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Perception of mandibular position in Caucasian models in a sagittal view via eye-tracking

Percepção da posição mandibular em modelos caucasianos em uma visão sagital via eye-tracking

Percepción de la posición mandibular en modelos caucásicos en una vista sagital mediante eye-tracking

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Abstract

Eye-tracking studies explore visual photographic perception from a variety of perspectives, as a renewed approach to traditional assessment. The present article aimed to evaluate the esthetic visual perception of laypeople on the lower third of the face, simulating an Angle Class I, Class II, and Class III profile. Class I (straight profile), Class II (mandibular retrognathism), and Class III (mandibular prognathism) were analyzed through a series of edited profile photographs, in the magnitudes of 2.5 mm 5mm, and 7.5 mm in male and female subjects. The changes occurred only in the lower third of the face and the maxilla remained unchanged. The scanning trace of 60 laypeople raters (30 males and 30 females) were recorded using the eye-tracker hardware and the Ogama software to visualize the ocular movement in areas of interest. Heat maps and dots maps were generated by the software to evaluate the main regions of ocular fixation. Each subject was asked to score the attractiveness of each profile separately using a visual analog scale. One-way ANOVA was performed to identify statistically significant differences ($p < 0.05$). Regarding the heatmaps, the perception of lip called great attention from the laypeople. Statistical difference was found for a complete-time of fixation between Class I and Class II 5mm (p=0.029) for the female model, Class I and Class III 7.5mm (p=0,028), Class I and Class II 7.5mm (p=0,013) for the male subject, where the images with the alterations called more attention than with the Class I for both models. As for attractiveness scores, Class, I for the female and male models were considered more attractive. The lower and upper lip demonstrated an influence on profile perception for alterations of 7.5mm in class III for males and females. Class I was considered more attractive for both models. More aged evaluators tented to give higher grades for attractiveness.

Keywords: Eye-tracking technology; Retrognathia; Prognathism; Orthodontics; Orthognathic surgery.

Resumo
Os estudos de rastreamento do olhar exploram a percepção fotográfica visual de uma variedade de perspectivas, como uma abordagem renovada à avaliação tradicional. O presente artigo teve como objetivo avaliar a percepção visual estética de leigos no terço inferior da face, simulando um perfil de Classe I, Classe II e Classe III. Classe I (perfil reto), Classe II (retrognatismo mandibular) e Classe III (prognatismo mandibular) foram analisadas através de uma série de fotografias editadas de perfil, nas magnitudes de 2,5 mm 5 mm e 7,5 mm além do perfil reto em indivíduos dos sexos masculino e feminino. As alterações ocorreram apenas no terço inferior da face e a maxila permaneceu inalterada. O rastreamento do olhar de 60 avaliadores leigos (30 homens e 30 mulheres) foi registrado usando o hardware eye-tracker e o software Ogama. Mapas de calor foram gerados pelo software para avaliar as principais regiões de fixação ocular. Cada sujeito foi solicitado a dar notas de atratividade de cada perfil separadamente usando uma escala analógica visual. Teste ANOVA foi realizado para identificar diferenças estatisticamente significativas ($p < 0,05$). Em relação aos heatmaps, a percepção do lábio chamou bastante atenção dos leigos. Foi encontrada diferença estatística para um tempo completo de fixação entre Classe I e Classe II 5mm ($p=0,029$) para o modelo feminino, Classe I e Classe III 7,5mm ($p=0,028$), Classe I e Classe II 7,5mm ($p =0,013$) para o sujeito masculino, em que as imagens com as alterações chamaram mais atenção do que com a Classe I para ambos os modelos. Quanto aos escores de atratividade, Classe, I para os modelos feminino e masculino foram considerados mais atraentes. Os lábios inferior e superior demonstraram influência na percepção do perfil para alterações de 7,5mm na Classe III para homens e mulheres. A Classe I foi considerada mais atrativa para ambos os modelos. Avaliadores mais velhos tenderam a dar notas mais altas para atratividade.
Palavras-chave: Tecnologia de rastreamento ocular; Retrognatismo; Prognatismo; Ortodontia; Cirurgia ortognática.

Resumen
Los estudios de seguimiento ocular exploran la percepción fotográfica visual desde una variedad de perspectivas, como un enfoque renovado de la evaluación tradicional. El presente artículo tuvo como objetivo evaluar la percepción visual estética de legos en el tercio inferior de la cara, simulando un perfil de Clase I, Clase II y Clase III de Angle. La clase I (perfil recto), la clase II (retrognatismo mandibular) y la clase III (prognatismo mandibular) se analizaron a través de una serie de fotografías de perfil editadas, en las magnitudes de 2,5 mm, 5 mm, 7,5 mm y perfil reto en sujetos masculinos y femeninos. Los cambios ocurrieron solo en el tercio inferior de la cara y el maxilar permaneció sin cambios. El rastreo ocular de 60 evaluadores legos (30 hombres y 30 mujeres) se registró utilizando el hardware de seguimiento ocular y el software Ogama para visualizar el movimiento ocular. El software generó mapas de calor y mapas de puntos para evaluar las principales regiones de fijación ocular. Se pidió a cada sujeto que calificara el atractivo de cada perfil por separado utilizando una escala analógica visual. Se realizó ANOVA unidireccional para identificar diferencias estadísticamente significativas ($p < 0,05$). En cuanto a los mapas de calor, la percepción del labio llamó mucho la atención de los legos. Se encontró diferencia estadística para un tiempo completo de fijación entre Clase I y Clase II 5mm ($p=0,029$) para el modelo femenino, Clase I y Clase III 7,5mm ($p=0,028$), Clase I y Clase II 7,5mm ($p=0,028$). =0,013) para el sujeto masculino, donde llamaron más la atención las imágenes con las alteraciones que con la Clase I para ambos modelos. En cuanto a las puntuaciones de atractivo, Clase, I para los modelos femenino y masculino se consideraron más atractivos. El labio superior e inferior demostraron influencia en la percepción del perfil para alteraciones de 7.5mm en clase III para hombres y mujeres. La Clase I se consideró más atractiva para ambos modelos. Los evaluadores de mayor edad tendieron a otorgar calificaciones más altas por atractivo.
Palabras clave: Tecnología de seguimiento ocular; Retrognatismo; Prognatismo; Ortodoncia; Cirugía ortognática.

1. Introduction

The chin is an important determinant of facial profile attractiveness. Its prominence is one of the facial characteristics that society tends to associate with an individual’s personality. (Naini et al., 2012)

A major role in orthodontics, orthognathic surgery, and plastic surgery is to increase facial profile attractiveness. Those treatments intend to achieve a better facial appearance through increased dental attractiveness. (Gasparello et al., 2022) The orthodontic treatment must be well planned by the orthodontist and patient. Among the many factors that influence the aesthetics of the smile, there is the harmony of the lower profile of the face and the lip that is correlated with a more youthful and aesthetically maximized profile and can be modified by orthodontic movements of the teeth or with the use of agents fillers. (Correa et al., 2014) The lower third of the face is considered an area of paramount importance for cosmetic treatments. The lips, perioral region, and chin need to be in tune and symmetric for a good aesthetic to be achieved. (Raphael et al., 2013)

With the incessant quest for beauty, everything that is not considered aesthetic is seen as out of the norm. (Alhammadi et al., 2018) Some people who complain of unpleasant facial aesthetics and seek orthodontic treatment to restore balance to their facial profile exhibit biprotrusion, a condition in which the upper and lower anterior teeth are prominent, creating a convex profile and making it difficult to close the lips. (Pithon et al., 2014)

It has been suggested that the position of the lips changes according to variations of the facial type. A study suggested that the position of the lips altered according to variations in the size of the nose and chin and asserted the importance of the balance between the parts that make up the face. (Czarnecki et al., 1993)

There is a growing concern about facial aesthetics among patients and professionals, and soft tissues are increasingly emphasized in orthodontic diagnostic methods. Facial harmony is one of the main objectives of orthodontic treatment because the correct positioning of the teeth in the basal bone can alter the profile, including the positions of the upper and lower lips and the nasolabial angles. (Mattos et al., 2012)

The eye-tracking technology is used to assess aesthetics in conjunction with a visual analog scale (Cai et al., 2019; de Oliveira et al., 2019), (Hartmann et al., 2022; Huang et al., 2019) and is known that chin prominence is a potentially important factor in the perception of facial attractiveness. (Huang et al., 2019)

Hence, the objective of this study was to evaluate the aesthetic visual perception of the lower third facial profile in a sagittal view simulating a straight profile in Class I, convex profiles in Class II, and concave profiles in Class III.

2. Methodology

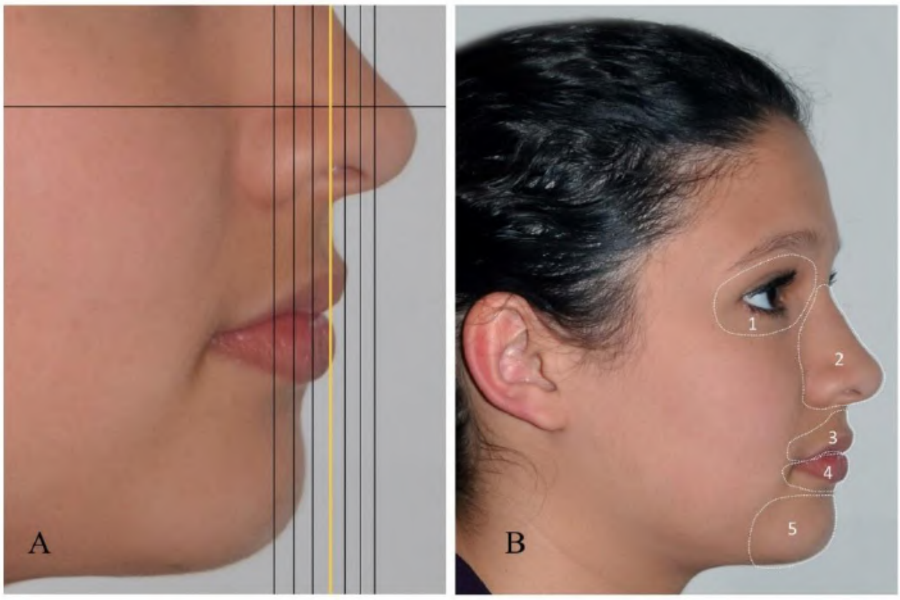
The present study was analyzed and approved by the Research ethics committee of the university under registry number 2,235,302. The study recorded the eye-tacking of 60 laypeople raters not working in dentistry, aged 18-70 years who did not receive any prior notice of the study’s purpose. Raters signed a consent form in which stated that they had good vision, did not use medication or using drugs that could interfere with cognitive or motor skills, no phycological problems, or wearing mascara. Rater who did not meet the criteria for this study were excluded.

Only facial images of the nonsmiling face were used, and in sagittal view, with the Frankfurt plane parallel to the ground. Photographs were taken with a Canon Rebel XTI camera (Canon, Tokyo, Japan).

The selected images were standardized and modified with the help of Photoshop® (Adobe Systems Inc, San Jose, California), using its main tools to dissolve, healing brush, stamp and rectangular sign. The images were calibrated using the ruler and protractor tool, linking height, width and resolution, thus transforming pixels into centimeters so that the changes were performed in real size and proportion (Figure 1). The program was also used to remove imperfections from the face that could distract the attention of the observers (e.g., scars, props, spots on the skin) and interfere with the focus of the project objective.

The Class I profile was chosen considering that the models had the Steiner’s “S” line (Steiner, 1953), passing through the upper and lower lip to the soft pogonion and the middle of the nose base. Then, changes of 2.5 mm, 5.0 mm, and 7.5 mm were altered based on the true vertical line (TVL) (Arnett et al., 1999) to simulate retrognathism (Class II) and prognathism (Class III), in the male and female models (Figure 1A). The changes occurred only in the lower third of the face; thereby, the maxilla remained unchanged.

Figure 1. A. Class I female and lines used for the alterations; B. Areas of interest.



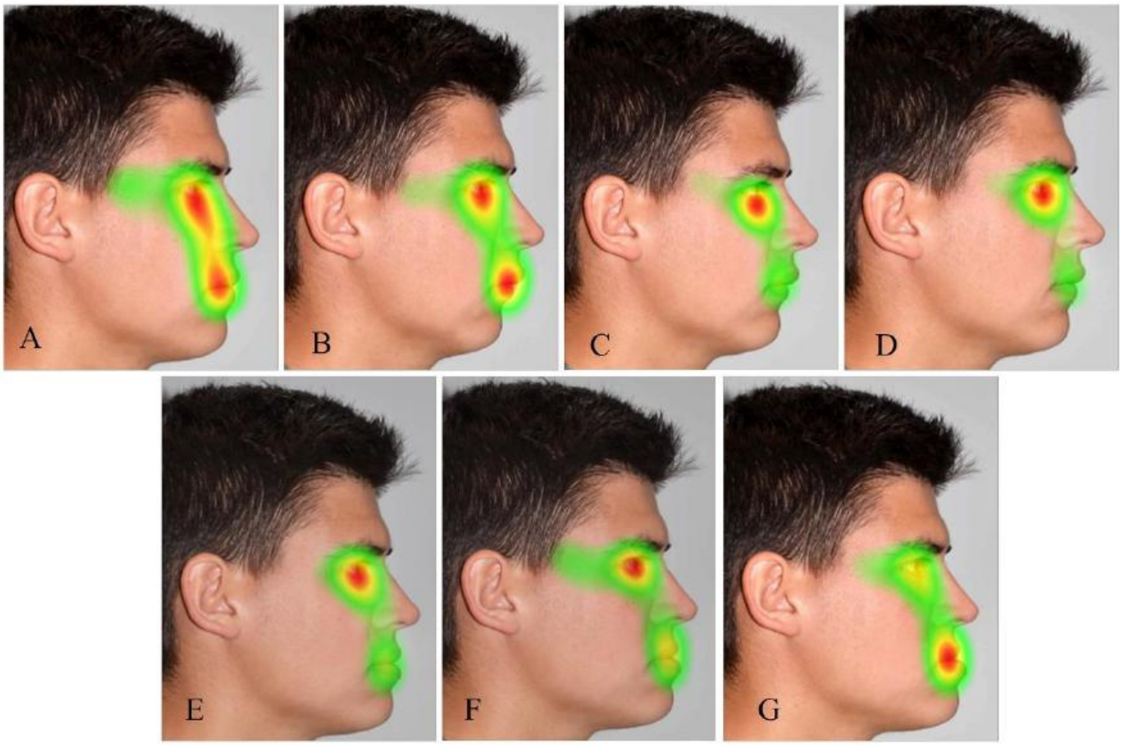
Source: Authors.

To obtain the ocular tracing, Eye Tribe Tracker® (The Eye Tribe Aps, Copenhagen, Denmark) hardware was used in conjunction with Ogama software (Freie Universität, Berlin) to observe the ocular movement of each evaluator in a given interest area. The areas of interest (AOI) are tools used to select regions that maybe extract metrics in a determined zone. For this experiment, those areas were mapped in the images as follows: AOI 1 - Eye, AOI 2 – Nose, AOI 3 – Upper lip, AOI 4 – Lower lip, AOI 5 – chin. (Figure 1B).

After a 9 points calibration and validation, raters were informed that they could freely observe the images and were instructed to sit in a chair so that they felt comfortable at a distance of 60 cm from a 17-inch monitor (Dell P2317H; Dell Inc., Round Rock, TX, USA) following the manufactures recommendation, then the images at a true size were projected vertically. The Eye Tribe Tracker® was positioned just below the monitor as recommended by the manufacturer. In the experiment itself, 14 images were projected, 2 with a straight profile (Class I) 6 presenting retrognathism with changes of 2.5 mm, 5mm, and 7.5 mm (Class II), and 6 showing prognathism also with changes of 2.5 mm, 5mm and 7.5 mm (Class III). Each image was visible for 3 seconds and, between the exchange of images a light-green transition slide was placed to avoid raters' fatigue and that the previous image did not interfere with the first fixation point of the next image. The order of the images was drawn before the experiment via the website <randomizer.org> and followed the same sequence for all raters.

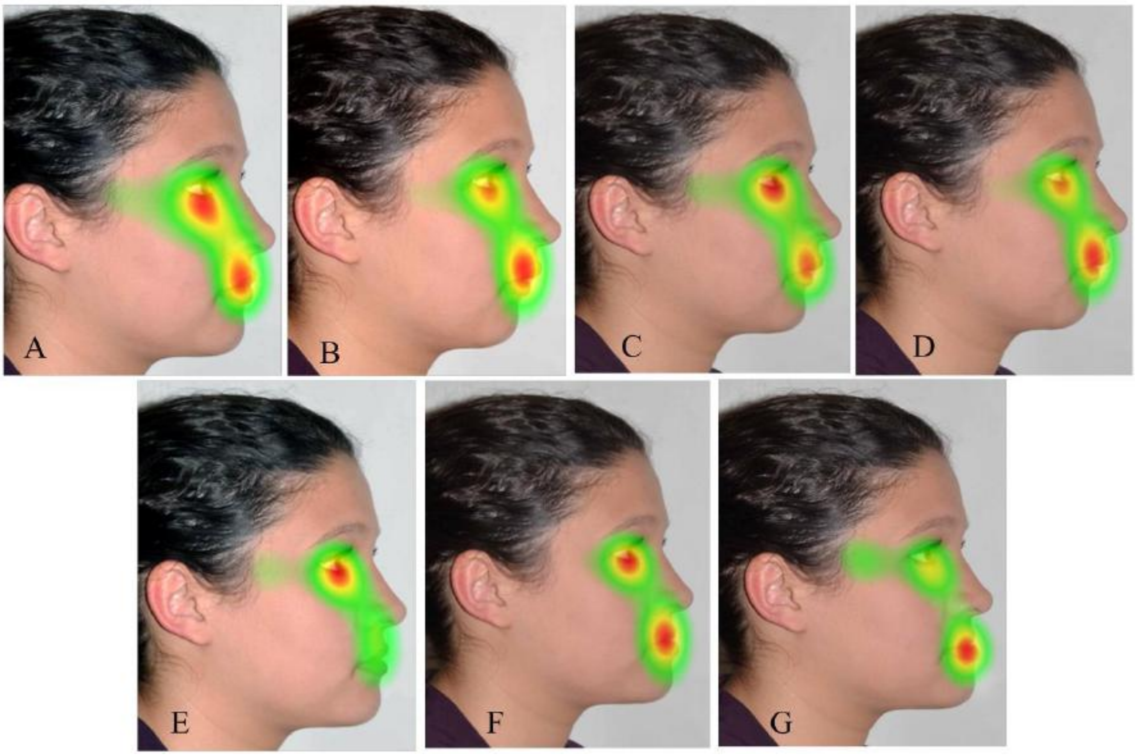
The tracing generated data on heat maps (for Class I, retrognathism, and prognathism of 2.5 mm, 5mm, and 7.5 mm) for the same magnitudes. Heat maps provide information regarding which areas were most observed by raters in the selected AOI, from a color scale ranging from cool (green) to warm (red) colors, and the hotter the color, the more fixations occurred at this point, as well as information from the other areas that will be considered as "other."

Figure 2. Male heatmaps. A. Class I; B. Class II 7,5mm; C. Class II 5mm; D. Class II 2,5mm; E. Class III 2,5mm; F. Class III 5mm; G. Class III 7,5mm



Source: Authors.

Figure 3. Female heatmaps. A. Class I; B. Class II 7,5mm; C. Class II 5mm; D. Class II 2,5mm; E. Class III 2,5mm; F. Class III 5mm; G. Class III 7,5mm.



Source: Authors.

The VAS was used to judge the attractiveness of the same images that were reproduced in Ogama software. The images were shown in full size and were arranged in an album in the same order as the website www.randomizer.org made available. The VAS was delivered in printed form to the evaluator to complete, in which the scores were from 0 to 10, and the closer to 0, the less attractive, the closer to 10, the more attractive. [11]

Statistical Analyses

The results obtained from the eye-tracking software and VAS were tabulated in Microsoft Excel and analyzed in the Statistical Package for Social Sciences version 25 (SPSS; SPSS Inc., Chicago, IL) program.

Kruskal–Wallis test was performed for the eye-tracking data because it presented non-normal distribution. ANOVA test was applied for the VAS score. Levene's homogeneity test was applied to identify homogeneous or heterogeneous distribution. Post-hoc testing was conducted to identify statistical differences; in the event of a homogeneous population, Tukey's honestly significant difference was used, and in the event of a heterogeneous population, the Games–Howell test was applied.

The Pearson correlation was carried out for VAS scores and the age of the subjects. Regarding the reliability test, the Interclass Correlation Coefficient (ICC) was calculated.

Pilot Study

Previously, a pilot study was carried out with 15 subjects following the same study design to test the reliability of the study. The eye-tracking and VAS, were found to $p<0,000$ with Crombach Alfa of 0,822, showing excellent reliability and showed great value for this study.

Results

For the 60 laypeople who entered this study, all the requirements were accomplished and none of them were disqualified. Among the participants, were 50% male (n=30) and 50% female (n=30) and the mean age of the raters was 25,2 years old.

Regarding the heat maps, the results for both male and female models showed gaze concentration mostly in the eye and mouth (lips) areas. It was not possible to observe important differences between Class I profiles compared to Class II and Class III profiles with 2.5 mm changes.

More substantial differences were observed in Class II and Class III profiles with 7.5 mm changes, where the density of the rater's fixation was more focused on the mouth (lips) areas, except for the Class II male which shared the greater fixation in the eye and mouth (lips) area.

Regarding eye-tracking, a statistical difference was found for a complete-time of fixation between Class I and Class II 5mm ($p=0.029$) for the female model, Class I and Class III 7.5mm ($p=0,028$), Class I and Class II 7.5mm ($p=0,013$) for the male subject, where the images with the alterations called more attention than with the Class I for both models. (Table 1)

Table 1. Descriptive data and P value using Kruskall-Wallis Test for complete fixation time

1. Descriptive data and P value using Kruskall-Wallis Test for complete fixation time

Complete fixation time at Eye	N	Mean	SD	p Value
Classe I Female	60	227,83	273,477	
Classe II 2.5mm Female	60	327,47	445,071	
Classe II 5mm Female	60	254,48	406,514	
Classe II 7.5mm Female	60	258,17	400,636	
Classe III 2.5mm Female	60	288,63	332,941	
Classe III 5mm Female	60	759,37	504,176	
Classe III 7.5mm Female	60	236,52	353,065	0,64
Classe I Male	60	213,81	281,776	
Classe II 2.5mm Male	60	253,16	290,169	
Classe II 5mm Male	60	200,15	234,043	
Classe II 7.5mm Male	60	253,42	432,426	
Classe III 2.5mm Male	60	204,50	267,689	
Classe III 5mm Male	60	228,19	312,079	
Classe III 7.5mm Male	60	212,77	328,747	
60 Participants				
P<0,05 Statistical Difference				

Complete fixation time at Nose	N	Mean	SD	p Value
Classe I Female	60	529,77	375,280	
Classe II 2.5mm Female	60	1616,41	1245,785	
Classe II 5mm Female	60	487,64	356,614	
Classe II 7.5mm Female	60	645,67	487,395	
Classe III 2.5mm Female	60	415,57	309,023	
Classe III 5mm Female	60	335,18	225,024	
Classe III 7.5mm Female	60	439,32	453,509	0,365
Classe I Male	60	380,23	283,777	
Classe II 2.5mm Male	60	497,90	384,323	
Classe II 5mm Male	60	378,81	290,700	
Classe II 7.5mm Male	60	478,63	528,109	
Classe III 2.5mm Male	60	529,42	642,366	
Classe III 5mm Male	60	328,180	65,636	
Classe III 7.5mm Male	60	399,50	299,515	

Complete fixation time at Upper Lip	N	Mean	SD	p Value
Classe I Female	60	706,06	624,215	
Classe II 2.5mm Female	60	587,75	430,854	
Classe II 5mm Female	60	633,04	509,482	
Classe II 7.5mm Female	60	675,60	559,873	
Classe III 2.5mm Female	60	559,89	396,657	
Classe III 5mm Female	60	708,96	659,550	
Classe III 7.5mm Female	60	705,86	529,492	0,998
Classe I Male	60	649,27	495,646	
Classe II 2.5mm Male	60	540,63	464,794	
Classe II 5mm Male	60	403,44	214,200	
Classe II 7.5mm Male	60	659,95	454,617	
Classe III 2.5mm Male	60	751,22	626,651	
Classe III 5mm Male	60	607,38	510,184	
Classe III 7.5mm Male	60	677,23	494,781	

Complete fixation time at Lower Lip	N	Mean	SD	p Value
Classe I Female	60	428,67	330,894	
Classe II 2.5mm Female	60	498,38	306,364	
Classe II 5mm Female	60	720,29	585,138	
Classe II 7.5mm Female	60	386,67	223,527	
Classe III 2.5mm Female	60	314,93	200,604	
Classe III 5mm Female	60	720,29	585,138	
Classe III 7.5mm Female	60	663,48	433,090	0,042*
Classe I Male	60	315,76	207,821	
Classe II 2.5mm Male	60	499,59	307,683	
Classe II 5mm Male	60	403,44	214,200	
Classe II 7.5mm Male	60	670,67	540,888	
Classe III 2.5mm Male	60	390,14	219,483	
Classe III 5mm Male	60	410,247	105,925	
Classe III 7.5mm Male	60	596,32	505,238	

Complete fixation time at Chin	N	Mean	SD	p Value
Classe I Female	60	679,50	732,797	
Classe II 2.5mm Female	60	493,00	389,844	
Classe II 5mm Female	60	345,27	196,925	
Classe II 7.5mm Female	60	408,50	169,202	
Classe III 2.5mm Female	60	717,29	653,875	
Classe III 5mm Female	60	717,29	653,875	
Classe III 7.5mm Female	60	757,90	428,231	0,054
Classe I Male	60	473,20	271,958	
Classe II 2.5mm Male	60	569,70	385,141	
Classe II 5mm Male	60	525,15	546,193	
Classe II 7.5mm Male	60	461,86	362,312	
Classe III 2.5mm Male	60	808,78	591,535	
Classe III 5mm Male	60	525,15	546,193	
Classe III 7.5mm Male	60	724,86	436,193	

Source: Authors.

Table 2. Descriptive data and P value using Kruskall-Wallis Test time until 1 fixation

2. Descriptive data and P value using Kruskall-Wallis Test time until 1 fixation

Time until 1 fixation in t Eye	N	Mean	SD	p Value
Classe I Female	60	384,60	650,830	
Classe II 2.5mm Female	60	464,24	637,835	
Classe II 5mm Female	60	318,48	589,949	
Classe II 7.5mm Female	60	451,68	691,432	
Classe III 2.5mm Female	60	503,43	659,650	
Classe III 5mm Female	60	507,76	845,602	
Classe III 7.5mm Female	60	258,85	447,136	0,052
Classe I Male	60	328,58	518,804	
Classe II 2.5mm Male	60	414,19	621,851	
Classe II 5mm Male	60	259,52	394,477	
Classe II 7.5mm Male	60	209,90	332,616	
Classe III 2.5mm Male	60	327,02	625,117	
Classe III 5mm Male	60	249,10	489,933	
Classe III 7.5mm Male	60	256,71	469,728	
60 Participants				
P<0,05 Statistical Difference				

Time until 1 fixation in Nose	N	Mean	SD	p Value
Classe I Female	60	317,94	535,198	
Classe II 2.5mm Female	60	326,90	604,654	
Classe II 5mm Female	60	475,21	747,429	
Classe II 7.5mm Female	60	311,97	509,495	
Classe III 2.5mm Female	60	411,64	604,334	
Classe III 5mm Female	60	278,06	490,403	
Classe III 7.5mm Female	60	364,39	681,733	0,978
Classe I Male	60	371,61	656,772	
Classe II 2.5mm Male	60	416,19	725,745	
Classe II 5mm Male	60	338,53	599,292	
Classe II 7.5mm Male	60	320,58	609,386	
Classe III 2.5mm Male	60	310,32	507,861	
Classe III 5mm Male	60	194,05	321,630	
Classe III 7.5mm Male	60	280,74	457,856	

Time until 1 fixation in Upper Lip	N	Mean	SD	p Value
Classe I Female	60	382,95	609,021	
Classe II 2.5mm Female	60	354,95	556,444	
Classe II 5mm Female	60	386,63	660,167	
Classe II 7.5mm Female	60	345,87	554,029	
Classe III 2.5mm Female	60	262,48	355,154	
Classe III 5mm Female	60	379,11	632,076	
Classe III 7.5mm Female	60	319,31	581,979	0,078
Classe I Male	60	305,60	515,353	
Classe II 2.5mm Male	60	303,89	469,195	
Classe II 5mm Male	60	426,03	651,766	
Classe II 7.5mm Male	60	322,21	529,465	
Classe III 2.5mm Male	60	268,45	447,523	
Classe III 5mm Male	60	312,92	482,660	
Classe III 7.5mm Male	60	374,31	586,417	

Time until 1 fixation in Lower Lip	N	Mean	SD	p Value
Classe I Female	60	291,50	526,363	
Classe II 2.5mm Female	60	445,68	721,922	
Classe II 5mm Female	60	219,95	403,415	
Classe II 7.5mm Female	60	406,52	702,615	
Classe III 2.5mm Female	60	364,51	684,294	
Classe III 5mm Female	60	302,81	519,876	
Classe III 7.5mm Female	60	578,47	800,952	0,052
Classe I Male	60	335,53	606,225	
Classe II 2.5mm Male	60	207,06	427,089	
Classe II 5mm Male	60	263,53	490,882	
Classe II 7.5mm Male	60	306,05	541,150	
Classe III 2.5mm Male	60	244,18	414,558	
Classe III 5mm Male	60	212,92	377,666	
Classe III 7.5mm Male	60	393,77	615,817	

Time until 1 fixation in Chin	N	Mean	SD	p Value
Classe I Female	60	193,63	365,487	
Classe II 2.5mm Female	60	225,31	496,130	
Classe II 5mm Female	60	245,24	437,920	
Classe II 7.5mm Female	60	264,50	559,053	
Classe III 2.5mm Female	60	294,07	592,097	
Classe III 5mm Female	60	267,31	412,151	
Classe III 7.5mm Female	60	382,21	666,889	0,113
Classe I Male	60	221,08	363,687	
Classe II 2.5mm Male	60	150,11	246,385	
Classe II 5mm Male	60	271,30	597,544	
Classe II 7.5mm Male	60	217,27	479,322	
Classe III 2.5mm Male	60	343,63	579,393	
Classe III 5mm Male	60	234,02	473,256	
Classe III 7.5mm Male	60	415,03	653,604	

Source: Authors.

Table 3. Descriptive data and P value using ANOVA.

VAS				
	N	Mean	SD	p Value
Classe I Female	60	7,53	1,686	0,0003
Classe II 2.5mm Femaleb	60	6,34	1,736	
Classe II 5mm Female	60	6,08	2,220	
Classe II 7.5mm Female	60	5,06	2,553	
Classe III 2.5mm Female	60	7,23	2,077	
Classe III 5mm Female	60	5,34	2,509	
Classe III 7.5mm Female	60	4,98	2,045	
Classe I Male	60	7,02	1,635	
Classe II 2.5mm Male	60	6,21	2,026	
Classe II 5mm Male	60	5,92	2,263	
Classe II 7.5mm Male	60	5,37	2,471	
Classe III 2.5mm Male	60	6,82	2,162	
Classe III 5mm Male	60	5,43	1,779	
Classe III 7.5mm Male	60	4,42	2,855	
60 Participants				
P<0,05 Statistical Difference				

Source: Authors.

Table 4. Pearson Correlation		
	Pearson Correlatio	P Value
A.VAS X Age of participants	-0,154	,000
60 Participants		

Source: Authors.

No difference was found in the analyses of time until first fixation (Table 2). Regarding VAS, the models of both gender class I scored higher grades. Shows the statistical difference between Class I females with Class II 5mm (p=0,015) and Class II 7.5mm (p<0,0001), and Class I females with Class III 5mm (p<0,0001) and Class II 7.5mm (p<0,0001). As for Class I males statistical difference was found when comparing with Class II 7.5mm male (p=0,002), Class III 5mm (p<0,0001), and Class III 7.5mm (p<0,0001). Class III 2.5mm female recorded statistical difference with Class II 7.5mm (p=0,001) and Class III 5mm (p=0,001) and Class III 7.5 (p<0,0001). (Table 3)

In addition, Pearson correlation was applied between VAS x Age of the participants. A small but significant difference was found (p<0,0001 r=0,154). No difference was found regarding the gender of the subjects.

3. Discussion

This study aimed to evaluate the aesthetic perception of laypeople via tracking of the eyes. The results were obtained through heat maps and VAS. Laypeople observed images with different positions of the mandible in the sagittal plane, and only higher Class II and III simulations (7.5 mm) seem to have changed their aesthetic perception.

In a general assessment, the laypeople noticed the differences in the lower third of the face when analyzing profile photographs. The perception of the studied group presented the same deviation for the female and male subjects because there was a difference between the alterations, which had a high density in the maximal alterations (7.5 mm), were the results presented significant amounts of concentration in the regions of interest of the group's eyes and perioral region through the heat maps and the gaze trajectory and represent the same results from previous studies using eye-tracking. (Richards et al., 2015)

For Class II and Class III with less alteration (2.5 mm), close to normal Class I, it was noticed that little attention was in the AOI of the lip and perioral region, and presented similar results, (Hockley et al., 2012) sharing attention with the AOI of the eye, thus showing that a subtle alteration of both a Class II and Class III profile may not be relevant to the aesthetics of the individual, influencing as the basis for orthodontic treatment. Although, alterations of 5mm seem to call attention to the lips area for the female model, which may suggest 5mm of retrognathism affected the perception of the female model.

At present, an increased effort is made by orthodontists for the resolution of aesthetic issues related to the lower third of the face, and on many occasions, it is correlated with self-esteem besides aesthetic questions— it is, therefore, necessary to be aware that the two problems are caused by malocclusion; thus, other reasons arise for orthodontists to reconcile functionality and aesthetics, and to potentiate or balance between attractiveness and occlusion. (Kiyak, 2008) In this study, it was described the importance of finishing with balanced relation with the soft tissues of the face.

Human perception is subjective and directly influenced by experiences and gender. Therefore, the concern of the present study was to have a heterogeneous population, composed of 30 women and 30 men. The equal division of the gender is controversial because some studies show that there were no differences independent of gender, (Springer et al., 2011) and another study demonstrated that female observers had increased visual attention in the eye region compared to male observers. (Richards et al., 2015) For this study no difference regarding gender was found. Although, it was found a weak but positive and significant correlation between age and attractiveness scores, meaning as older the evaluator, intended to give higher scores to attractivity.

There is essentially no perfectly symmetrical face, and excessive symmetry can lead to monotony. However, the presence of notorious asymmetries mainly in aesthetic areas leads to an unfavorable harmony, and the visualization of disharmonies (in this case, the position of the mandible) with the use of eye-tracking is innovative in dentistry and maybe the differential of a general practitioner in orthodontic treatment planning. (Baker et al., 2018)

For Naini et al., the facial profile may be a particular source of concern for some individuals, with the chin being a significant reason for patients seeking orthognathic surgery/genioplasty—the authors concluded that chin retrusion or protrusion up to 4 mm is essentially unnoticeable. (Naini et al., 2012) Surgery is desired for chin protrusions more than 6 mm and retrusion higher than 10 mm. The overall direction of aesthetic opinion appears to be the same for all of the observer groups; the higher the retrusion or prominence of the chin, the less the rating of the perceived attractiveness and the stronger the desire for surgical correction. (Naini et al., 2012) In our findings~~,~~ we observed that chin and lower lip changes of 2.5 mm were not perceived by laypeople, in contrast to increased changes of 7.5 mm which it was perceived as less attractive and called attention from the evaluators regarding eye-tracking, as the Class II 5 mm female model, which the lower lip drew attention from the observers.

During interpersonal interaction, the focus of the individuals is mainly on the eyes and mouth of the other person, with little time spent on other facial features. (Ioi et al., 2012) In the opinion of the public, the smile appears in second place, second only to the eyes, the most important feature in facial attractiveness. (Martin et al., 2007)

Every professional who deals with orthodontic treatments with an aesthetic purpose should be aware and alert to the parameters that affect the perception of beauty—the type of beauty that matters in orthodontic treatment. The results of the heat maps showed that the movement of the eyes went toward the increased changes made in the lower third of the face. Ioi et al. concluded that the evaluators tended to prefer a more retrograde lip position for both men and women as facial convexity decreases. (Ioi et al., 2012) As for this study, no statistical differences were found for attractiveness among Class I and Class II and III for the subtle alterations (2.5mm) suggesting that alteration did not interfere with the preference of the evaluators.

Some limitations can be observed in this study by analyzing only one male and one female face, with just mandibular positioning change, and in sagittal view. Other future works can be done using profile and frontal images together or face scans. The suggestion in future investigations is to include dental observers and also to divide by age groups (young, adult, and senior).

4. Conclusion

Visualization of the lower and upper lip demonstrated an influence on profile perception for alterations of 7.5mm in Class III for males and females. As for Class II, 7.5 mm for males and 5 mm for females called the attention of the observers. Class I was considered more attractive for both models. More aged evaluators tented to give higher grades for attractiveness.

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