *Odontology* **2024**, *112*, 1284–1295. [CrossRef]
80. Ho, D.K.; Ghinea, R.; Herrera, L.J.; Angelov, N.; Paravina, R.D. Color range and color distribution of healthy human gingiva: A prospective clinical study. *Sci. Rep.* **2015**, *5*, 18498. [CrossRef]
81. Huang, J.W.; Chen, W.C.; Huang, T.K.; Fu, P.S.; Lai, P.L.; Tsai, C.F.; Hung, C.C. Using a spectrophotometric study of human gingival colour distribution to develop a shade guide. *J. Dent.* **2011**, *39*, e11–e16. [CrossRef]
82. Gómez-Polo, C.; Martín-Casado, A.M.; Montero, J. Fifteen ceramic gingival samples: A proposed gingival shade guide. *J. Dent.* **2023**, *138*, 104648. [CrossRef]
83. Lucena, C.; Benavides-Reyes, C.; Ruiz-López, J.; Tejada-Casado, M.; Pulgar, R.; Pérez, M.M. Relevant optical properties for gingiva-colored resin-based composites. *J. Dent.* **2022**, *126*, 104316. [CrossRef]
84. Pérez, M.M.; Benavides-Reyes, C.; Tejada-Casado, M.; Ruiz-López, J.; Lucena, C. Does backgrounds color influence the appearance of gingiva-colored resin-based composites? *Materials* **2022**, *15*, 3712. [CrossRef]
85. Arora, O.; Ahmed, N.; Siurkel, Y.; Ronsivalle, V.; Cicciù, M.; Minervini, G. A comparative evaluation of physical properties of CAD/CAM complete denture resins—An in vitro study. *BMC Oral Health* **2024**, *24*, 65. [CrossRef]
86. Gruber, S.; Kamnoedboon, P.; Özcan, M.; Srinivasan, M. CAD/CAM complete denture resins: An in vitro evaluation of color stability. *J. Prosthodont.* **2021**, *30*, 430–439. [CrossRef]
87. Batra, P.; Daing, A.; Azam, I.; Miglani, R.; Bhardwaj, A. Impact of altered gingival characteristics on smile esthetics: Laypersons' perspectives by Q sort methodology. *Am. J. Orthod. Dentofac. Orthop.* **2018**, *154*, 82–90.e2. [CrossRef]
88. Alomari, S.A.; Abu Alhaija, E.S.; AlWahadni, A.M.; Al-Tawachi, A.K. Smile microesthetics as perceived by dental professionals and laypersons. *Angle Orthod.* **2022**, *92*, 101–109. [CrossRef]
89. Najarzadegan, F.; Eslamipour, F. Laypersons' perception of smile esthetics from different backgrounds. *Dent. Res. J.* **2024**, *21*, 30. [CrossRef]
90. Dindaroğlu, F.; Karabıyıkoğlu Özmutlu, M.; Işıksal, E. The effect of educational status on the perception of social and spontaneous smiles. *Turk. J. Orthod.* **2016**, *29*, 10–15. [CrossRef]
91. Benamghar, L.; Penaud, J.; Kaminsky, P.; Abt, F.; Martin, J. Comparison of gingival index and sulcus bleeding index as indicators of periodontal status. *Bull. World Health Organ.* **1982**, *60*, 147–151.

92. Smith, R.N.; Lath, D.L.; Rawlinson, A.; Karmo, M.; Brook, A.H. Gingival inflammation assessment by image analysis: Measurement and validation. *Int. J. Dent. Hyg.* **2008**, *6*, 137–142. [CrossRef]
93. Osorio-Ayala, L.D.; Cantos-Tello, P.M.; Carvajal-Endara, A.S. Melanosis gingival: Diagnóstico y terapéutica de su implicación estética. Revisión de la literatura [Gingival melanosis: Diagnosis and therapy of its aesthetic involvement. Literature review]. *Odovtos Int. J. Dent. Sci.* **2021**, *23*, 39–51. [CrossRef]
94. Ponnaiyan, D.; Gomathy, L.; Anusha, J.A. The correlation of skin color and gingival pigmentation patterns in a group of South Indians in Tamil Nadu, India. *SRM J. Res. Dent. Sci.* **2013**, *4*, 54–58. [CrossRef]
95. Strajnić, L.; Bulatović, D.; Stančić, I.; Živković, R. Self-perception and satisfaction with dental appearance and aesthetics with respect to patients' age, gender, and level of education. *Srp. Arh. Celok. Lek.* **2016**, *144*, 580–589. [CrossRef]
96. Cheng, J.H.-C.; Hsu, Y.-C.; Lee, T.Y.-H.; Li, R.-W. Factors affecting perception of laypeople and dental professionals toward different smile esthetics. *J. Dent. Sci.* **2023**, *18*, 739–746. [CrossRef]
97. Tin-Oo, M.M.; Saddki, N.; Hassan, N. Factors influencing patient satisfaction with dental appearance and treatments they desire to improve aesthetics. *BMC Oral Health* **2011**, *11*, 6. [CrossRef]
98. Grosofsky, A.; Adkins, S.; Bastholm, R.; Meyer, L.; Krueger, L.; Meyer, J.; Torma, P. Tooth color: Effects on judgments of attractiveness and age. *Percept. Mot. Skills* **2003**, *96*, 43–48. [CrossRef]
99. Arokia Raj, H.; Anandapandian, P.A.; Thillaigovindan, R.; Raj, B.S.C. A cross-sectional observational study of gingival color patterns in the South Indian population. *Cureus* **2024**, *16*, e67340. [CrossRef]
100. Ayan, G.; Dayı, B. Evaluation of plaque index, gingival index and oral health-related quality of life in obese patients. *Odovtos Int. J. Dent. Sci.* **2023**, *25*, 166–178. [CrossRef]
101. Lobene, R.R.; Mankodi, S.M.; Ciancio, S.G.; Lamm, R.A.; Charles, C.H.; Ross, N.M. Correlations among gingival indices: A methodology study. *J. Periodontol.* **1989**, *60*, 159–162. [CrossRef]
102. Abramov, I.; Gordon, J.; Feldman, O.; Chavarga, A. Sex and vision II: Color appearance of monochromatic lights. *Biol. Sex Differ.* **2012**, *3*, 21. [CrossRef]
103. Mylonas, D.; Paramei, G.V.; MacDonald, L.W. Gender differences in colour naming. In *Colour Studies: A Broad Spectrum*; Anderson, W., Biggam, C.P., Hough, C., Kay, C., Eds.; John Benjamins Publishing Company: Amsterdam, The Netherlands, 2014; pp. 225–239. [CrossRef]
104. Rodríguez-Carmona, M.; Sharpe, L.T.; Harlow, J.A.; Barbur, J.L. Sex-related differences in chromatic sensitivity. *Vis. Neurosci.* **2008**, *25*, 433–440. [CrossRef]
105. Pérez-Carpinell, J.; Baldoví, R.; de Fez, M.D.; Castro, J. Color memory matching: Time effect and other factors. *Color Res. Appl.* **1998**, *23*, 234–247. [CrossRef]
106. Murakami, S.; Mealey, B.L.; Mariotti, A.; Chapple, I.L.C. Dental plaque-induced gingival conditions. *J. Periodontol.* **2018**, *89*, S17–S27. [CrossRef]
107. Bharti, V.; Bansal, C. Drug-induced gingival overgrowth: The nemesis of gingiva unravelled. *J. Indian Soc. Periodontol.* **2013**, *17*, 182–187. [CrossRef]
108. Binmadi, N.O.; Bawazir, M.; Alhindi, N.; Mawardi, H.; Mansour, G.; Alhamed, S.; Alfarabi, S.; Akeel, S.; Almazrooa, S. Medication-induced oral hyperpigmentation: A systematic review. *Patient Prefer. Adherence* **2020**, *14*, 1961–1968. [CrossRef]
109. Glick, A.; Sista, V.; Johnson, C. Oral manifestations of commonly prescribed drugs. *Am. Fam. Physician* **2020**, *102*, 613–621.
110. Gaur, S.; Agnihotri, R. Is dental plaque the only etiological factor in amlodipine-induced gingival overgrowth? A systematic review of evidence. *J. Clin. Exp. Dent.* **2018**, *10*, e610–e619. [CrossRef]
111. Kolte, R.; Kolte, A.; Mahajan, A. Assessment of gingival thickness with regards to age, gender and arch location. *J. Indian Soc. Periodontol.* **2014**, *18*, 478–481. [CrossRef]

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.