Received: 27 March 2019 | Revised: 11 July 2019 | Accepted: 25 August 2019

DOI: 10.1111/jerd.12526

REVIEW ARTICLE

WILEY

Layperson's preference of the transverse occlusal plane in asymmetric facial model

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Abstract

Objective: Facial asymmetries are common, especially deviated nose and chin. The clinician must consider these variables when establishing the smile, placement and angulation of the occlusal plane. The purpose of this article is to determine if nose and chin deviations affect the perception of laypeople towards different angulations of the occlusal plane cant.

Materials and Method: An asymmetric facial model was created from a symmetric facial model used in a previous study. Nose and chin were deviated 3 mm to the left and eight different pictures were created, each with different degrees of occlusal plane cant in both direction. Using a visual Likert scale delivered via Websurvey within the private practice setting, 120 randomly selected laypersons evaluated each image according to their own beauty preferences.

Results: In an asymmetric face, nose and chin deviated 3 mm to the left, a minor occlusal plane angulation of 2° can be perceptible regardless of the direction of the cant.

Conclusions: The occlusal plane should be as parallel to the interpupillary line as possible. If occlusal cant is present, less than 2° of angulation it is preferable, regardless of the direction of the nose and chin.

Clinical Significance: In the presence of an asymmetric face, the occlusal plane should be as parallel as possible to the interpupillary line. The direction of the deviation of the nose and the chin are irrelevant factors to determine the occlusal plane. An inclination of the occlusal plane can cause vertical discrepancy, which could subsequently create malocclusion. A complete dentofacial analysis can aim at assessing the angulation of the occlusal plane not only for esthetic outcomes, but for also allowing correct occlusal function.

KEYWORDS

asymmetric face, occlusal angulation, occlusal plane cant

1 | INTRODUCTION

During social interactions, attention is usually directed to the eyes and the mouth of the speaker, suggesting that the smile is an important characteristic of facial appearance.[1,2] Different factors contribute to an ideal smile; the length of the maxillary teeth, the inclination of the maxillary incisors, arch width, the curvature of the lower lip, and the occlusal plane angle.[3] The biometric

correlation between the angulation of the eyes, lips, and nose is generally very inconsistent.

Therefore, establishing a harmonic relationship between the anterior teeth, maxillary bone, and the face can be very daunting and confusing.[4] The dentofacial analysis of an extraoral exam is usually the starting point for diagnosing asymmetries and establishing references. One important reference of priority is the horizontal plane. It is commonly claimed that the interpupillary line should be parallel with the horizon line and perpendicular to the midline of the face.[5] Furthermore, this line should be parallel with the commissure line and occlusal plane (OP). The interpupillary line is often used for its convenience (easy to locate and fairly consistent among most people) and for providing an accurate visualization of the true OP inclination. Although asymmetries between the eyes might be present due to orbit position, jaw asymmetries are usually more pronounced.[5-7] Growth discrepancies and developmental anomalies of the lower facial third can cause a transverse cant of the OP more frequently than that of a cant or inclination of the interpupillary line.[7]

The cant or angulation of the occlusal plane has a relevant effect on the occlusion. Facial esthetics, dental occlusion, function, jaw relationships are all influenced by the cant of the OP.[6] Silva et al have previously demonstrated that the prevalence of inclined OP is considerable, especially in the transverse direction, which can compromise the masticatory function and esthetics of the smile.[7] For example, there is an approximately 0.5 mm change in the occlusal relationship for each degree of occlusal plane rotation in either downward and backward or upward and forward directions.[6]

Deviations of the chin and nose are a common finding among patients as well.[7] Silva et al came to the conclusion that facial asymmetries, such as nose and chin deviations, can interfere with the perception of dental midline shift and dental midline angulation.[8] However, some discrepancies of the transverse occlusal plane that might call for treatment due to esthetic reasons could be in harmony with facial structures according to the patient's perception.

The purpose of this article is to determine if the nose and chin deviations affect the layperson's perception of transverse occlusal plane.

2 | MATERIALS AND METHODS

A frontal portrait including face, hair and neck taken of a young female patient was used as a starting point,[7-10] this photograph was constructed in a previous study.[8] This picture was edited and morphed creating a symmetrical facial model (SFM) using Adobe Photoshop CS3 Extended (for Mac/Windows VISTA).[7-10]

On a previous research study[8] all the facial and dental parameters were tested separately. The thresholds of recognition were determined for this specific facial model and an asymmetrical facial model (AFM) was created, as shown in Figure 1A. The dorsum, tip of the nose and chin were digitally shifted 3 mm to the left.[7-9] The aim was to create an asymmetric facial model that simulates what happens with a large number of our patients, which is, having an asymmetric face where asymmetries are subtle and present, but below the evident threshold of recognition.[8]

Both the SFM (Figure 1B) and AFM displayed a dental midline that was perpendicular to the interpupillary line and horizontally coincident with the philtrum.[11] The asymmetry was created to be only on one side of the face, because the direction of the deviation has been proven not to be relevant[12] and to avoid the excessive number of pictures to be evaluated.[7]

The next step was to create six different versions of the AFM face, which had a different degree of transverse cant of the occlusal plane (both in and against the direction of the deviated chin and nose).

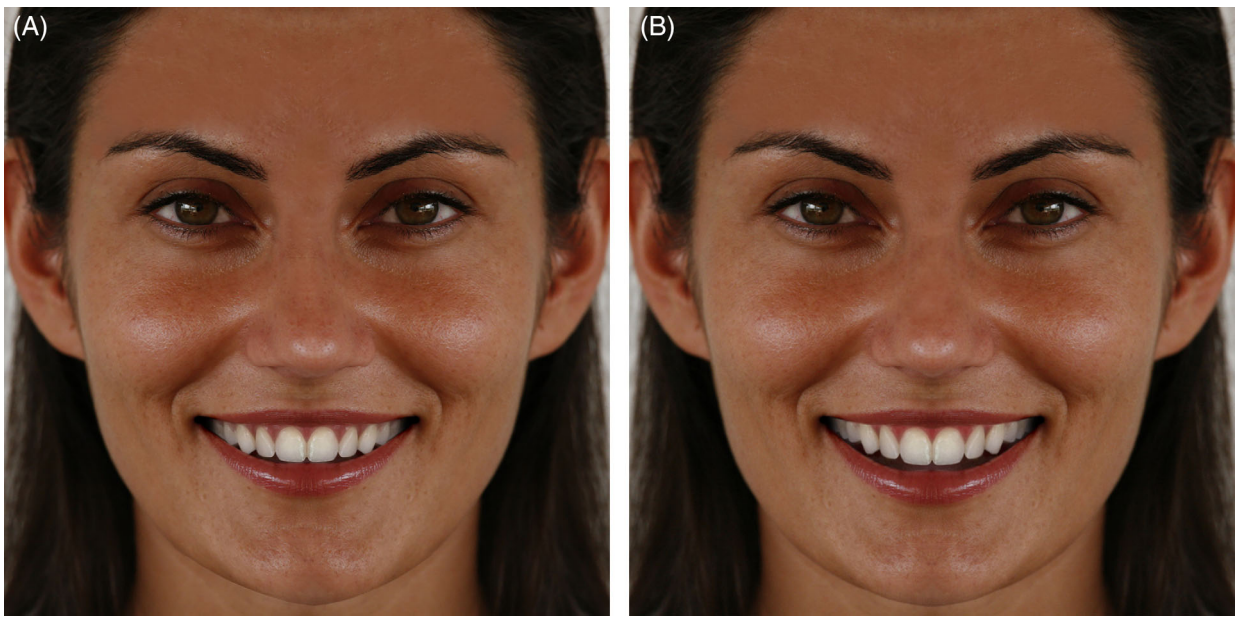

FIGURE 1 A, Asymmetrical facial model (AFM) (right) made from a symmetrical digital control picture. B, Symmetrical facial model (SFM) (left)

A line running parallel to the occlusal plane (OP) was drawn as a reference and then projected next to the previously set interpupillary line. The angle formed between these two lines was measured. In each version of the AFM the transverse cant of the occlusal plane was modified obtaining an angle between OP and interpupillary line of +2°,as seen in Figure 2A, +3°, as showed in Figure 3A, +4°, as seen in Figure 4A, −2°, as showed in Figure 2B, −3°, as seen in Figure 3B and −4°, as showed in Figure 4B.

In total, eight photographs were created: SFM, AFM, and six versions of the AFM with the varying positive and negative angulation of the occlusal plane (Figures 1–4).

Then, a visual Likert scaled was used and delivered via Websurvey software (SurveyGizmo; Widgix, LLC).[7] As in one author's previous publications,[7-9] the Likert scale was used as an alternative to VAS type scale to try to get more objective responses from the subjects and avoid some subjectivity inherent to the natural rating process.[9]

A pilot study was completed by some of the authors to select the sample size.

A cohort of 120 laypersons were selected from a pool of patients who visited 4 different dental practices in Spain (Madrid, Barcelona, Seville and Marbella) during 6 months in 2014 to perform an online internet-based survey. Inclusion criteria were included in the survey

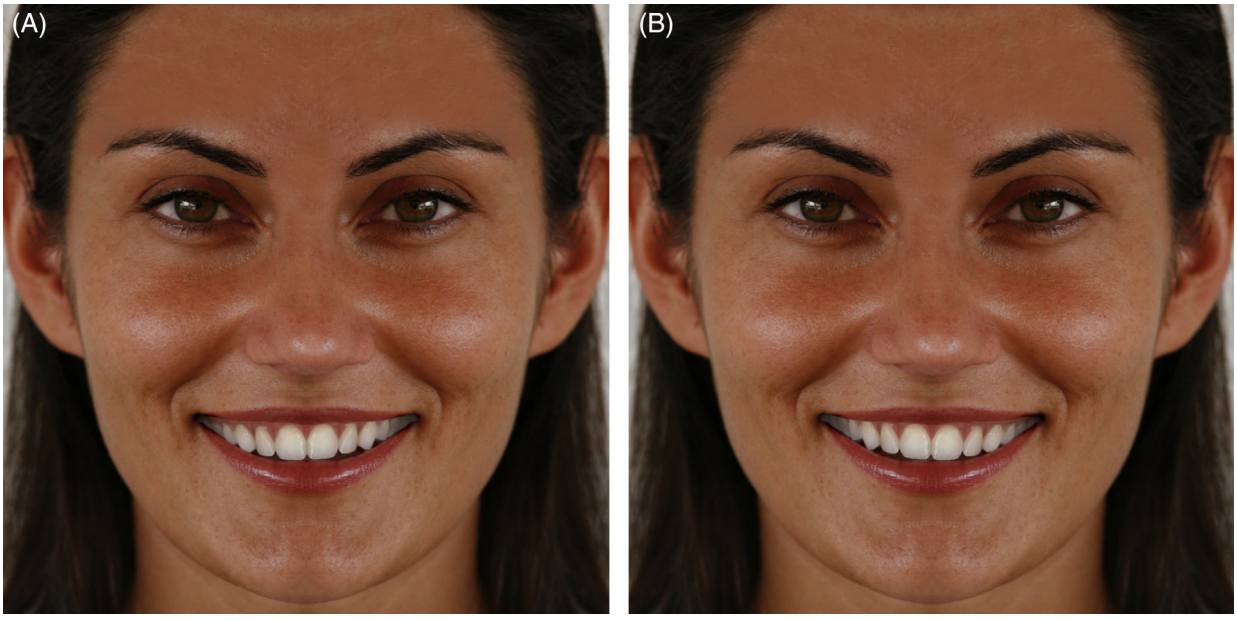

FIGURE 2 A, Occlusal plane cant +2° (left). B, Occlusal plane cant −2° (right)

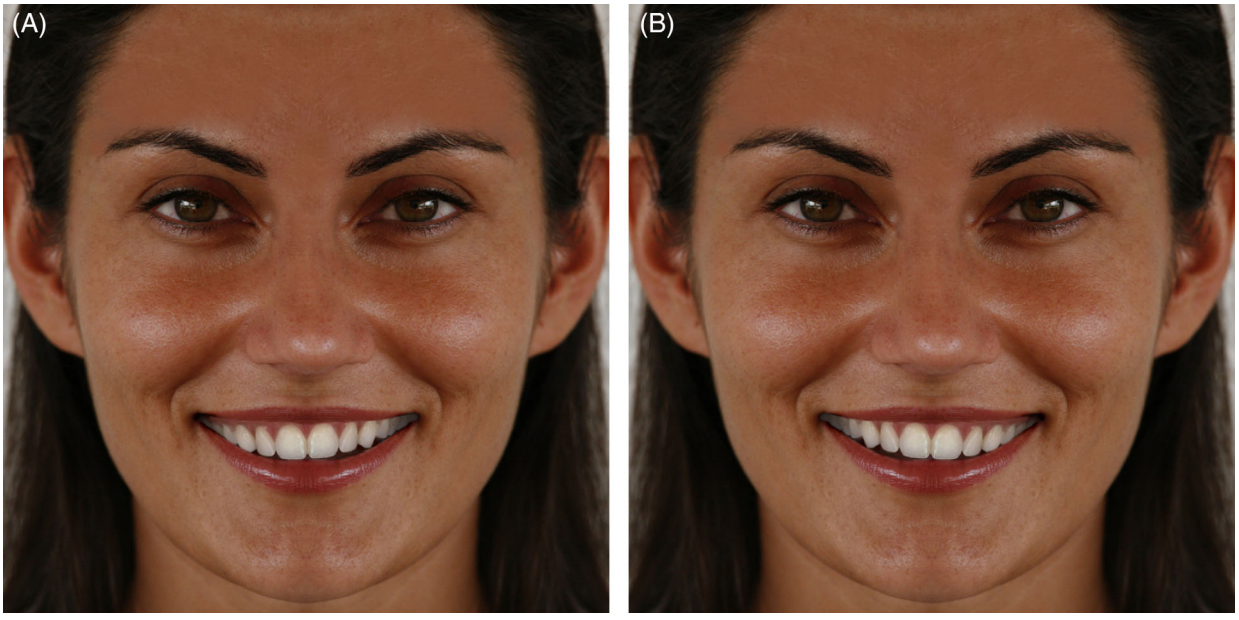

FIGURE 3 A, Occlusal plane cant +3° (left). B, Occlusal plane cant −3° (right)

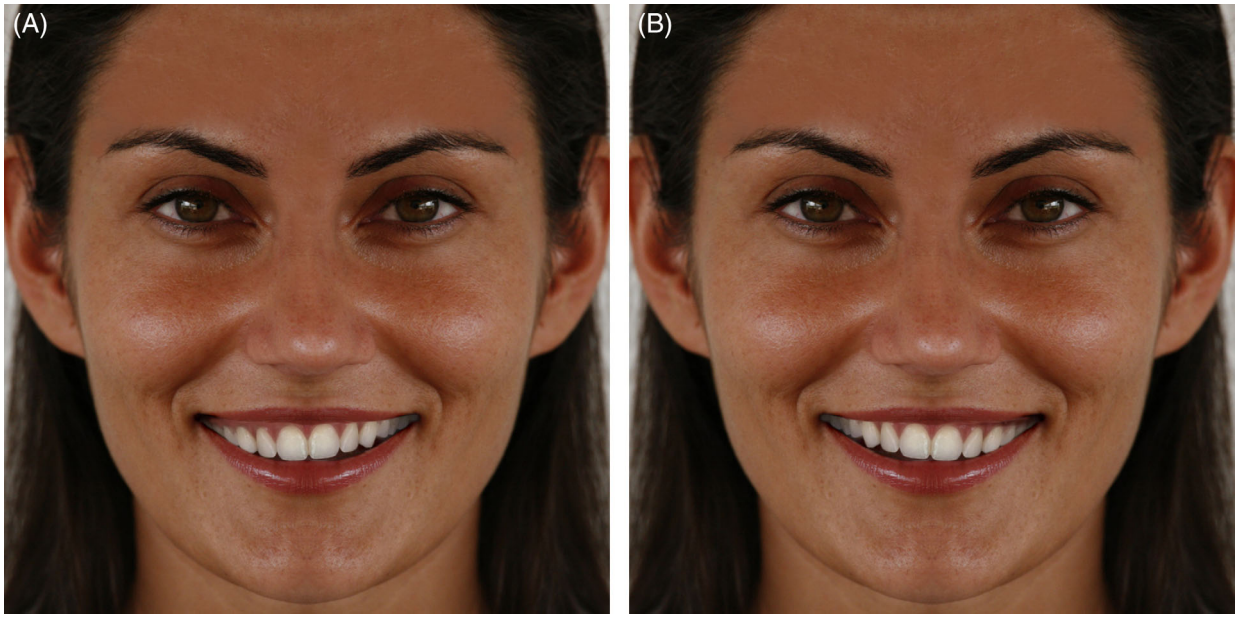

FIGURE 4 A, Occlusal plane cant +4° (left). B, Occlusal plane cant −4° (right)

questions; participants were at least 21 years of age and did not have any knowledge of dental field. Ethnicity and educational background were also noted. This group included 63 females and 57 males, and their age ranged from 21 to 62, with a mean of 40 years old. Educational background and profession were also noted.

The observers had to submit to a survey software through the Internet (surveygizmo.com), where eight random photographs were presented in two different steps. During the first step, the participants only had to observe the images. On the second time, the images were displayed in a different random order and the participants were instructed to evaluate each facial expression according to their personal attractiveness criteria on a Likert rating scale from 1 to 4; 1 being less attractive and 4 being more attractive. Unlimited time was given to evaluate each picture. The same rating method was used in a previous study.[9] No instructions were given to the participants to focus their attention in any specific area, such as smile, midline, teeth, or any other dental parameters, as they were asked about the attractiveness of the facial expression.[8]

The data was collected, and the ratings were charted using SPSS 14-Amos6 Windows.[7] Different tests were used for the statistical analysis. Friedman test (after verification that there was no similarity of variances) was found to be significant ($P < .01$), so the multiple-sample analysis was completed with the Wilcoxon test for paired samples with Bonferroni correction ($P < .0017$). Mann Whitney test was used to determine if age and gender of the participants played any role in their evaluations. Finally, a Kruskal-Wallis test was used to find out if the order in which the photos were presented was of significance in the raters' evaluations. Materials and methods of this study are very similar to a previous study conducted by Silva et al.[10]

TABLE 1 Mean, SD, minimum, and maximum for each picture

	Mean	SD	Max	Min
Symmetrical facial model (control)	3.47	0.593	4	2
Asymmetrical facial model	3.46	0.634	4	1
Occlusal cant +2°	2.85	0.763	4	1
Occlusal cant −2°	2.80	0.763	4	1
Occlusal cant +3°	2.27	0.857	4	1
Occlusal cant −3°	2.23	0.804	4	1
Occlusal cant +4°	2.11	0.924	4	1
Occlusal cant −4°	2.15	0.816	4	1

3 | RESULTS

The descriptive analysis for all pictures is presented in Table 1 and Figure 5. It shows that the mean ratings between control picture SFM and the AFM are very similar.

The subjects rated "less attractive" an occlusal plane cant of 2° or greater compared with the control picture SFM ($P < .0017$).

Standard deviations were found to be consistent, which favors the data dispersion from the average. The maximum value was reached on all pictures, and the same was registered for minimum values, except for the SFM, as seen in Table 1. This supports the assumption that the inclination of the occlusal plane has a significant effect on the perception of facial attractiveness.

The Wilcoxon test was performed for multiple comparisons with the Bonferroni correction, with $P < .0017$.

The comparisons between the pictures' rating values were statistically significant for the following pairs: SFM (Figure 1B) and OC −2° (Figure 2B), AFM (Figure 1A) and OC −2° (Figure 2B), SFM (Figure 1B) and OC +4° (Figure 4A), AFM (Figure 1A) and OC +4° (Figure 4A),

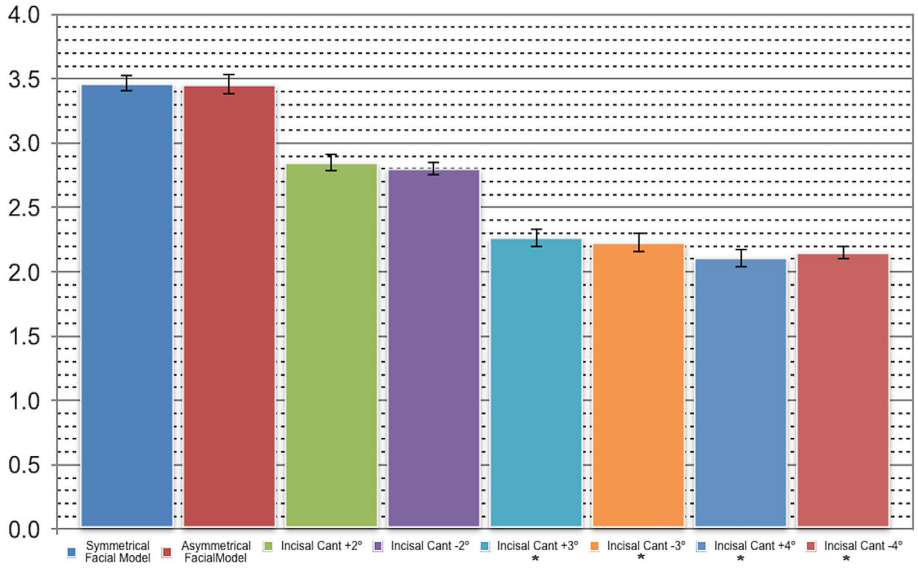

FIGURE 5 Symmetrical facial model, asymmetrical facial control, occlusal cant +2°, occlusal cant −2°, occlusal cant +3°, occlusal cant −3°, occlusal cant +4°, occlusal cant −4° rating preference average results. An asterisk (*) indicates the difference between the these means are not statistically significant ($P > .05$) and these are different statistically at being compared with the others angles

SFM (Figure 1B) with OC +2° (Figure 2A), AFM (Figure 1A) with OC +2° (Figure 2A).

The bar chart shown in Figure 5 indicate OC +3°, OC −3°, OC +4°, OC −4°are statistically equivalent between them, additionally those data points are different statistically from AFM, SFM, OC +2° and OC −2°. Also, AFM and SFM are statistically equivalent and these have shown a statistically significant difference from OC +2 and OC −2°.

This seems to indicate that in asymmetric faces (deviated nose and chin), even a minor occlusal plane angulation, such as 2°, can be perceptible independently of the direction of the cant.

A Mann Whitney test was conducted to disclose if gender and age were determinant factors. There were no significant differences in the ratings between males and females for any picture ($P < .01$).

To analyze age of the rater as a potential factor, subjects in both groups were grouped into segments (decades of age) and no differences were found ($P < .01$).

4 | DISCUSSION

The study was conducted to determine if the nose and chin deviations affect the layperson's perception of transverse occlusal plane. It was based on pictures of several variations of AFMs and a SFM of a patient's face.

The participants of this study evaluated the images in two separate sessions: the first session was a trial observation and the second was the one used for data collection. The initial trial visualization may help to overcome the inherent limitations of the rating process.[5]

As in a previous publication, the Likert scale was used as an alternative to VAS type scale in an attempt to get more objective responses from the participants and avoid subjectivity inherent to the natural rating process.[9]

Although the surveyed subjects were mostly Caucasian, the sample size of the other races included in this study was not representative to establish conclusions at a statistical significance regarding races. Provided that gingival esthetic parameters vary among individuals from different races and that overall smile attractiveness could be influenced, the authors of the present study could not find any references that correlate the perception of chin and nose asymmetries with the race of the subjects. Further studies are needed to establish possible differences.

Many publications have been done in order to establish guidelines regarding the alignment of the anterior segment and the occlusal plane comparing laypersons, dental students, general practitioners, restorative dentists, orthodontists, and prosthodontists. Behrend et al compared the alignment of the anterior segment accepting an angle of 0° to 1°.[4] Some publications came to similar findings and have shown that deviations in the occlusal plane orientation cannot be noticeable unless they are between 2° and 4°.[4,7-9,13-15] Other investigators have reported discordant results, such as Geron et al[16] who concluded that laypersons detect occlusal plane asymmetries when they are larger or equal to 1°. Conversely, Ker et al[17] found that laypeople accepted cants of as much as 4° and that one-third of the participants accepted cants at the maximum deviation of 6°. Fernandes et al[18] found that laypersons considered OP cant not acceptable at 5°. Based on these findings the present study considered reasonable to create pictures with 2°, 3°, and 4° in order to establish the laypersons perception.

On the other hand, other studies like Jimenez-Castellanos et al found no differences between gender,[14] which supports the findings of this study as well.

Some studies compared directly dentists vs laypersons, finding tolerances of 1 mm for dentists and 3 mm for laypersons,[19] others found similarities between both groups.[20,21] The present study found the threshold at 2° (or the equivalent of 1 mm[19]), corroborating the results of Padwa et al,[22] showing a slightly higher sensitivity of the laypersons interviewed compared to the literature. It is evident that there is a high variability of results in the literature regarding

thresholds of esthetically acceptable inclinations of different facial lines and landmarks. One reasonable explanation is the high variability of study designs, landmarks used and targeted groups. The present study, in an attempt to simplify and overcome these drawbacks, tried to assess the isolated variables within the same subject, by modifying the pictures and changing the occlusal cant only. The ultimate goal was to see if the nose and chin inclinations affected the ratings considering which side of the cant was involved.

Nose and chin variables were tested individually in a previous study[9] where the threshold of recognition was 4 mm for the nose and 6 mm for the chin. Human faces usually present subtle asymmetries in both structures that normally are not evident at a first sight. Nevertheless, they can be a modifying factor for some of the smile esthetic parameters such as dental midline shift and dental midline inclination.[9,10] Both of these studies used the same facial model with exactly the same amount of nose and chin asymmetries. It was concluded, that even with the asymmetries being under the threshold of recognition, the perception of midline parameters was influenced. Therefore, this present study was aimed to assess if the same facial asymmetries interfere with the perception of the occlusal cant.

For all pictures where the occlusal plane was canted to the right side (–) of the AFM, opposite direction the nose and chin deviations (Table 1, Figure 5), the mean values were similar to the ones where the occlusal plane was canted to the left side (+). This indicates that the direction of the occlusal plane cant is not relevant in faces with asymmetric noses and chins, because the direction of the asymmetry did not influence the ratings. (Table 1, Figure 5). These results bring out the fact that the inclination of only the nose or only the chin to any side, might not influence the inclination of the occlusal plane cant, since the inclination of both of them to the same side demonstrated not to be relevant to the subject's ratings.

In the present study, no statistically significant differences between the rating values of the SFM and the AFM were found (Figure 1), which suggests that the asymmetries introduced in the nose and chin were not perceivable for most of the subjects (Table 1).

Silva et al, in a previous study, concluded that 3° of frontal incisal plane cant cannot be noticeable by the majority of laypeople.[8] An angulation of 3.5° in the axial dental midline (vertical component) can be notice independently of the direction of the cant, specifically when midline was canted in the opposite direction of nose and chin deviations.[10] There seems to be a relevant correlation between the vertical lines and the horizontal lines.[23]

Facial midline inclination seems to be relevant to determine the dental midline,[10] but horizontal lines like the occlusal plane seem to be more related to the other horizontal lines like the interpupillary line and not really influenced by a nose and chin deviation. The outcomes of this study support that idea, at least from an esthetic standpoint. (perception of laypeople) Since the occlusal plane is an horizontal reference, the perception of its orientation is affected by horizontal references such as lip and commissures as Silva et al showed in 2017.[7] On the other hand, nose and chin define a vertical reference which seems to interfere significantly with vertical dental references (vertical component) such as the dental midline.[9,23]

5 | CONCLUSION

Within the limitations of this study it can be concluded that increasing the occlusal plane cant angulation consistently decreases the attractiveness of a smile. In a face with an asymmetric nose and chin, the direction of the occlusal cant is not a relevant factor to consider.

The occlusal plane should be as parallel as possible with the interpupillary line or the horizontal plane of reference. If an occlusal cant is present, it is more favorable to have an occlusal cant of less than 2° of angulation regardless of the direction of the nose and chin deviations.

Moreover, more studies are needed to evaluate occlusal plane cant on the asymmetric facial model, adding other factors like the height of gingival exposure, different tooth forms, and its relation with other facial lines and structures.

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How to cite this article: Silva BP, Tortora SC, Stanley K, Mahn G, Coachman C, Mahn E. Layperson's preference of the transverse occlusal plane in asymmetric facial model. *J Esthet Restor Dent*. 2019;1–7. https://doi.org/10.1111/jerd.12526