Laypersons' Perception of Facial and Dental Asymmetries

Bruno Pereira Silva, DMD[1]/Emilio Jiménez-Castellanos, MD, DDS, PhD[2]/ Rafael Martinez-de-Fuentes, DMD, PhD[3]/Joseph R. Greenberg, DMD, FAGD[4]/ Stephen Chu, DMD, MSD, CDT[5]

The purpose of this article was to determine the individual visual perception thresholds of certain facial and dental discrepancies for a symmetric face model (SFM). A facial photograph of a female subject's smile was digitally manipulated into an artificially symmetric picture. Modifications were made on the SFM for shifts in the dental midline, nose, and chin (group 1) and cants of dental midline and incisal plane (group 2), resulting in a total of 24 different images divided into two groups. One-hundred randomly selected laypersons divided into two groups were used to evaluate each image according to their own personal beauty and esthetic criteria using a visual analog scale. The visual perception thresholds found for the SFM were 2 mm for a dental midline shift, 4 mm for nose deviation, 5 degrees for dental midline cant, and 3 degrees for frontal incisal plane cant. Chin deviations of 6 mm or less were not noticed. Dental midline shift, nose deviation, dental midline cant, and incisal plane cant relative to an SFM have an impact on the perception of facial attractiveness. Chin deviations did not have a statistically significant impact. (Int J Periodontics Restorative Dent 2013;33: e162–e171. doi: 10.11607/prd.1618)

[1]Clinical Professor, Department of Prosthodontics, School of Dentistry, University of Seville, Seville, Spain.
[2]Professor, Department of Prosthodontics, School of Dentistry, University of Seville, Seville, Spain.
[3]Assistant Professor, Department of Prosthodontics, School of Dentistry, University of Seville, Seville, Spain.
[4]Clinical Professor, Department of Restorative Dentistry, Kornberg School of Dentistry, Temple University; Clinical Professor, Department of Periodontics, University of Pennsylvania School of Dental Medicine, Philadelphia, Pennsylvania.
[5]Clinical Associate Professor; Director of Esthetic Education, Columbia University College of Dental Medicine, New York, New York, USA.

Correspondence to: Dr Bruno Pereira da Silva, Departamento de Prótesis Estomatológica, Facultad de Odontología, Universidad de Sevilla, Calle Avicena 41009, Sevilla, Spain; email: brunopereira.doc@gmail.com.

There has been an increasing awareness and relevance of facial esthetics in contemporary societies in developing and industrialized countries. Social media is one vehicle responsible for the growing demand in esthetic dental treatment. It has invited dental clinical practices to not only treat functional dental pathology, but also to improve the esthetic condition of their patients.

Esthetics should also be taken into account in dental therapeutics together with restoring oral function. Functions such as chewing, phonation, and even breathing should be considered priority goals of rehabilitative work, but they must be harmonized with an appropriate esthetic concept for the individual patient to psychologically achieve his/her role in life.

In published studies, great discrepancies can be observed in aspects that affect smile perception and the beauty of the face as a whole, such as asymmetries, midline shifting, and canting of the incisal plane.[1–7] These can make a noticeable difference in the success rate of dental treatments, even when the restorative and functional rehabilitation goals have been achieved, if the esthetic expectations of our patients are not achieved.

Few authors seem concerned about the importance of facial context in the perception of dental composition discrepancies; most of these studies have used smile or retracted intraoral pictures, eliminating the facial structures to control and limit extraneous variables.[4–7] Even though exceptions exist,[8] the smile can rarely be evaluated outside its facial context in an objective manner. People usually communicate within a prudent or social speaking distance where the smile is always perceived as a facial gesture. In daily clinical practice, clinicians work within a position that shortens the social and visual speaking distance into the dentofacial field, neglecting the complete facial composition. The location of the maxillary dental midline relative to the face is often an important factor in restorative and/or orthodontic diagnosis and treatment planning, such as the relationship between the incisal plane and interpupillary line.[9–11] Therefore, it is very important to step back from the usual dentofacial and dental working distance into the facial diagnostic position, with the patient in a vertical or standing posture and with an upright natural head position.

Some variations of facial asymmetry are not considered esthetic pathology, despite the nonexistence of objective criteria scientifically designed to differentiate normal and abnormal asymmetries.[12] This judgment generally results from subjective criteria and the harmonic sense of the clinician or technician involved in the fabrication of the restoration.

In 1998, Beyer and Lindauer[13] wrote about the importance of some structural facial asymmetries and what impact they had on the perception of dental esthetics. Reference was made to thresholds that vary between individuals, depending upon their facial characteristics. They also stated that the alignment of the dental midline in patients with either a deviated chin or chin and nose could be more complicated but did not refer to how these facial structures could interfere with the perception of dental midline deviations.

Based on the assumption that the working field of the clinician is limited to the stomatognathic system, the facial characteristics of each patient should be taken into account during treatment planning. The importance of understanding the roll of facial structures in smile esthetics rises to the forefront.

If some structural facial asymmetries, such as deviations of the chin and nose, interfere with the perception of smile beauty, then preoperative diagnoses for any rehabilitative treatment, orthodontic or prosthetic, should include a detailed analysis of these facial structures.

Some discrepancies of the dental midline and incisal plane that might call for treatment due to esthetic reasons could be in harmony with the remaining facial structures according to the patient's perception.

The purpose of this article was to determine the individual visual perception thresholds of facial and dental discrepancies for a symmetric face model (SFM).

Method and materials

From a facial photograph of a female subject's smile, including her hair and neck, an SFM (control image) was digitally created (Fig 1). For this purpose, the computer program Adobe Photoshop CS3 Extended (for Mac/Windows VISTA) was used for image editing.

From this model, different facial and dental structures located along the facial midline were intentionally altered with increased degrees of deviation. Modifications were made on the dental midline (shift), nose, and chin on group 1 and dental midline (cant) and incisal plane on group 2. Each structure was altered progressively. On the SFM, the dental midline was coincident with the philtrum and perpendicular to the interpupillary line.[11]

The shifting of the dental midline was made toward the left side of the face model. Incremental changes of 1 mm were made in four progressive steps (Figs 2 to 5).

The nasal alterations were made by deviating the pronasal point to the left side of the face model, trying to simulate a deviation of the nasal septum of four progressive steps, with an increment of 1 mm (Figs 6 to 9).

Chin deviations were made by moving the pogonion point to the left of the face model, with six pro-

Fig 1 *Symmetric model or control image.*

Fig 2 *1-mm dental midline shifting to left of face.*

Fig 3 *2-mm dental midline shifting.*

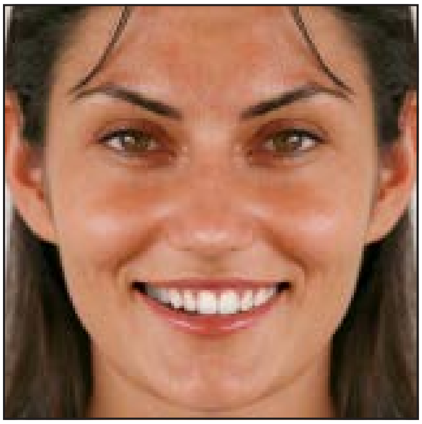

Fig 4 *3-mm dental midline shifting.*

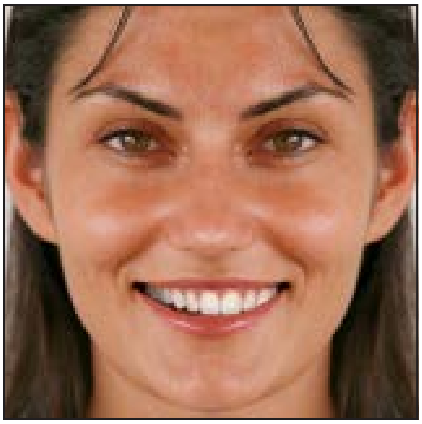

Fig 5 *4-mm dental midline shifting.*

Fig 6 *1-mm nose deviation to left of face.*

Fig 7 *2-mm nose deviation.*

Fig 8 *3-mm nose deviation.*

Fig 9 *4-mm nose deviation.*

gressive steps and increments of 1 mm (Figs 10 to 15).

The cant of the dental midline was made toward the right side of the face model. Incremental changes of 5 degrees were made in three progressive steps (Figs 16 to 18).

Fig 10 *1-mm chin deviation to left of face.*

Fig 11 *2-mm chin deviation.*

Fig 12 *3-mm chin deviation.*

Fig 13 *4-mm chin deviation.*

Fig 14 *5-mm chin deviation.*

Fig 15 *6-mm chin deviation.*

Fig 16 *5-degree canting of the dental midline.*

Fig 17 *10-degree canting of the dental midline.*

Fig 18 *15-degree canting of the dental midline.*

The incisal plane of the SFM was parallel with the interpupillary line.[3] The cant of this plane was done to the right side of the face model, where incremental changes of 1 degree were made in four progressive steps, starting with 2 degrees of incisal plane cant (Figs 19 to 22).

Fig 19 *2-degree canting of incisal plane.*

Fig 20 *3-degree canting of incisal plane.*

Fig 21 *4-degree canting of incisal plane.*

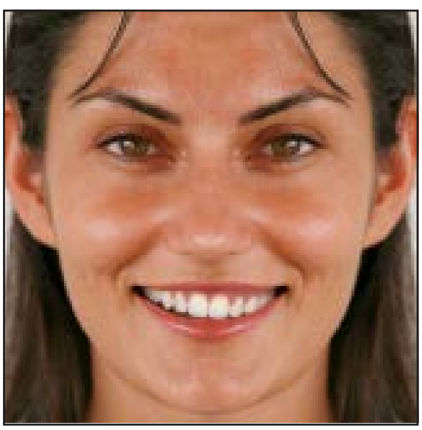

Fig 22 *5-degree canting of incisal plane.*

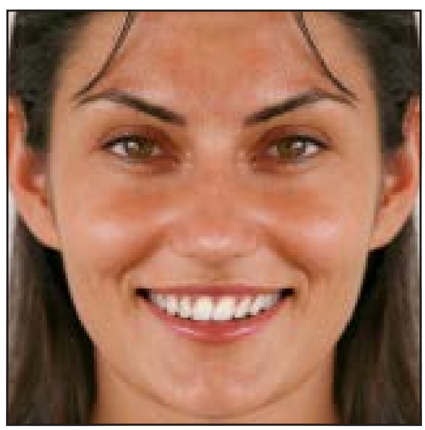

Fig 23 *Control image for 15-degree canting of the dental midline.*

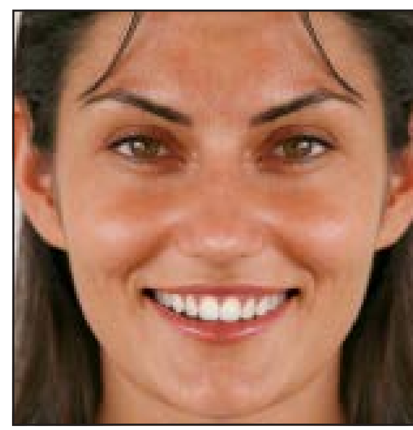

Fig 24 *Control image for 3-degree canting of incisal plane.*

A total of 22 photographs were obtained and divided into two different groups: group 1 included the SFM and photographs with the modifications on the dental midline (shift), nose, and chin (15 photographs) (Figs 1 to 15), and group 2 included the SFM and dental midline (cant) and incisal plane modifications (8 photographs) (Figs 1 and 15 to 22).

One hundred randomly selected laypersons without any specific dental training who were at least 18 years of age were divided into two groups. The first 50 selected subjects comprised group 1 (29 men, 21 women), and the other 50 were group 2 (25 men, 25 women).

The group 1 age ranged from 18 to 57 years with a mean of 32 years and group 2 from 18 to 53 years with a mean age of 31 years.

Each rater was given the same instructions with an evaluation sheet with a total of 15 and 10 questions for group 1 and group 2, respectively.

In group 2, two parameters were studied so a smaller number of pictures were used (8) compared with group 1 (15), which allowed the authors to randomly choose two pictures to be evaluated twice by the same subject—15 degrees of dental midline cant (Fig 23) and 3 degrees of incisal plane cant (Fig 24)—to control the intrasubject reproducibility of the evaluations.

The photographs were shown to the raters through two different digital presentations: one to group 1 with dental midline (shift), nose, and chin modifications and the second (posteriorly) prepared for group 2 with dental midline (cant) and incisal plane alterations.

Table 1 Mean, SD, and minimum and maximum ratings (mm) for group 1

Parameter	Deviation (mm)	Figure	Mean	SD	Minimum	Maximum
SFM	0	1	37.92	8.502	15.0	50.0
Dental midline shift	1	2	37.11	7.024	20.0	50.0
	2	3	31.28	11.506	50.0	50.0
	3	4	22.58	10.891	0	45.5
	4	5	17.87	10.492	0	42.0
Nose	1	6	37.71	7.502	15.0	50.0
	2	7	36.56	7.444	20.0	50.0
	3	8	36.56	7.889	19.5	50.0
	4	9	30.71	11.815	3.0	50.0
Chin	1	10	38.30	7.573	20.5	50.0
	2	11	37.48	8.545	17.0	50.0
	3	12	34.50	9.519	60.0	50.0
	4	13	36.22	9.011	60.0	50.0
	5	14	35.71	8.253	15.5	50.0
	6	15	35.18	8.214	17.0	50.0

Presentations were made on a 15-inch screen, conducted by the same operator, as a slideshow in Microsoft Office PowerPoint 2007.

The pictures were organized in four different sequences to avoid systematic errors or biases that could lead the observer to take the first image as a model and compare all the remaining to that first one. The four different sequences of images were randomized and saved as four different slideshows.

The raters had to classify the facial expression of each image, according to their own personal beauty and esthetic criteria, bearing in mind that the left side of the scale corresponds to the least attractive facial expression observed, and the right side being most attractive. No instructions were given to the raters to focus their attention in any specific area, such as smile, midline, teeth, or any other dental parameters, as they were asked about facial expression beauty.

The visual analog scale (VAS) is a tool to measure a feature or an attribute that is within a continuous range of values that cannot be easily or directly measured.[14–20] The rating scale was 50 mm for group 1. Raters from this group felt that the 50-mm VAS scale was too narrow to allow observers the ability to express small differences between different pictures[1]; therefore, the rating scale used for group 2 was lengthened to 100 mm. Once all questionnaires were collected, the scores given on the scale to each photograph were measured with a digital caliper. Ratings were from 0 to 5 and the results were registered from 0 to 50 mm for group 1 and from 0 to 100 mm for group 2, and increased in values of 5.

Table 2 Mean, SD, and minimum and maximum ratings (mm) for group 2

Parameter	Deviation (deg)	Figure	Mean	SD	Minimum	Maximum
SFM	0	1	69.9	17.263	33.5	99.0
Dental midline cant	5	16	63.5	16.265	34.0	99.0
	10	17	39.1	18.721	5.0	87.5
	15	18	29.5	18.225	0	80.0
	15	23	24.7	15.940	0	74.0
Incisal plane cant	2	19	68.3	18.705	24.0	100
	3	20	59.1	18.522	14.0	97.5
	3	24	60.9	19.654	13.0	100
	4	21	56.2	20.013	15.5	98.0
	5	22	39.1	20.558	25.0	84.0

The scores were introduced on a chart in the statistical program SPSS 14 (IBM) and measured statistically to determine the thresholds for the discrepancies studied and to analyze the sample and its validity.

The student *t* test was used for multiple comparisons with the Bonferroni correction to determine which pictures were statistically significant. The Mann-Whitney test was used to determine if sex and age were a factor throughout the evaluation. Lastly, the Kruskal-Wallis test was performed to find out if the four different photographic sequences were of significance in the raters' evaluation.

Results

The descriptive analysis for groups 1 and 2 are presented in Tables 1 and 2, respectively. For group 1, the mean rating of 1-mm dental midline shift (Fig 2) is very similar to the mean of the control picture of the SFM (Fig 1). Regarding the mean of the nose deviation ratings, the first three values are very similar (Figs 6 to 8) but there is a decrease for the 4-mm nasal deviation. The arithmetic means of the chin deviations ratings (Figs 10 to 15) are all very similar, indicating that chin deviations are less significant than the other parameters analyzed for group 1 and therefore is unnoticed (Table 1).

The SDs on group 1 are quite similar and favor the data dispersion from the mean, except for 2, 3, and 4 mm midline shifting (Figs 3 to 5) and 4-mm nose deviation, which are higher. The maximum value had been reached on all images except for the 3- and 4-mm midline shifting; this seems to indicate that the dental midline shift has a significant impact on the esthetic perception of facial esthetics. This idea is supported by the minimum values, which are precisely the ones obtained by a 3- and 4-mm midline shift (Figs 4 and 5, Table 1).

In group 1, the student *t* test was performed for multiple comparisons with the Bonferroni correction, with $P < .005$ for midline shifting and nose deviations values and $P < .002$ for chin deviations values.

The observers rated a 2-mm or greater dental midline shift (visual threshold) less attractive compared with the control picture ($P < .005$) (Table 3). Nose deviation required a 4-mm divergence before observers rated it as significantly less attractive ($P < .005$) (Table 3). For chin deviations, raters did not perceive any significant difference in attractiveness compared with the control image ($P < .002$) (Table 3).

For group 2, the mean rating of the midline cant decreased progressively, although a greater drop was registered between 5 degrees and 10 degrees of dental midline canting (Figs 16 and 17) (Table 2).

The mean rating of the image with 2 degrees of incisal plane cant (Fig 19) is very similar to the mean of the control picture of the SFM (Fig 1).

The SDs are quite similar, which favors the dispersion of the data from the mean. The maximum values reached on both pictures of 15-degree canting of the dental midline (Figs 18 and 23) were the lowest among all pictures, and these same pictures registered the smallest minimum values; this seems to indicate that this deviation was the least acceptable to the observers in group 2.

To determine which were significant, the student *t* test was performed for multiple comparisons with Bonferroni correction with $P < .003$ for canting of dental midline and canting of incisal plane values.

The observers rated a 5-degree or greater midline cant (visual threshold) less attractive compared with the control image ($P < .003$) (Table 3). The incisal plane required 3 degrees of canting before observers rated it as significantly less attractive ($P < .003$) (Table 3).

The repeated images of 15 degrees of dental midline cant (Fig 23) and 3 degrees of incisal plane cant (Fig 24) presented no statistically significant difference ($P < .003$) compared with their homologous images (Figs 18 and 20, respectively).

For both groups, a Mann-Whitney test was conducted to determine if sex and age were determinant factors. There were no significant differences in the ratings between men and women for any classified picture ($P < .01$).

To analyze age of rater as a potential factor, subjects in both groups were divided into two different groups; less than 30 years old and more than 30 years old, and no differences were found ($P < .01$).

Finally, a Kruskal-Wallis test was used to determine if the photographic sequence was a significant factor, and no differences were found for any photograph rating among the four different observation sequences ($P < .01$) in either group.

Discussion

According to the statistical analysis, it can be concluded that dental midline shift, nose deviation, dental midline cant, and incisal plane cant relative to an SFM have an impact on the esthetic perception of facial gesture.

Thresholds of visual recognition can be established based on the statistically significant differences obtained between the ratings given to pictures with deviations/alterations compared with the SFM (Table 3). They represent the alterations from which most of the observers would notice a change relative to the face. It can be said that any discrepancy under these thresholds would be unnoticeable to most laypersons.

Table 3 Threshold level of significant difference

	Threshold of recognition
Midline shift	2 mm
Nose deviation	4 mm
Chin deviation	ND
Midline cant	5 degrees
Incisal plane cant	3 degrees

ND = not detectable.

The thresholds are: 2 mm for dental midline shift to the left side (Fig 3), 4 mm for the nose deviation (Fig 9), 5 degrees for dental midline cant (Fig 16), and 3 degrees for the incisal plane cant (Fig 20) (Table 3). These values cannot be considered the absolute minimum thresholds since some of the intermediate values have not been investigated.

Based on the mean values of the different discrepancies, the results are quite consistent. When the deviations become greater, the observer ratings become smaller, except for one value of 3 mm of chin deviation, supporting the SFM and the current study design.

The two pictures randomly repeated in group 2 were used to try to control the reliability of the study. None registered a statistically significant difference when compared to the homologous images, which supports the reliability of the observers' ratings and the validity of the study methodology.

When comparing group 1 results with existing publications, studies are in accord regarding the shifting of the dental midline. Beyer and Lindauer,[13] Ker et al,[5] and Johnston et al[1] established that a 2-mm or greater dental midline shift would be easily recognized. However, some investigations have reported discordant results, such as Kokich et al[4] and Pinho et al,[3] who found that a 4-mm dental midline shift had no impact on the esthetic perception of a layperson. Ker et al argued that the maximum allowed deviation from the facial midline by an inexpert person was 2.9 mm.[5] There is a significant difference between the results obtained in these studies and the current study. The main difference in material and methods is that this study used full facial photographs, while those that obtained higher thresholds used photographs limited to the lower third of the face.

Comparing group 2 results regarding dental midline cant, Thomas et al[26] performed a study using a facial model that established 10 degrees as unacceptable to 41% of laypeople, Gule-e-Erum and Fida[27] found 5 degrees, while Kokich et al,[4] using a model that excluded facial structures and only included the lips, used a linear value to measure an angular variable and found 2 mm to be the approximate threshold. It is difficult to compare these studies due to the differences in material and methods; however, Gule-e-Erum and Fida do describe very similar results.[27]

Ker et al[5] investigated laypeople's perspectives regarding an ideal incisal plane cant and found it to be 0 degrees, while Padwa et al[2] concluded that a 3-degree inclination would be recognized by over 50% of the population. Other authors proposed a range of acceptability that varied from 2 to 5 degrees of canting.[2,27,28]

From the parameters studied in this research, dental midline parameters (shifting and canting) were clearly the dominant determinant that had the greatest negative impact on the facial esthetics of the studied SFM, and the chin deviation had the least or no impact.

Chin deviations did not have statistically significant impacts compared with the control image. This can be interpreted in two different ways: in the model used in this research, the chin deviations were subtle or almost imperceptible, which could explain some inconsistent results obtained for chin deviations; or that chin deviations are quite normal among the population, which is supported by some of the literature,[22] and laypeople could not recognize them.

Age and sex did not represent a significant factor in the evaluation of any studied facial parameters for both groups, which is a very interesting finding taking into considering that women are known to be more critical regarding beauty and esthetics.[23–25]

The four different photographic sequences were used to overcome the learning process that naturally occurs during the visualization of the images and did not influence the observer ratings throughout the slideshow. The Kruskal-Wallis test did not find significant differences among the four sequences in any photograph classification in any studied group.

Deviations made digitally over the SFM in Photoshop CS3 attempt to portray reality but even these have limitations since there is infinite individual variability attached to the human self. This study does not aim to establish minimum threshold or recognition levels that can be applied to the general population. Its goal was to establish the levels of recognition for this created model to further investigate where different dental and facial deviations can be combined to try to find their roles in the perception of smile esthetics.

The 50-mm VAS used in group 1, as used in other studies, appeared to be too narrow to allow raters the ability to express small differences between different pictures. The 100-mm VAS appears to be the more adequate since it allows the observer to express better the differences noticed. However, it should be noted here, as other investigators have concluded, that observers tend to score toward the middle of the scale without using scale extremes.[8] A new evaluation method might be considered for future investigations.

Further investigation will combine the various facial discrepancies examined in the current study on an asymmetric face model with programmed dental discrepancies. This will attempt to determine if facial structural asymmetries have an impact on the perception of the attractiveness of the dental composition.

Conclusions

According to the results obtained in this investigation, the following can be concluded: *(1)* The visual perception thresholds at which most laypersons first recognize a negative impact on facial gesture esthetics are 2 mm for a dental midline shift, 4 mm for nose deviation, 5 degrees for a dental midline cant, and 3 degrees for a frontal view/incisal plane cant. For chin deviations of 6 mm or less, no threshold could be established. *(2)* Out of all the parameters studied in this investigation, alterations at the maxillary dental midline showed the greatest impact on the ratings of facial esthetics of the studied model, while the chin deviation had the least or no impact. *(3)* The altered facial model with dental deviations has limitations but is a starting point to help understand the relationship between the smile and other facial structures.

Acknowledgment

The authors reported no conflicts of interest related to this study.

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