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Research Article

Lay Person's Esthetic Perception of Black Triangles Using Q-Sort Assessment and Visual Analog Scale

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KEYWORDS

Esthetic perception, Black triangles, Q-Sort, Visual analog scale.

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ABSTRACT

Introduction: Smile is considered the cornerstone of social interactions and smile esthetics may vary depending on various smile variables. Smile variables including buccal corridor space, smile arc, gingival display, occlusal cant and maxillary midline and black triangles. **Objective:** To evaluate the perception of laypersons regarding black triangles between the maxillary central incisors on the esthetics of smile. In addition, we also evaluated the difference between the two grading systems used i.e., Visual analog scale and Q sort assessment. **Methods:** A picture at smile was manipulated using Photoshop (CC 2019; Adobe Systems) computer program. Black triangles of different sizes were then created between the maxillary central incisors in the embrasure areas. Multiple photographs were generated, and they were evaluated via Visual analog scale and Q sort assessment method by 161 laypersons. **Results:** The results showed that the larger the black triangle the less attractive the images were rated, regardless of the assessment method used. The presence of no black triangle or a small black triangle (0.5 mm) resulted in the highest scores in both methods. **Conclusion:** The most attractive image with both assessment methods was the one without any black triangles. Q- sort assessment method is comparable to VAS method in assessing smile esthetics with Laypersons showing consistent agreement in identifying unattractive and attractive smiles. Both assessment methods (VAS scale and Q-sort) showed correlation value =0.9.

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INTRODUCTION

Facial appearance plays an important part in creating a person's impression which is often long lasting.[1] The smile is considered the cornerstone of social interactions and has an impact on attractiveness.[2,3] Facial esthetics is considered an integral part of orthodontic treatment plans for creating beautiful smiles.[2] Aesthetic perception, however, is subjective and influenced by social environment, professional opinion, and personal experience. It has been reported that a difference in perception exists between orthodontists, general dentists and laypersons considering smile aesthetics.[1,3,4] According to previous studies, preferences for smile esthetics may vary depending on various smile variables including buccal corridor space, smile arc, gingival display, occlusal cant and maxillary midline and black triangles.[5,6]

Different grading systems are used to evaluate perception e.g., Standardized Continuum of Aesthetic Need (SCAN)[7] the Oral Aesthetic Subjective Impact Scale (OASIS) or the Visual Analogue Scale (VAS).[8,9,10] To evaluate the degree of perception, the visual analog scale method and Q-Sort assessment methods were used in this study. The visual analog scale (VAS) method is cost effective and simple for obtaining value judgments; therefore, it has good practical application for evaluating esthetic preferences.[7,11] Whereas Q-sort method is executed differently compared to VAS but is still understandable and uncomplicated. Additionally, because Q sort presents a slightly higher level of agreement between evaluators, in terms of evaluating the smile and overall facial esthetics, it could be considered the first choice as a method of scientific evaluation regarding dentofacial attractiveness.[9,10,12]

Black triangle is an important parameter of micro esthetics, which is considered unattractive if appears while smiling, especially in maxillary anterior teeth.[13,14] Black spaces are found in approximately one third of the adult orthodontic patients, in 15% of the general adolescent population and 41.9% in post orthodontic patients treated for maxillary incisor crowding.[15,16] Their presence at the end of orthodontic treatment reportedly influences the smile esthetics and its perception. Hence, the orthodontist must always consider the presence of black spaces before, during and especially at the end of orthodontic treatment. The orthodontist must make use of resources such as interproximal reduction or the space closure for the triangular teeth or any artistic folds.

The etiology of black triangles is multifactorial, it can be related to orthodontic treatment, periodontal disease, loss of the alveolar bone height, decreased papillary height, diverging roots and triangular-shaped crowns or excessive mesial inclination of the central incisors.[9,17] According to a study conducted among patients and dentists, black triangles greater than 3 mm are perceived as unattractive.[17] Another study by Chompunuch et al[8] reported that the absence of a black triangle was considered the most pleasing among a younger age group and an older age group. Some studies have also compared sex differences on smile attractiveness. Similarly, another study reported that both sexes showed same perception when rating black triangles.[18] While several studies have explored the perception of black triangles, most have been conducted with limited focus on regional or cultural differences in esthetic judgment. Moreover, many of these investigations have used a single evaluation tool, often the Visual Analog Scale (VAS), without comparing it to alternative perception-based methods such as Q-sort.

Since, the decision of a patient to undergo orthodontic treatment is based on aesthetic considerations mainly. Various questions can be asked by the patient if the black triangles arise at the end of the treatment. It is imperative for orthodontists to assess and recognize the factors influencing their decision considering the sex-based preferences as well.[19]

To our knowledge, till date there is no research conducted, focusing on laypersons' perception of black triangle in Pakistan. Therefore, the aim of this study was to evaluate the perception of laypersons regarding black triangles between the maxillary central incisors to help the orthodontists better understand patients' needs and concerns, provide patient focused treatment, enhance esthetic treatment planning and minimize dissatisfaction with post-treatment esthetics. In addition, this study compares two different assessment tools—Visual Analog Scale (VAS) and Q-sort methods to evaluate laypersons' esthetic perception of black triangles, something not previously studied together in this context that can provide valuable insight into how black triangles are perceived within the local population and how different evaluation methods may influence esthetic judgment, ensuring that orthodontic outcomes align not only with clinical excellence but also with patient esthetic satisfaction.

MATERIALS AND METHODS

This study was conducted at Rehman College of Dentistry, Peshawar, Pakistan. The data was collected within three months after the approval from the ethical review board of RCD EC Ref no:2021-06-072. Sample size calculated was 161 participants (81 Females, 80 males) using G power 3.1. Effect size was set as 0.58, α error was 0.05, confidence interval was set at 95%.[12]

After an informed consent frontal intraoral photograph of a female patient, in normal occlusion and well aligned teeth was obtained using a digital single-lens reflex (DSLR) camera (Canon EOS 1200D, Canon Inc., Tokyo, Japan) equipped with an EF-S 100 mm f/2.8 Macro USM lens and a macro ring flash for uniform illumination. The photograph was captured at a

standardized distance of approximately 60 cm between the camera lens and the subject's lips, with the camera positioned perpendicular to the facial midline at the patient's natural head position. The image was later cropped to display only the lips, teeth, and gingiva. The purpose being to focus attention on the smile and minimize any confounding factors. The photograph was later manipulated using Photoshop (CC 2019; Adobe Systems) computer program. After alteration, the image was condensed or enlarged to represent the actual size of the patient's teeth. To ensure content validity and visual authenticity, the manipulated images were independently reviewed and approved by two experienced orthodontists, confirming that the modifications appeared realistic and clinically acceptable.

Black triangles of different sizes were then created between the maxillary central incisors in the embrasure areas. This resulted in six photographs: the reference image (Fig.1) with no black triangles and the other images with incremental increase in the size of black triangles (0.5, 1, 1.5, 2, and 2.5 mm). The mandibular arch was left intact. (Fig.1)

The photographs were coded from 1 to 6, later Microsoft office form was created, with two sets of images A and B, so that they could be evaluated via (Visual analog method, 0-10) and Q sort assessment method respectively. Set A had sequential arrangement of photographs with incremental increase in the sizes of black triangles and Set B had a random arrangement of photographs. For VAS, participants were asked to rate the images (0 = least attractive, 10 = most attractive). For the Q-sort assessment, participants were presented with the same six photographs. The images were randomly coded from 1 to 6 to avoid order bias. Each participant was instructed to arrange the six photographs in order of attractiveness, starting with the most attractive (rank 1) and ending with the least attractive (rank 6), based on their personal perception.

Figure 1(A) Images showing black triangles between the maxillary central incisors. 1-No black triangle, 2- Black triangle of 0.5mm ,3- Black triangle of 1mm, 4-Black triangle of 1.5 mm, 5- Black triangle of 2mm, 6-Black triangle of 2.5 mm.

Figure 1(B) Set B: 1- Black triangle of 1mm, 2- No black triangle, 3- Black triangle of 2.5 mm, 4- Black triangle of 0.5mm, 5-a, Black triangle of 2mm, 6-Black triangle of 1.5 mm.

The photographs were evaluated by 161 laypersons from both sexes using both grading systems. Participants were recruited through non-probability convenience sampling from general population including individuals representing the age group most concerned with smile esthetics i-e 13-40 years, residents of the local community (general population, not restricted to a single

institution), good visual acuity (with or without corrective lenses) ensuring reliable assessment of photographs and equal distribution of males and females to minimize gender bias in perception. Individuals with an orthodontic background i-e dental professionals, dental students, and orthodontic patients were excluded from the study. To minimize bias, participants were blinded to true objective of the study and were informed only that they were evaluating smile attractiveness. After asking for their consent for participation in the study, they were asked to complete Microsoft office questionnaires about the images, including both systems. Age, sex, and occupation were mentioned on the front page of questionnaires.

All images were placed 30 cm (about 11.81 in) from the evaluators' eyes. One factor for exclusion of an evaluator was lack of visual acuity. The evaluators were asked to examine each view for a maximum of 20 seconds without being able to re-evaluate the previously seen photographs. The time gap between both sets was 5mins to eliminate fatigue bias.

Data were analyzed using IBM SPSS version. The Mean scores and standard deviation were calculated for the quantitative data (age, VAS assessment scores). Frequencies were calculated for the qualitative data (Sex, and Q sort assessment rating). Sex based comparisons with the scores of VAS and Q-Sort Assessment methods were determined via independent t test and Chi-square test, respectively. When the expected frequency was found to be less than 5, the Fischer exact test was used. The level of significance was adopted as 5 % (P = < 0.05). Spearman correlation was used to determine the similarity of perceptions between the two assessment methods.

RESULTS

Out of 161 subjects 50.3% were females and 49.7% males. Figure 2 and 3 shows the Graphic representation of descriptive statistics of the overall perception of the participants, calculated for VAS and Q-sort assessment methods, respectively.

Using VAS scale assessment, the participants rated image 1 as the most attractive and image 6 as least attractive, mean values were found to be 7.28 ± 2.08 and 3.91±1.5. (Figure 2). The most attractive picture rated by the participants using Q-Sort assessment was Image 2 (53.4%) i.e. 1 in original distribution and least attractive was image 3 (46%) i.e., in original distribution was image 6. (Figure 3). Both assessment methods (VAS scale and Q-sort) showed correlation value = 0.9

Table 1 shows the perception of participants using VAS assessment scale regarding sex. The data revealed insignificant difference in the mean scores of perceptions among males and females for both the most and least preferred images. Although, Levene test for equality of variances reported the perception to be significantly different (p=0.016), rejecting the null hypothesis, among the two groups for image no 3, revealing lack of homogeneity between the variables of the two groups. However, this difference of mean values was clinically insignificant among the group using independent t-test (p=0.87).

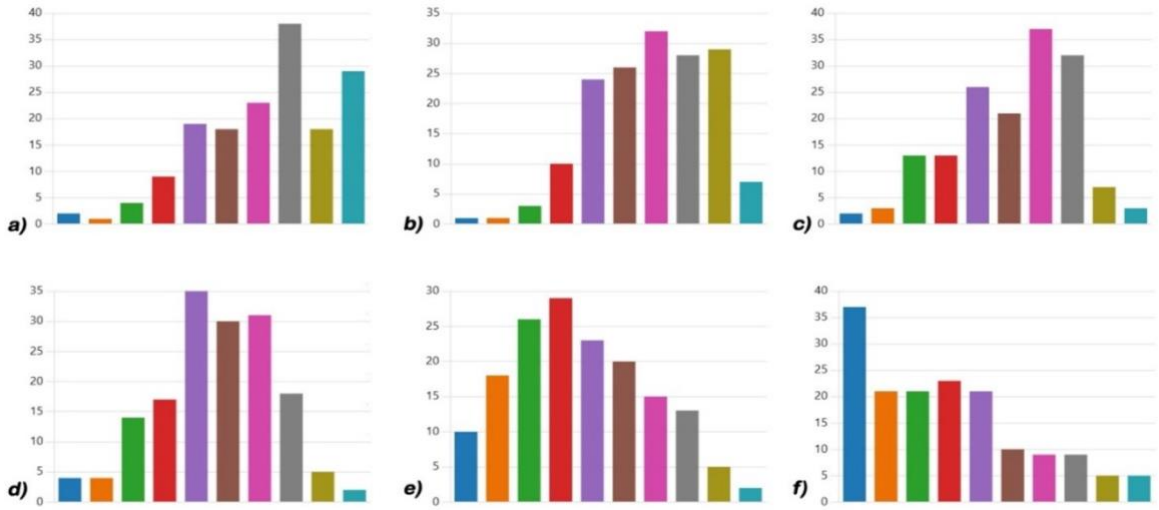

Figure 2. Showing overall perception of the laypersons by VAS assessment (Most Attractive to least attractive) using set A; a=7.28 ± 2.08, b=6.87±1.83, c=5.98±2.1, d =5.61±1.9, e=4.61±2.1, f=3.91±1.5

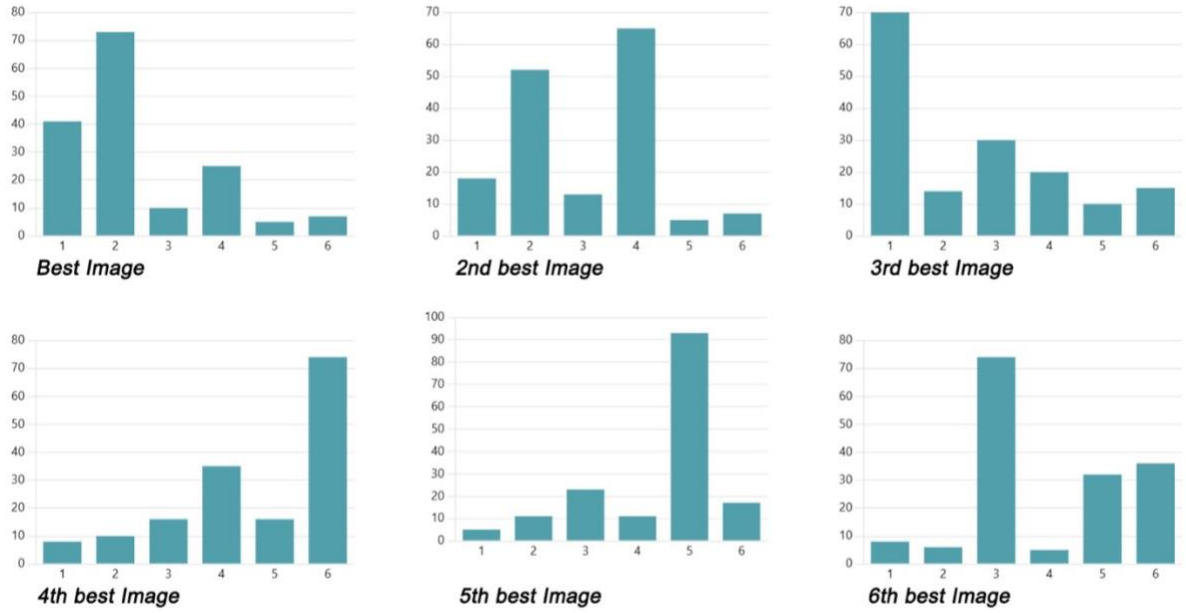

Figure 3: Showing overall perception of the lay persons by Q-sort assessment using Set B

Table 1. Participants perceptions and differences with respect to gender using VAS assessment

	Gender	N	Mean	SD	P value
Picture 1	Females	81	7.68	2.126	0.14
	Males	80	6.88	1.971	
Picture 2	Females	81	7.07	1.961	0.155
	Males	80	6.66	1.683	
Picture 3	Females	81	5.94	2.389	0.79
	Males	80	6.03	1.800	
Picture 4	Females	81	5.53	1.988	0.60
	Males	80	5.69	1.839	
Picture 5	Females	81	4.51	2.276	0.39
	Males	80	4.80	2.089	
Picture 6	Females	81	3.74	2.534	0.40
	Males	80	4.08	2.540	

Independent t test

Table 2. Distribution of Participants perceptions and differences with respect to gender using Q-sort assessment

	Gender	1	2	3	4	5	6
Best 1	Females	12	47	4	15	2	1
	Males	13	39	8	13	3	4
Best 2	Females	7	19	3	44	3	4
	Males	13	19	5	36	2	5
Best 3	Females	48	5	7	7	4	9
	Males	36	7	9	12	6	9
Best 4	Females	3	3	3	8	5	57
	Males	6	6	12	10	11	35
Best 5	Females	1	5	8	4	58	5
	Males	4	6	16	6	35	12
Best 6	Females	3	2	53	1	12	10
	Males	4	5	38	4	20	9

Chi square test

Table 2 presents the perception of the participants using Q-sort assessment of set B with respect to the sex. The data showed an insignificant difference in perception of images using the Q- sort assessment method with respect to sex.

DISCUSSION

In this study we evaluated the layperson's perception of smile esthetics in patients with black triangles of different sizes, using the Q-sort and visual analog scale (VAS) assessment methods. The use of two independent assessment techniques allowed for both a quantitative evaluation (VAS) and a comparative ranking (Q-sort) of the same photographic stimuli, enhancing the reliability of the findings. By including a randomized image set, potential order or learning biases were minimized, ensuring that each photograph was judged independently based on its esthetic value rather than its position in the sequence. This approach provided a more robust understanding of how incremental changes in interdental spacing influence perceived smile attractiveness among lay observers.

The results of both groups concerning the esthetic effect of black triangles between the maxillary central incisors were similar, i.e., the larger the black triangle, the less attractive the images were rated. The presence of 0.5-mm black triangles or no black triangle resulted in the lowest scores in both methods. These results are in accordance with a study by Sriphadungporn et al[9] which showed comparable

results but contrasted when compared with lay people in the study of Kokich et al.[17] which showed greater deviation (3 mm) for the lay people to rate the smile as less attractive. This difference may reflect that esthetic perception gradually changes over time and is subject to ethnicity.

We found that the overall perception of the participants calculated for VAS and Q-sort assessment methods was correlated well. These results are in contrast with a study by Schabel et al[12] who found that the reliability of the Q-sort method was greater than the VAS method.

Our study results are difficult to compare with literature as limited studies have been conducted to determine and evaluate the relationship between Q-sort and VAS assessment methods. A study by Oliveira et al[10] compared VAS and Q sort for assessing smile and dental attractiveness and found that Q-sort rates were higher in all groups. Another study showed that Q-sort was more reliable than the VAS for measuring smile esthetics.[12]

The average scores of both the assessment methods (VAS and Q-sort) were correlated well in our study, suggesting both methods agreed with respect to esthetic perception. The reason behind the perfect correlation between the two methods could be related to the increase in raters. Factors, such as sex and age, are considered to have an influence on the esthetic perception of the smile. This study showed statistically insignificant differences regarding sex. The data revealed insignificant difference in the mean scores of perceptions among males and females for both the most and least preferred images for both the methods. This is in agreement with the previous literature which showed no difference in perception of black triangles with regard to sex.[8,18]

However, study by Schabel[12] et al concluded men and women to poorly agree with respect to smile both attractive and unattractive. In their study women rated more smile as attractive compared to males. They concluded women to be better able to judge certain parameters of smile esthetics compared to males.[12] Some studies have compared esthetic preferences based on age. A study by Matheus et al[7] showed statistically significant differences in perception of black triangles with regard to age. Similarly, another study reported that age impacts smile perception based on maxillary gingival display and black triangle.[8]

This study had certain limitations, no comparisons in age groups were made in this study, however there are reported differences with respect to age in literature. The sample size was limited and drawn from a single community, which may restrict the generalizability of the findings to other populations or ethnic groups. Only static photographs were used for evaluation; dynamic facial expressions and natural head movements, which influence smile perception in real life, were not assessed. The study included a female subject, which may have introduced gender-related bias in perception.

Future studies should consider larger, multi-center samples, inclusion of both male and female models, dynamic smile assessments (e.g., video-based evaluations) to enhance external validity. Furthermore, other esthetic parameters e.g., gingival display, midline, smile arch, tooth widths etc. can be compared. There are reported differences in perception of laypersons vs orthodontists**.** Hence, more categories should be created in future studies comparing different population groups.

CONCLUSIONS

The study concluded that the most attractive image, according to both assessment methods, was the one without any black triangles. Furthermore, the Q-sort assessment method proved comparable to the Visual Analog Scale in evaluating smile esthetics, as laypersons showed consistent agreement in identifying both attractive and unattractive smiles. Clinically, these results emphasize the importance of orthodontists and restorative dentists to identify patients' sensitivity to black triangles, especially in the anterior esthetic zone. Early detection and treatment, using methods such interproximal reduction, controlled tooth movement, or restorative contour modification, can reduce post-treatment aesthetic concerns and increase patient satisfaction with treatment results.

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