Influence of mandibular sagittal position on facial esthetics

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Abstract

Objectives: To analyze the influence of mandibular sagittal position in the determination of facial attractiveness. **Methods:** Facial profile photographs were taken of an Afro-descendant man and a Caucasian man, as well as an Afro-descendant woman and a Caucasian woman. These photos were manipulated on the computer using Adobe Photoshop™ CS2 to produce—from each original face—a straight profile, three simulating retrusion and three protrusion mandibular discrepancies. In all, 28 photographs were evaluated by orthodontists (n = 20), oral maxillofacial surgeons (n = 20), plastic artists (n = 20) and laypersons (n = 20). The descriptive analysis was performed by calculating the mean and standard deviation for each group. **Results:** The straight facial profile was met with greater acceptance by Afro-descendant male faces and female faces. Caucasian males found a lightly concave facial profile with a more prominent mandible to be the most pleasant. After an analysis of skeletal discrepancies simulations, Caucasian males also showed a preference for mandibular protrusion versus retrusion. Females, however, preferred convex over concave profiles. **Conclusion:** The results showed agreement between groups of evaluators in selecting the most attractive profiles. Regarding male faces, a straight profile with a slightly concave face seemed more attractive and a straight facial profile was also greatly valued.

Keywords: Facial profile. Orthodontics. Orthognathic surgery.

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INTRODUCTION

Physical appearance influences an individual's integration and self-esteem and may become critical to their psychological well-being.[8,10] Therefore, many patients seek orthodontic treatment motivated by the desire to improve their facial appearance[15,23] and minimize aesthetic-related psychosocial problems.[17]

Perception of beauty depends upon individual preference but is influenced by ethnic and cultural experiences as well as by family beliefs.[1] By showing famous faces as beautiful mass media can also exert a powerful influence. These different aspects underlie certain claims that the perception of beauty changes with time and place.[7]

With a view to accomplishing their aesthetic goals, orthodontists must prepare a treatment plan substantiated by a thorough patient evaluation.[17] Using the clinical examination of the frontal and profile views of the face, one can evaluate the harmony of the structures that compose it. A patient's profile evaluation is so important that many researchers have conducted studies to better define their normal conditions, harmony and balance. Legan and Burstone[11] recommend an angular measurement to evaluate the profile of the patient's soft tissue. The facial convexity angle or facial contour angle—formed by a line joining the glabella to the subnasale and another that connects the subnasale to the pogonion—is considered normal at 12°. As the values of this angle decrease the facial profile begins to suggest a Class III skeletal relationship. As the angular measurements increase the profile becomes more convex, suggesting a Class II skeletal relationship.

In order to study the patterns established in the literature and adapt them to the faces of various human races, Brito[2] evaluated the preference given by the Brazilian population in terms of facial esthetics of Caucasian adults who have undergone orthodontic treatment. The results showed considerable consistency in the preference for a straight facial profile, conforming to Steiner's S line[21], for both male and female individuals.

On the other hand, Sushner[22] used references from some reviews to evaluate the faces of the Afro-descendant population and found that their men and women are more protrusive than Caucasians. Thus, the values established by analyses using samples of the Caucasian population are not applicable to the faces of Afro-descendant individuals.[22] Other researchers[6] also conducted a study to examine facial attractiveness in Afro-descendants. Faces with straight profiles were considered the most beautiful. These faces, however, showed a slight lip protrusion when evaluated using the Steiner[21] and Ricketts[18] analyses.

Many of these studies help clinicians to perform the facial analysis of different races and genders. However, although research uses established standards as the prototype of beauty, it is essential that practitioners be aware of patient perception. Professional opinion regarding the assessment of facial aesthetics may not match the beliefs and expectations of patients. To test this difference, some studies have been conducted comparing the sensitivity of professionals and laypersons to horizontal and vertical changes in human faces, as well as determining which, in their opinion, is the most pleasant facial composition.[12,19]

For all these reasons, professionals should be aware of aspects of facial appearance that patients consider attractive or not.[3] Thus, the most important problems will be identified and treatment will be based not only on clinical aesthetics, function and stability but also on what is most important and beneficial for the patient.[23]

Thus, since orthodontists and oral maxillofacial surgeons share a compelling need to obtain data to help them evaluate the components of facial harmony, this study aims to examine the influence of the mandibular sagittal position in determining profile attractiveness

and compare the views of dentists, maxillofacial surgeons, artists and laypersons on the aesthetics of the faces examined.

MATERIAL AND METHODS

This study used 28 photographs depicting the facial profile of four adults, two Caucasians and two Afro-descendants of both genders, defined according to the classification of the Brazilian Institute of Geography and Statistics (IBGE) (State of São Paulo / USP / FSP, 2000). These four individuals were selected because their faces featured what is considered the standard patterns of facial harmony both in the vertical plane, based on quotes by Medeiros and Medeiros[13]and Proffit[17], and in the horizontal plane, according to the precepts advanced by Legan and Burstone[11].

The photographs were obtained with the subjects in a sitting position, with both the Frankfort plane and the pupillary plane parallel to the ground by using the ear positioners of a cephalostat. An EOS Rebel-D (Canon™) digital photography equipment was used with an EF 100 mm macro lens (Canon™) and MR14EX circular flash (Canon™). The distance between individual and photo sensor was kept at 1.47 m and a speed of 1/125.

The four photographs of the original, balanced profiles were manipulated on the computer using Adobe Photoshop™ CS2 (Adobe Systems Incorporated - San Jose, CA) in order to eliminate any details that might distort rater perception, such as spots on the skin and excess fat in the cervicomandibular angle region. Landmarks were also defined in all the original images in order to standardize photograph changes and allow a more accurate analysis.

The landmarks were as follows: Glabella (G), most prominent point on the forehead; subnasale (Sn), cut-off point between the nasal septum and the skin of the upper lip; pogonion (Pg), the anterior-most point of the chin's soft tissue; mentum (Me), lower-most point of the chin's soft tissue;[11,13,17] upper lip (Ls) and lower lip (Li), the most external points of the upper and lower lips, respectively.

The vertical proportions of the subjects' faces, which were analyzed in each photograph, were standardized so that the middle and lower thirds were close to 1:1 ratio. The middle third was measured in a line perpendicular to the Frankfort plane—from G to Sn—and the lower third, from Sn to Me.[13,17] The profiles were analyzed and changed in the horizontal direction according to the facial convexity angle.[11] This angle, formed by a line connecting G to Sn and another that connects Sn to Pg, should be 12° in adults with 4° standard deviation.[11] Therefore, 12° was the yardstick applied to measure the convexity angles of the four ideal profiles.

The degree of lip protrusion considered ideal was different for Caucasians and Afro-descendants. For Caucasians, the protrusion was rated and changed in order to reflect normality, according to Steiner.[21] This author advocates that the upper and lower lips should touch the line connecting the middle of the nose base to the pogonion. Afro-descendants' profile photographs had their lip protrusion altered in order to represent the harmony referenced by Farrow et al.[6] To this end, a line was drawn perpendicular to the Frankfort plane cutting through point G. The upper and lower lips were manipulated to be between 3 mm and 6 mm ahead of this line. These measurements were defined in each profile in order to produce harmonious changes with the upper lip always positioned ahead of the lower lip.

For every profile considered ideal, the Pg was moved ahead by decreasing the G-Sn-Pg angle by 4°, sequentially, down to 0°. Similarly, the Pg was also repositioned by increasing the G-Sn-Pg by 4°, down to 24. During this Pg movement, there was need to assess the vertical dimension through point Me so that it remained un-

FIGURE 1 - Photographs of facial profiles of Caucasian woman with convexity angles of 0° (**A**), 4º (**B**), 8º (**C**), 12º (**D**), 16º (**E**), 20º (**F**), 24º (**G**) .

changed. Seven profiles were thus obtained of each photographic model, i.e., one ideal, three derived from mandibular advancement and three simulating mandibular setback. The mentum, lower lip and mentum/labial sulcus were advanced or retruded in an order of magnitude similar to the Pg movement but the profile was outlined so as to make manipulations imperceptible. One example of the seven photographs, showing the ideal profile and the protrusion and retrusion mandibular discrepancies—in this case representing a Caucasian woman—can be seen in Figure 1.

The photo album was organized with seven

images of each individual laid out on the same page. The layout order for each photograph on the pages was randomly selected as was the sequence of photographs of each individual in the album.

To assess the 28 profiles for facial attractiveness, 80 raters, 20 orthodontists, members of the Bahia Orthodontics Association (SOBA), 20 oral maxillofacial surgeons, members of the Brazilian College of Surgery and Oral Maxillofacial Traumatology and/or professionals who had attended specialization courses, 20 artists with academic training in this area, and 20 laypersons, graduates from or attending university, excluding those who had attended or were attending a dentistry or fine arts course and who were employed by dental clinics or orthodontic patients. The subdivision of each group according to rater gender was not justified since there were only two women in the group of oral maxillofacial surgeons while the other eighteen were male.

Along with the albums, each rater received a form comprising eight rulers (visual analog scale), one for each page, and were then instructed to mark with a dot and identify the letter corresponding to the image and then rate each image according to its attractiveness. Rater could mark the dot anywhere on the image and place two or more letters on each dot, if necessary. The visual analog scale[12,14,23] was 10 cm long and had "VERY BAD" written on the left end and "VERY GOOD" at the other end. In the center of the ruler, as well as on the differential semantic scale,[16] the following word was written: "REGULAR". The distance (in mm) between the mark made by the photograph rater and the extreme left of the ruler defined the attractiveness of each face being rated.[20]

The data from each questionnaire were compiled in a spreadsheet and then treated statistically. A descriptive analysis was performed by calculating the mean and standard deviation in each group. Subsequently, the Kolmogorov-Smirnov test was used to analyze normal distribution. Once data normality had been identified, a one-way ANOVA and Tukey's Test were applied to identify differences between the groups. A 5% alpha test ($p < 0.05$) was used for all tests.

RESULTS

Descriptive statistics was used to compare the total marks of the 80 raters for each face and thus evaluate the influence of the anteroposterior mandibular position—in a side view—in determining facial attractiveness.

Table 1 allows an analysis of the mean and confidence interval (at 95% attractiveness) that the different profiles exert on all raters, according to facial convexity angle—regardless of the rater group—on the Afro-descendant and Caucasian men and Afro-descendant and Caucasian women.

TABLE 1 - Mean and standard deviation of the degree of attractiveness for Afro-descendant and Caucasian men and Afro-descendant and Caucasian women, according to facial convexity angle.

G-Sn-Pg	AFRO-DESCENDANT MAN		CAUCASIAN MAN		AFRO-DESCENDANT WOMAN		CAUCASIAN WOMAN	
	X	SD	X	SD	X	SD	X	SD
0°	1.10	1.19	2.07	1.74	0.74	1.07	0.74	0.98
4°	3.43	2.08	4.77	2.36	2.15	1.60	3.00	2.01
8°	6.96	2.12	8.97	1.18	6.40	2.12	6.75	2.53
12°	8.48	1.69	8.31	1.46	8.64	1.45	8.81	1.40
16°	6.09	2.01	5.62	1.98	7.14	2.02	6.89	2.03
20°	3.24	1.91	2.36	1.45	3.74	2.11	3.86	1.80
24°	1.04	1.18	0.87	1.11	1.52	1.56	1.48	1.46

Tables 2, 3, 4 and 5 show the degree of attractiveness that each facial profile of Afro-descendant men, Caucasian men, Afro-descendant women and Caucasian women, respectively, exert on the different rater groups. The results showed that for Afro-descendant men facial profiles with a Class I skeletal pattern were the preferred choice whereas for Caucasian men, a more prominent mandible held the strongest aesthetic appeal. Regarding female faces, rater preference was given to the straight profile, while the discrepancies that simulated a skeletal Class III were the most widely rejected.

TABLE 2 - Mean and standard deviation of the degree of attractiveness for the faces of the Afro-descendant man, according to each rater group.

G-Sn-Pg	ORTHODONTIST		OMF SURGEON		PLASTIC ARTIST		LAYMAN	
	X	SD	X	SD	X	SD	X	SD
0º	0.95	1.11	1.43	1.08	0.60	0.74	1.40	1.57
4º	3.17	1.90	3.08	1.63	3.70	2.48	3.77	2.26
8º	6.86	2.31	6.69	1.98	7.40	2.06	6.89	2.21
12º	8.39	1.19	7.86	1.85	9.30	1.19	8.36	2.11
16º	5.61	1.74	4.99*/ **	1.82	6.97**	2.38	6.77*	1.43
20º	2.47*	1.59	2.46**	1.37	3.88	2.23	4.13*/ **	1.82
24º	0.33*	0.51	1.12	0.97	1.11	1.11	1.59*	1.57

*, ** p < 0.05 - difference between rater groups.

TABLE 3 - Mean and standard deviation of the degree of attractiveness for the faces of the Caucasian man, according to each rater group.

G-Sn-Pg	ORTHODONTIST		OMF SURGEON		PLASTIC ARTIST		LAYMAN	
	X	SD	X	SD	X	SD	X	SD
0º	1.44	1.22	1.95	1.60	2.79	2.27	2.08	1.58
4º	4.44	2.08	4.45	2.51	5.36	2.48	4.82	2.41
8º	9.20	0.95	8.53	1.44	9.27	1.14	8.86	1.08
12º	8.10	1.12	7.90	1.43	8.94	1.30	8.30	1.79
16º	5.31	1.93	5.02	1.98	6.33	1.99	5.80	1.90
20º	1.85*	1.20	2.00	1.04	2.49	1.61	3.08*	1.64
24º	0.41	0.80	0.78	0.86	1.00	1.32	1.26	1.26

* p < 0.05 - difference between rater groups.

TABLE 4 - Mean and standard deviation of the degree of attractiveness for the faces of the Afro-descendant woman, according to each rater group.

G-Sn-Pg	ORTHODONTIST		OMF SURGEON		PLASTIC ARTIST		LAYMAN	
	X	SD	X	SD	x	SD	X	SD
0º	0.40	0.43	0.76	0.95	0.77	1.48	1.00	1.14
4º	1.52	0.91	1.93	1.76	2.43	1.80	2.69	1.62
8º	5.93	2.13	6.16	1.99	6.66	2.34	6.82	2.03
12º	8.71	1.08	7.87*	1.40	9.33*	1.11	8.64	1.80
16º	7.14	1.79	6.00*	2.40	8.05*	1.95	7.37	1.35
20º	3.47*	2.00	2.31**	1.84	5.30*/ **	1.83	3.85	1.75
24º	0.67*/**	0.74	1.30	0.99	1.98**	1.88	2.11*	1.92

*, ** p < 0.05 - difference between rater groups.

TABLE 5 - Mean and standard deviation of the degree of attractiveness for the faces of the Caucasian woman, according to each rater group.

G-Sn-Pg	ORTHODONTIST		OMF SURGEON		PLASTIC ARTIST		LAYMAN	
	X	DP	X	DP	X	DP	X	DP
0º	0.51*	0.70	0.60	0.58	0.56	0.87	1.26*	1.41
4º	2.16*	1.54	2.25**	1.43	4.05*/**	2.07	3.52	2.29
8º	6.24	2.65	5.98	2.32	7.86	2.19	6.91	2.68
12º	8.98	1.14	8.32	1.48	9.23	1.17	8.70	1.66
16º	6.96	1.79	6.44	2.01	7.67	2.21	6.46	1.97
20º	3.23	1.54	3.66	1.78	4.61	2.08	3.94	1.58
24º	0.78	0.96	1.64	1.13	1.76	1.82	1.72	1.63

*, ** $p < 0.05$ - difference between rater groups.

DISCUSSION

Since facial aesthetics is an important component of diagnosis and treatment planning in orthodontics, many studies have been conducted in order to assess whether there are differences in the perception of facial attractiveness among professionals and laypersons.[3,9,10,12] In this study, color profile photographs were used for this analysis given the fact that images impart more realism to the representation of facial aesthetics than do silhouettes and profile drawings.[12] However, the use of photographs involves many factors that influence facial attractiveness, such as color and style, nose size, eye color and age of the photographic model.[3] These variables were eliminated in this research by using the profile reproduction method, which makes use of digital images and Adobe Photoshop™ CS2. Therefore, the key features of each photographic model were retained and only the mandible position of each facial profile was changed.

To evaluate the esthetic perception of the manipulated images a visual analog scale was utilized which allowed swift, straightforward measurements to be obtained while streamlining and clarifying the process for the raters. Furthermore, according to Maple et al[12] when results are recorded as a continuous variable—in millimeters—researchers are afforded more leeway and sensitivity in analyzing the data, thereby averting biases towards any preferred values, as is the case with numeric interval scales. Additionally, Orsini et al[16] support the use of a scale with words of contrasting meanings at each end asserting that it is ideal for evaluating people's reactions to specific stimuli.

After reviewing the results of this study it becomes clear that any variation in the mandibular sagittal position exerts an impact on the raters' aesthetic opinion. This impact was affected by the gender and race of the photographic models since their profiles were rated as more or less attractive—given their different convexity angles—depending on the face being rated. On the other hand, unlike the present study, Knight and Keith[10] found that, although attractive faces tend towards a relationship that represents skeletal Class I, the values for the sagittal changes had little influence on facial attractiveness. This difference, however, seems to lie in the fact that Knight and Keith[10] studied the facial attractiveness in male and female faces of different individuals. Thus, other variables must have had a bearing on the results.

The results found for Afro-descendant faces showed a preference for the skeletal Class I profile, i.e., with a 12° convexity angle. This face, chosen as the most attractive, features slightly protruded lips.[6] No preference was noted regarding photographs representing skeletal Class

II or III discrepancies. Profiles with an 8° to 16° convexity angle were chosen as the second most attractive, followed by 4° to 20° convexity angle profiles. Profiles between 0° and 24° were considered the least attractive.

Concerning Caucasian males, preference was given to faces reflecting a skeletal Class III to the detriment of Class II profiles. The raters regarded faces with an 8° convexity angle as the most attractive, thereby denoting a preference for male faces with a more prominent mandible. This result corroborates a study by Czarnecki et al,[4] who concluded that straight profiles with a prominent chin are preferred for Caucasian men but not so much for Caucasian women.

Similarly to the present study, other researchers[19] used the convexity angle[11] to make changes in mandibular position. These authors[19] manipulated female and male faces simulating horizontal and vertical changes in both maxillas. Aesthetic preference was more clearly determined for differences in horizontal mandibular position, which showed an unequivocal tendency towards profiles with 9° facial convexity angle in both genders. These findings corroborate the results found in this investigation, especially in the assessment of Caucasian male profiles. However, this tendency to choose a profile with convexity angle lower than 12° did not apply to Afro-descendant faces. These faces are considered attractive when they featured a slight lip protrusion compared with Caucasians.[6,22] This may account for the fact that faces with a 12° convexity angle are most acceptable for Afro-descendant and 8° for Caucasians, since the latter is closer to a concave face.

Moreover, for Caucasian males, the face regarded as the least pleasant had a 24° convexity angle and represented the most severe Class II skeletal discrepancy. This result endorses that of other researchers,[3] who perceived greater rejection of Class II than Class III skeletal discrepancies.

As for Afro-descendant women, raters displayed preference for a 12° convexity angle[11] and slight lip protrusion.[6] For Caucasian women the straight profile was also the most widely accepted by the raters, in agreement with other investigators.[3] Caucasian females were preferred who had a 12° convexity angle[11] and lips touching the S line.[21] The profiles that simulated 18° to 16° convexity angles occupied the second place. Next, profiles with 20°, 4°, 24° and 0° were ranked in order of attractiveness and statistically significant differences were found between these angles. This shows that Class III skeletal discrepancies are more aggressive and therefore considered less attractive for women. Moreover, according to Cochrane et al,[3] Class II faces are the least attractive, irrespective of gender.

The influence of mandibular position upon facial esthetics in Caucasian women was studied as early as 1980,[5] with changes being made to photographic models using bite plates that simulated the sagittal and vertical movements of the mandible. According to the results for women, Class I faces are the most attractive while Class III faces the most unpleasant. In another study,[9] facial attractiveness was assessed by silhouettes representing profiles with different mandibular anteroposterior positions. Thus, the profiles were examined, irrespective of gender or race, which is confirmed by the preference given to profile skeletal Class I profiles.

As for the results, there was agreement between the views of four rater groups in choosing the most attractive profile for both Afro-descendants and Caucasians, which is consistent with the literature.[10,12,19] This observation bolsters the role of the aesthetic variable in orthodontic planning since the ideal standard is identical for professionals and laypersons alike. Inconsistency was found, however, in the groups' assessment of some of the faces. In general, clinicians were more demanding in terms of facial esthetics than non-clinicians, which coincide with the

study by Cochrane et al,[3] which concluded that the general public are less biased towards what it considers attractive.

Agreement in rater opinion was higher for Caucasian than for Afro-descendant faces. Regarding gender, there was greater consistency in the analysis of male faces than of women, which corroborates the findings in the literature.[10] A comparison between artists' and laypersons' opinions showed no statistically significant difference. The same concordance was found when comparing the opinions of orthodontists and oral maxillofacial surgeons, which agrees with Cochrane et al.[3] On the other hand, Arpino et al[1] asserted that orthodontists are more tolerant of changes in facial profiles than surgeons.

A comparison between the perception of clinicians and nonclinicians regarding changes in facial profiles shows that all have similar sensitivity to changes, i.e., laypersons and artists in general perceived the facial changes but were less demanding than clinicians concerning some of the faces. This observation coincides with a statement by Romani et al[19] that laypersons and orthodontists have the same degree of perception of mandibular sagittal changes. This assertion, however, disagrees with other studies,[12,16] suggesting that clinicians have greater ability to perceive changes than laypersons. This difference was attributed to the professional training that clinicians undergo to determine facial aesthetics,[16] or to differences in the socioeconomic or educational backgrounds of rater groups[12].

CONCLUSION

The results showed agreement between orthodontists, oral maxillofacial surgeons, artists and laypersons in the choice of the most attractive profiles for both Afro-descendants and Caucasians, regardless of gender. For Afro-descendant faces, the Class I profile gained greatest acceptance. Comparing the faces where some sort of skeletal discrepancy was simulated, there was no preference for either Class II or Class III. For Caucasian men, the most attractive face featured a straight profile with a more prominent mandible, but still within the normal range. An analysis of skeletal discrepancies discloses a preference for Class III than Class II profiles. Raters showed preference for a straight profile on the faces of both Afro-descendant and Caucasian women. For these women, the discrepancies that simulated skeletal Class III were the most rejected.

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