Comparing the Perception of Dentists and Lay People to Altered Dental Esthetics

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ABSTRACT

Purpose: This study was designed to determine the perceptions of lay people and dental professionals with respect to minor variations in anterior tooth size and alignment and their relation to the surrounding soft tissues.

Materials and Methods: Smiling photographs were intentionally altered with one of eight common anterior esthetic discrepancies in varying degrees of deviation, including variations in crown length, crown width, incisor crown angulation, midline, open gingival embrasure, gingival margin, incisal plane, and gingiva-to-lip distance. Forty images were randomized in a questionnaire and rated according to attractiveness by three groups: orthodontists, general dentists, and lay people; 300 questionnaires were distributed.

Results: The response rate was 88.2% for orthodontists, 51.8% for general dentists, and 60.6% for lay people. The results demonstrated threshold levels of noticeable difference between the varying levels of discrepancy. A maxillary midline deviation of 4 mm was necessary before orthodontists rated it significantly less esthetic than the others. However, general dentists and lay people were unable to detect even a 4-mm midline deviation. All three groups were able to distinguish a 2-mm discrepancy in incisor crown angulation. An incisal plane cant of 1 mm as well as a 3-mm narrowing in maxillary lateral incisor crown width were required by orthodontists and general dentists to be rated significantly less esthetic. Lay people were unable to detect an incisal plane asymmetry until it was 3 mm, or a lateral incisor narrowing until it reached 4 mm. Threshold levels for open gingival embrasure and gingiva-to-lip distance were both at 2 mm for the orthodontic group. Open gingival embrasure became detectable by the general dentists and lay people at 3 mm, whereas gingiva-to-lip distance was classified by these groups as noticeably unattractive at 4 mm.

CLINICAL SIGNIFICANCE

The results of this study show that orthodontists, general dentists, and lay people detect specific dental esthetic discrepancies at varying levels of deviation, which may aid the dental professional in making specific treatment recommendations.

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In recent years cosmetic or esthetic dentistry has become a major focus for the American public. Dale Carnegie described the smile as one of the most important methods of influencing people. Television and movies have exposed viewers to beautiful faces and brilliant smiles. Unfortunately, however, teeth are

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usually not in perfect balance with their surrounding structures. Miller stated that the trained and observant eye readily detects that which is out of balance, out of harmony with its environment, or asymmetric.[1] These imbalances may be seen in nature, architecture, art, and dentistry. Investigation of lay people's self-perception of dental esthetics has focused largely on gross esthetic discrepancies related to debilitating malocclusions.[2–6] However, no studies have evaluated anterior dental esthetics by investigating an individual's perception of graduated degrees of abnormality. Furthermore, no studies have established thresholds for these esthetic criteria that could be used by orthodontists, periodontists, restorative dentists, and oral and maxillofacial surgeons to aid in planning treatment. Therefore, the purpose of this study was to determine the lay person's and dental professional's perception of minor variations in anterior tooth size and alignment as well as their relation to the surrounding soft tissues. The following four hypotheses were tested:

1. Orthodontists will be more perceptive than general dentists in detecting minor degrees of variation from ideal in specific dental esthetic discrepancies.
2. Lay people will be less discerning of specific dental esthetic discrepancies than general dentists or orthodontists.
3. The ranking of the most and least noticeable dental or facial feature will differ significantly among orthodontists, general dentists, and lay people.
4. Respondents with strong obsessive-compulsive tendencies will be more perceptive in detecting minor degrees of specific dental esthetic discrepancies.

MATERIALS AND METHODS

Sample

Three groups of raters were used in this study: orthodontists, general dentists, and lay people. The orthodontic and general dental groups consisted of graduates of the University of Washington School of Dentistry. They were randomly selected from lists provided by the school. The lay group consisted of business people, attorneys, teachers, and other assorted workers. Each rater was given as little information about the study as possible. Three hundred surveys were distributed to the three groups. The response rate was 88.2% (60/68) for orthodontists, 60.6% (74/122) for lay people, and 51.8% (57/110) for general dentists. The orthodontists had an age range of 29 to 61 years (mean, 45 yr); the general dentists, 27 to 67 years (mean, 42 yr); and the lay people, 22 to 61 years (mean, 39 yr).

Variables and Measurements

To test the hypotheses, the three groups rated a series of eight different esthetic discrepancies. The survey consisted of five variations of eight individual photographs, for a total of 40 images. Each smile was intentionally altered with one of eight common anterior esthetic discrepancies in varying degrees of deviation. The eight deviations were selected following consultation with clinically experienced orthodontists and general dentists. Deviations were chosen based on their frequency of occurrence and clinical significance to the smile. They included variations in

1. Crown length
2. Crown width
3. Incisor crown angulation
4. Midline
5. Open gingival embrasure
6. Gingival margin
7. Incisal plane
8. Gingiva-to-lip distance

The nose and chin were eliminated from the pictures to reduce the number of confounding variables. For the same reason only female smiles were used, and similar skin tones were chosen. Each esthetic characteristic was altered with four progressive variations of the original smile photograph. The smiles were scanned and altered in Adobe Photoshop 4.0 using a Macintosh Power PC computer. Following alteration, the images were condensed or enlarged to achieve an image size that represented actual tooth-size. Each esthetic characteristic was altered in varying increments. Some were altered in 0.5-mm increments, some in 1.0-mm increments, and others in 2.0-mm increments.

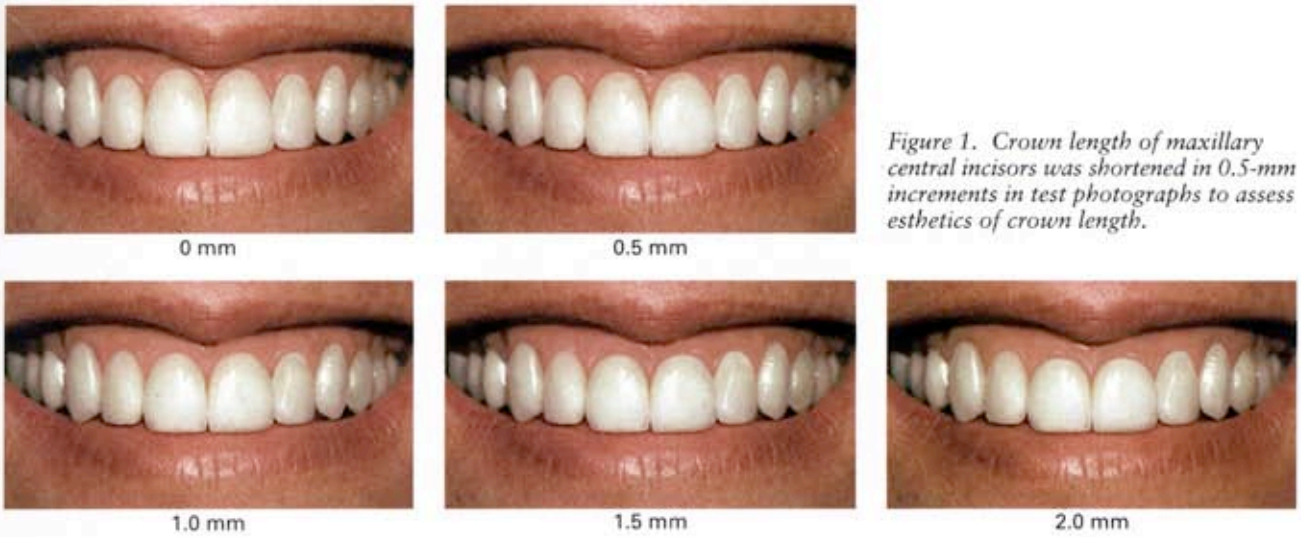

Figure 1. Crown length of maxillary central incisors was shortened in 0.5-mm increments in test photographs to assess esthetics of crown length.

Crown Length. The teeth chosen for alteration were the patient's maxillary central incisors. The crown length was shortened in 0.5-mm increments by selectively altering the level of the marginal gingiva (Figure 1). The consistent reference points for these measurements were the most superior points on the labial marginal gingiva of the patient's adjacent lateral incisors and canines. The incisal edges were maintained at the same level to simulate supra-eruption of the central incisors and isolated incisal wear.

Crown Width. Since the most common variation in crown width affects the size of the lateral incisors, the alterations of crown width were made to the maxillary lateral incisors. The marginal gingiva was kept at the same level, and the width of the lateral incisor crowns was decreased in 1.0-mm increments (Figure 2). Measurements were made between the interproximal contact points.

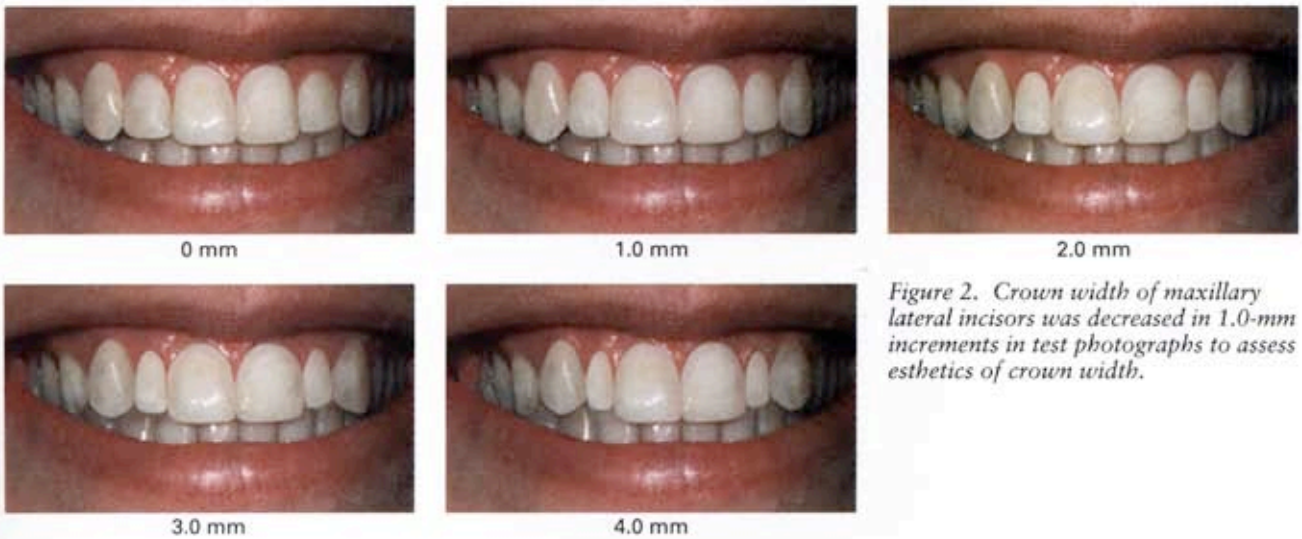

Figure 2. Crown width of maxillary lateral incisors was decreased in 1.0-mm increments in test photographs to assess esthetics of crown width.

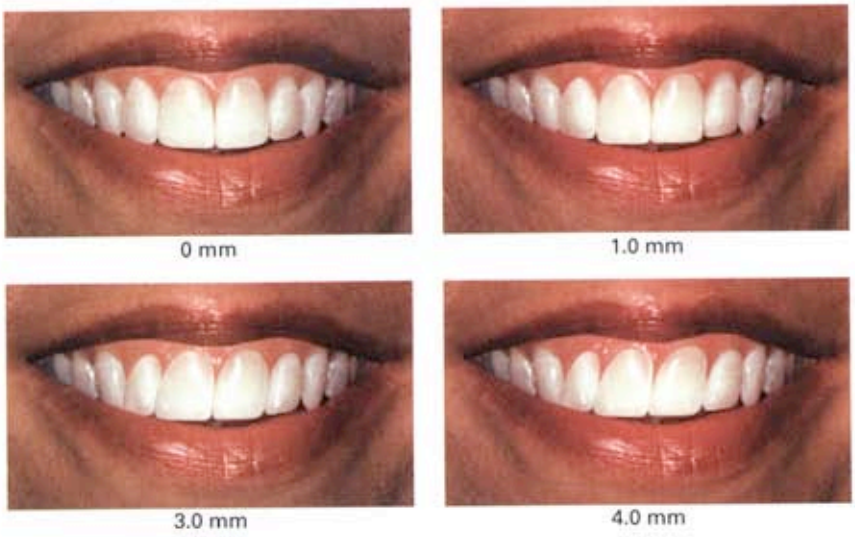

Figure 3. Incisor crown angulation of maxillary canine and incisor crowns was angled to the patient's right in 1.0-mm increments in test photographs to assess esthetics of crown angulation.

Incisor Crown Angulation. Alterations were made to the patient's maxillary canine and incisor crowns. They were angled toward the patient's right side in 1.0-mm increments when measured from the midline papilla to the most gingival portion of the incisal embrasure between the maxillary central incisor crowns. The adjacent lateral incisors and canines also were angled to the right in 1.0-mm increments (Figure 3).

Midline. When altering the midline, the surrounding soft tissues including the lips and skin were maintained, while the entire maxillary dental segment was shifted in 1.0-mm increments toward the patient's left. The center of the upper lip or the "cupid's bow" was used to represent the facial midline. The incisal plane was maintained at the same level in the five images.

Open Gingival Embrasure. The gingival embrasure between the maxillary central incisors was altered to simulate crown-shape

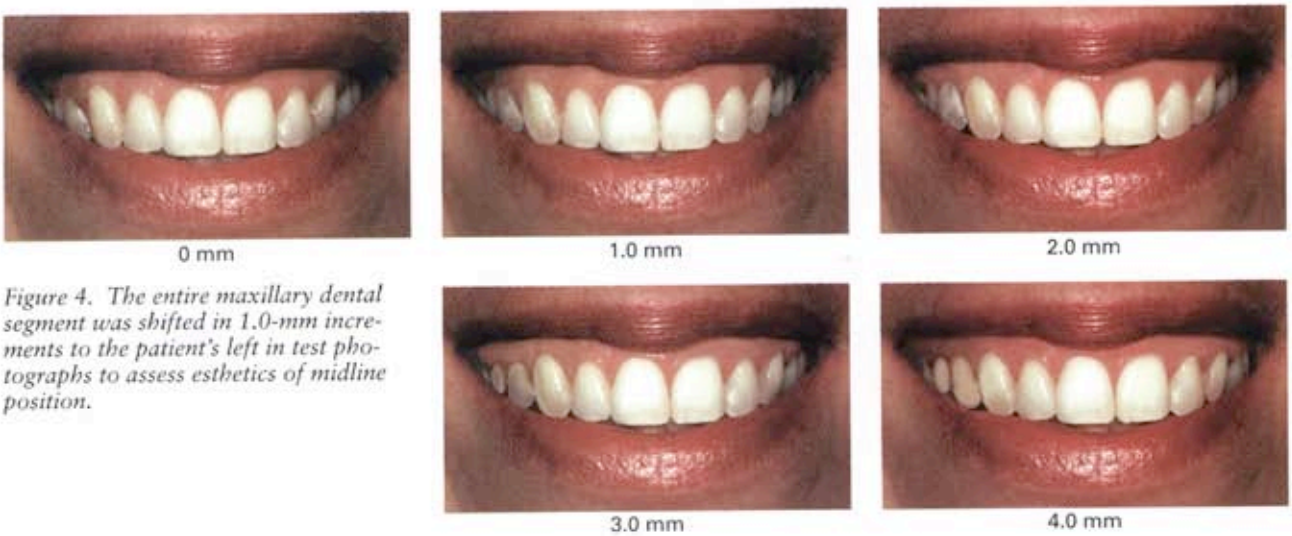

Figure 4. The entire maxillary dental segment was shifted in 1.0-mm increments to the patient's left in test photographs to assess esthetics of midline position.

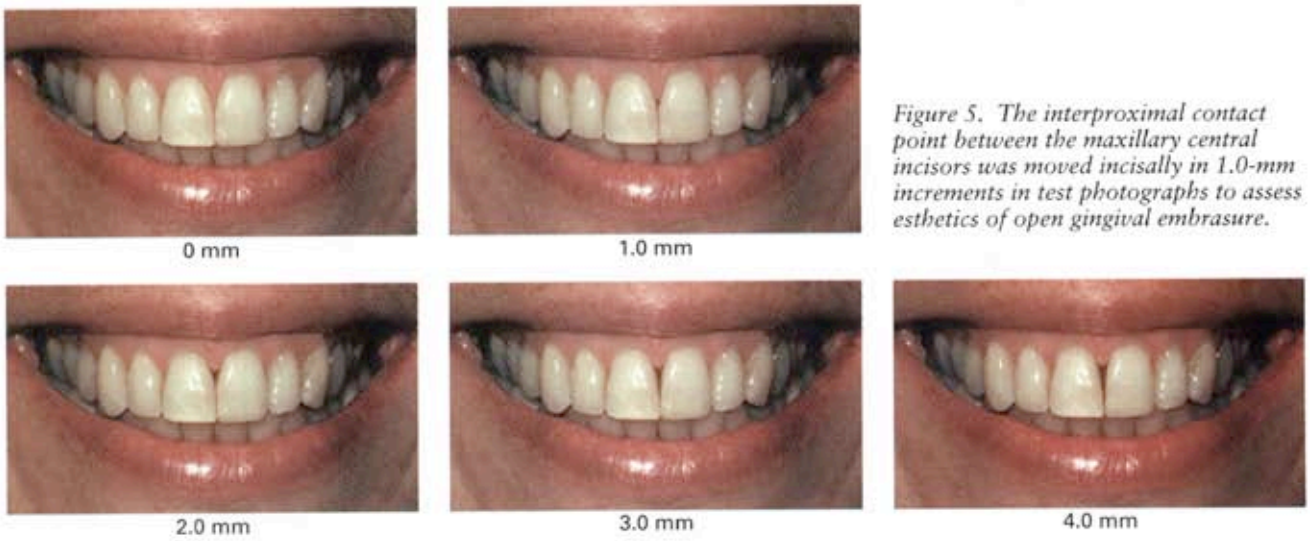

Figure 5. The interproximal contact point between the maxillary central incisors was moved incisally in 1.0-mm increments in test photographs to assess esthetics of open gingival embrasure.

discrepancies. The interproximal contact point between the maxillary central incisors was moved incisally in 1.0-mm increments (Figure 5). The varying lengths of open gingival embrasure were measured from the tip of the interdental papilla to the interproximal contact point. All attempts were made to retain a natural midline interdental papilla.

Gingival Margin. Alterations in gingival margin level were made to the lateral incisors. They were bilateral and affected the labial marginal gingiva of the maxillary lateral incisors. The smile used for this variable had radiating symmetry and balance of gingival margin level between the right and left sides. Canine and central incisor gingival margins were maintained at a consistent height. Each degree of variation was measured from this level. Ideal gingival level for the lateral incisors was considered to be 1.0 mm incisal to the canine and central incisor gingival levels. The altered images varied in 0.5-mm increments (Figure 6).

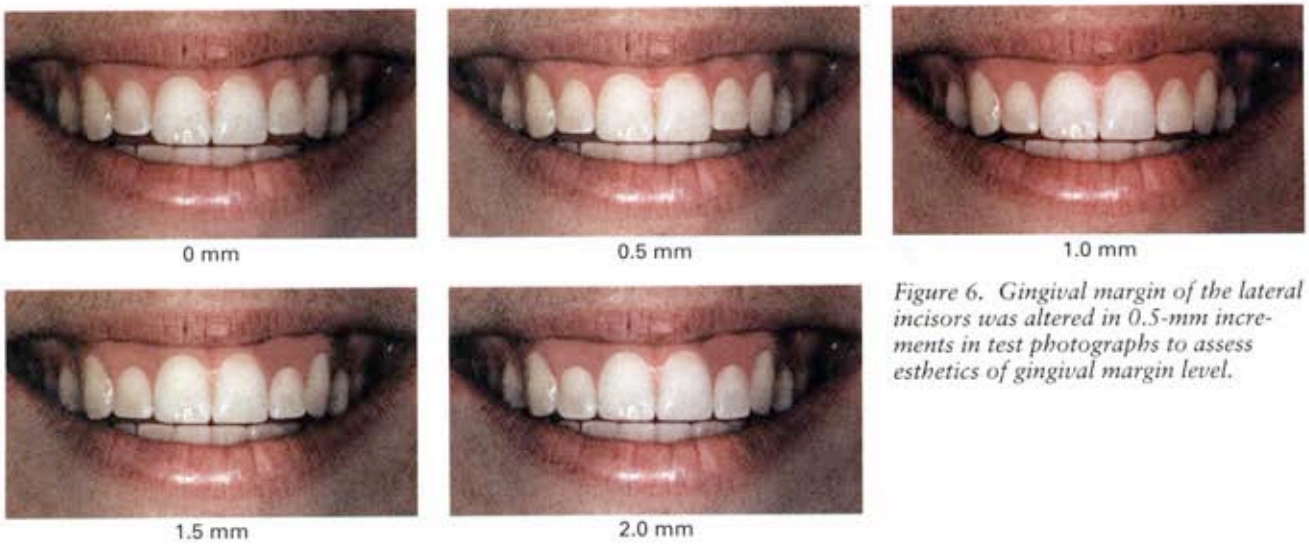

Figure 6. Gingival margin of the lateral incisors was altered in 0.5-mm increments in test photographs to assess esthetics of gingival margin level.

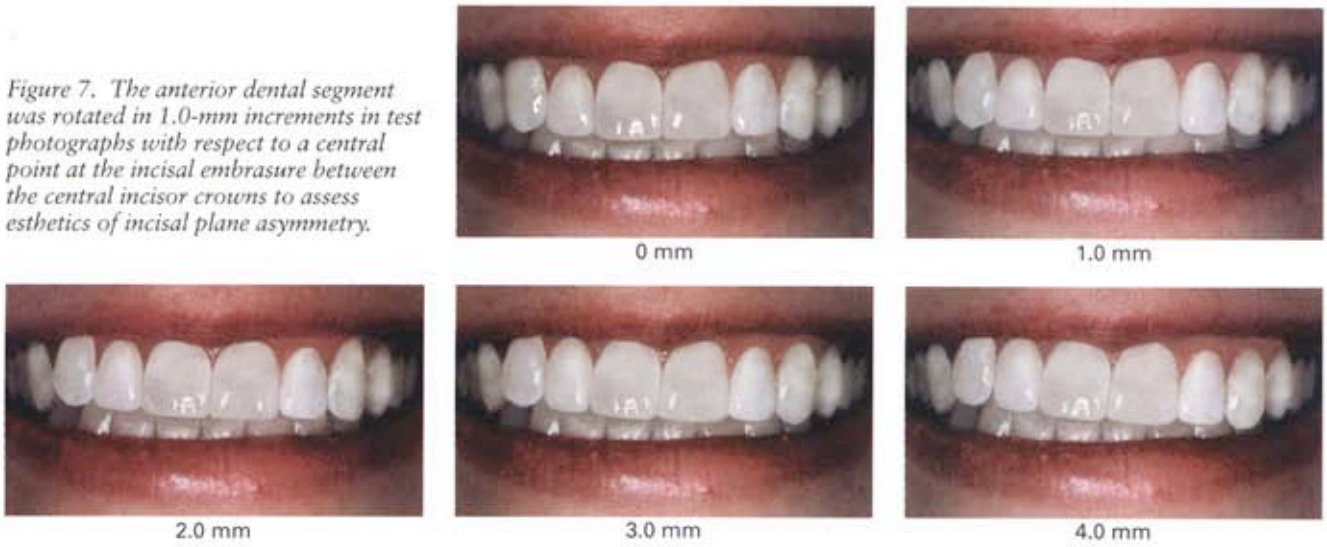

Figure 7. The anterior dental segment was rotated in 1.0-mm increments in test photographs with respect to a central point at the incisal embrasure between the central incisor crowns to assess esthetics of incisal plane asymmetry.

Incisal Plane. The computer alterations to the photograph involved altering the incisal plane from right to left canine. Since inclusion of the interpupillary line in the photographs was not possible, the lower lip line and incisal plane were positioned parallel to the lower border of the photograph to maintain symmetry. Each alteration varied in 1.0-mm increments by rotating around a central point at the incisal embrasure between the central incisor crowns (Figure 7). The changes made were positional and involved the entire anterior dental segment. The segment was rotated inferiorly on the subject's left and superiorly on the right.

Gingiva-to-Lip Distance. The gingiva-to-lip relation was altered to produce a "gummy smile." The smile was altered by progressively moving the upper lip superiorly and inferiorly to modify the distance from the lip to the gingival margin. The labial gingival margins of the maxillary central incisors were used as reference points for measurements. The upper lip was positioned at this level and called the 0 mm level. Additional lip positions included 2.0 mm inferior and 2.0, 4.0, and 6.0 mm superior to this level (Figure 8).

Grouping

The individual smiles were grouped randomly, but in such a way that different variables were presented on each page of the questionnaire. Each page consisted of four randomly assigned images arranged in two columns. Copies of the original questionnaire were randomly arranged in 10 different ways. An equal number of each of the 10 forms was distributed to each group of raters. Each image was coded for identification with a two-letter combination, such as "CR" or "FC." Respondents were asked to omit any identifying marks, such as a printed name or signature.

Rating Scale

A 50-mm visual analogue scale appeared under each of the images within the questionnaire and was used for individual ratings. It was labeled at both ends according to extremes of attractiveness. The left border (i.e., near zero) was labeled "least attractive" and the right border (i.e., near the 50-mm range) "most attractive." Each rater marked a point along the 50-mm visual analogue scale according to their perception of dental esthetics. The individual ratings were measured in millimeters with Fowler Ultra-Cal Mark III (Fred V. Fowler Co., Inc., Newton, Massachusetts) digital calipers to determine the respondent's score.

Additional Questions

Additional questions were asked to evaluate the individual esthetic focus for all three groups and to determine the number of years in practice for the dental groups. Respondents also were asked to rank 10 specific facial and dental characteristics according to noticeability. The general facial features included hairstyle, hair color, eye color, eyebrow expression, skin complexion, and nose size. The dental and perioral features included tooth position, tooth color, mouth expression, and lip shape. Raters were instructed to rank each item from 1 (most noticeable) to 10 (least noticeable), using each ranking only once.

Personality Evaluation

Also included were 16 questions from the Minnesota Multiphasic Personality Inventory-2 (MMPI) that represented the obsessive-compulsive dimension.[7] This test has been validated extensively and was used as the best way to assess obsessive-compulsive tendencies (OCD) among the respondents.

Analysis of Data

To test the four hypotheses, a series of parametric and non-parametric statistics were conducted. Hypothesis 2 stated that lay people would be less able to discriminate between levels of discrepancies than dentists and orthodontists. One-way repeated measures analysis of variance (ANOVA) tests were conducted within each group to assess how the groups rated each level of deviation. Significant overall tests were followed with a series of post-hoc multiple comparisons to test hypotheses 1 and 2. Multiple comparisons between each level of variation were used to determine the threshold of deviation at which each group was able to discriminate between esthetic and noticeably less esthetic dental features. Furthermore, to compare the three groups' ratings, two-way repeated measures ANOVAs with group (1 vs. 2 vs. 3) as the crossed factor and levels of discrepancy (e.g., 0 through 4 mm) as the repeated factor were conducted on each type of dental discrepancy.

Hypothesis 3 stated that rankings of the most and least noticeable dental or facial features would differ across groups. This was tested with Pearson chi-squared analyses comparing all three groups.

The final hypothesis stated that strong obsessive-compulsive tendencies would result in greater discrimination of minor degrees of esthetic discrepancies. To test for this hypothesis, a series of analysis

Figure 8. The distance from the upper lip to the gingival margin was altered in 2-mm increments above and below the labial gingival margins of the maxillary central incisors in test photographs to assess the esthetics of gingiva-to-lip distance.

of covariance (ANCOVA) tests were conducted. Total OCD scores (0–16) served as the covariate ratings on each type of facial disharmony outcome. Analysis of covariance also was used to test the effects of years of dental or orthodontic practice on ratings, categorized as 1 to 10 years versus 11 to 20 versus 21 or more years of dental or orthodontic practice. This permitted a test of the impact of practice experience on dentists' and orthodontists' ratings of all eight dental discrepancies.

RESULTS

Threshold Scores

The threshold at which each group could distinguish between the "ideal" smiles and deviations from the ideal varied (Figure 9; Table 1). These one-way ANOVAs represent a test of hypotheses 1 and 2.

Crown Length. Lay people were less discerning of a crown length discrepancy than the two dental groups. On average, a 2-mm deviation from ideal crown length was required for lay people to classify it as noticeably less esthetic ($p < .0001$). Orthodontists identified a 1-mm discrepancy from ideal ($p < .005$), whereas general dentists made the distinction when crown length exceeded 1.5 mm from ideal ($p < .0001$). The crown length ratings supported both hypotheses 1 and 2 (i.e., lay people could least distinguish discrepancies, followed by general dentists, then orthodontists) (see Figure 9, A).

Crown Width. A perceived mesiodistal dimension 3 mm narrower than the ideal lateral incisor crown width was required before it was rated significantly less attractive by orthodontists and dentists ($p < .0001$). Lay people required a 4-mm narrowing of the mesiodistal width of the lateral incisor to rate it as noticeably less attractive ($p < .001$). These results support hypothesis 2. However, the similarity between orthodontists' and general dentists' ratings do not support hypothesis 1 (see Figure 9, B).

Incisor Crown Angulation. All three groups were able to identify the discrepancy at the same level, 2 mm from ideal incisor angulation ($p < .0001$) (see Figure 9, C). However, the orthodontists were the best of the three groups in discriminating between ideal and a 2-mm deviation, supporting hypotheses 1 and 2. This conclusion is supported by the mean difference in ratings: orthodontists (14.49), general dentists (12.36), and lay people (7.28). The higher the mean difference, the greater the distinction made by a particular group of raters between levels of discrepancy.

Midline. Only orthodontists were able to identify a maxillary dental midline deviation from ideal ($p < .0001$). The threshold level at which orthodontists rated midline deviations as significantly less esthetic was 4 mm (see Figure 9, D). This means that the maxillary dental midline had to be shifted as much as 4 mm to one side before it became consistently noticeable by the orthodontists. However, neither the general dentists nor lay people perceived a significant difference in esthetics even with a 4-mm deviation, as illustrated by almost horizontal lines for these two groups in Figure 9, D.

Open Gingival Embrasure. Orthodontists rated a 2-mm open gingival embrasure as noticeably less attractive than the ideal smile with a normal gingival embrasure ($p < .0001$). In contrast, it took a greater deviation (3 mm) for the general dentists and lay people to rate the smile as less attractive ($p < .007$ and $p < .0001$, respectively) (see Figure 9, E).

Gingival Margin. None of the three groups could discriminate between levels of gingival margin discrepancy. This is illustrated by the three lines with minimal variation in Figure 9, F.

Incisal Plane. Both orthodontists and general dentists could detect a 1-mm incisal plane asymmetry ($p < .001$ and $p < .0001$, respectively) (see Figure 9, G). Lay people were less able to detect an incisal plane asymmetry; a 3-mm cant was required for the lay group to rate it as noticeably less attractive ($p < .007$), which is consistent with the second hypothesis.

Gingiva-to-Lip Distance. None of the three groups discriminated between levels of maxillary gingival absence on smiling (upper lip position at the level of or 2 mm inferior to the gingival margin). However, all three groups discriminated between these two levels and increased distance from gingiva to lip. Orthodontists made the distinction between esthetic and unesthetic when the distance was 2 mm ($p < .0001$). They rated 0 mm of gingival display as most attractive. General dentists and lay people were more tolerant of increasing the gingiva-to-lip distance. They classified it as excessive if 4 mm of gingiva was visible above the level of the anterior gingival margins ($p < .0001$ and $p < .009$, respectively) (see Figure 9, H).

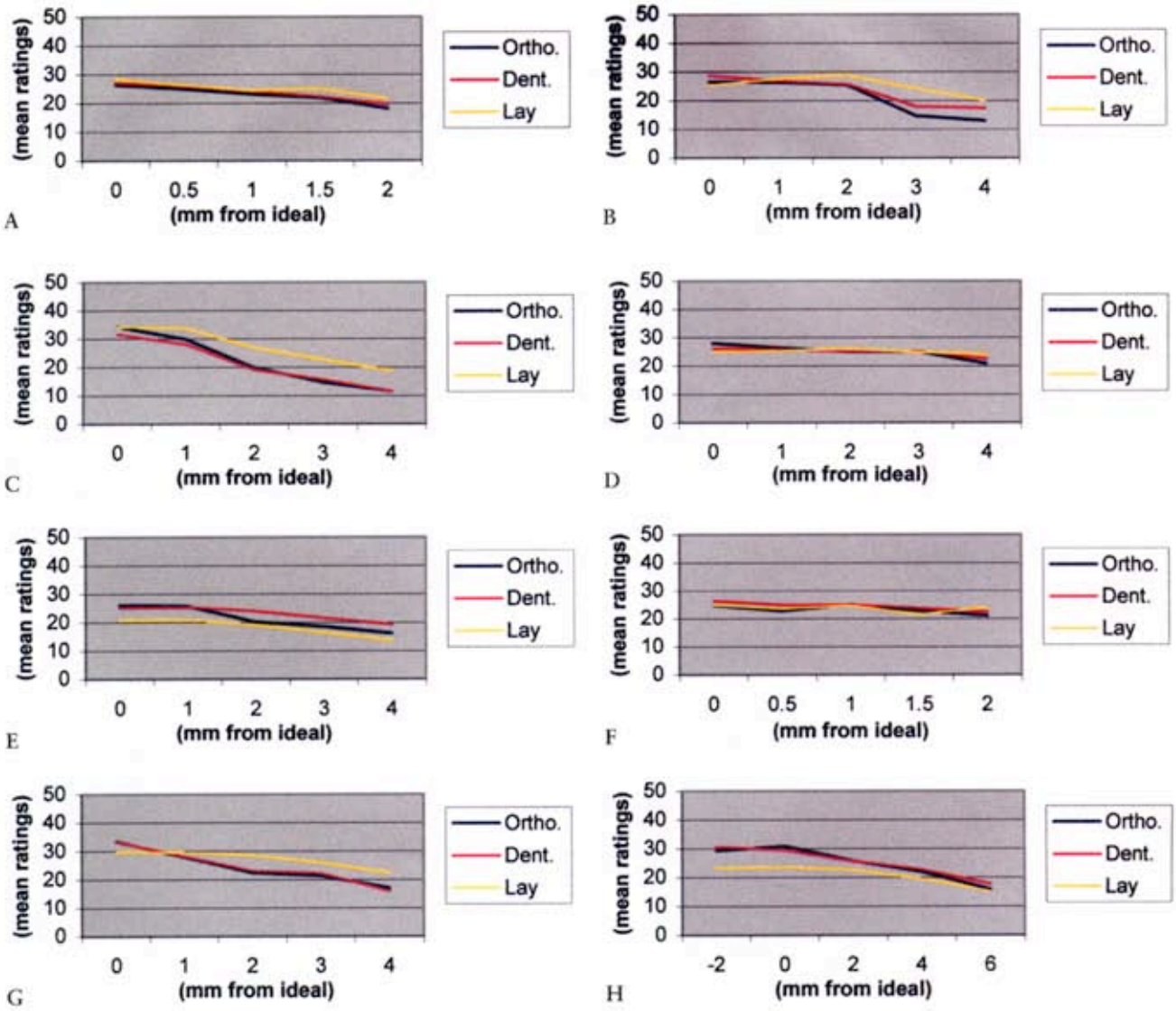

Figure 9. Graphic illustration of questionnaire results. A, *Crown length;* B, *crown width;* C, *incisor crown angulation;* D, *midline;* E, *open gingival embrasure;* F, *gingival margin;* G, *incisal plane;* H, *gingiva-to-lip distance.*

TABLE 1. THRESHOLD LEVELS OF SIGNIFICANT DIFFERENCE.

Parameter	Orthodontists	General Dentists	Lay People
Crown length (mm)	1.0	1.5	2.0
Crown width (mm)	3.0	3.0	4.0
Incisor angulation (mm)	2.0	2.0	2.0
Midline (mm)	4.0	ND	ND
Open gingival embrasure (mm)	2.0	3.0	3.0
Gingival margin (mm)	ND	ND	ND
Incisal plane (mm)	1.0	1.0	3.0
Gingiva-to-lip distance (mm)	2.0	4.0	4.0

ND = nondetectable.

Group Comparisons

As previously stated, a two-way repeated measure ANOVA was conducted to determine significant changes across levels of discrepancy among the three respondent groups. Significant ($p < .01$) overall mean differences were revealed for crown width, incisor angulation, gingiva-to-lip distance, and open gingival embrasure. This demonstrated a significant change across levels of discrepancy when the three groups were collapsed. However, this test did not identify the source of the significant effect (i.e., differences between groups 1 vs. 2, 2 vs. 3 or 1 vs. 3).

Therefore, to test for specific group differences, a one-way repeated measures ANOVA was performed. It demonstrated that in most of the dimensions all three groups noticed significant ($p < .01$) differences across all levels of discrepancy except gingival margin and midline deviation. General dentists were unable to detect differences for midline discrepancy, and lay people could not identify changes for either midline or gingival margin discrepancies. It is noteworthy that the high level of significance comparing orthodontists' ratings across levels of midline deviation was powerful enough to compensate for the lack of significance shown by the general dentists and lay people for this variation, as demonstrated in Figure 9, D, with the steadily declining, relatively linear slope for orthodontists. In contrast, the general dental and lay groups exhibited uneven slopes. This suggests that orthodontists could rate the more discrepant smiles in an order consistent with the degree of variation. However, general dentists and lay people did not perceive the discrepancies in a declining order.

Rankings of Dental and Perioral Features

Additional questions were asked of the respondents, to enable the researchers to compare the groups of raters according to esthetic focus and to evaluate possible connections between these rankings and their individual attractiveness ratings. Kruskal-Wallis chi-squared tests were conducted to compare rank orders of the four dental and perioral features across the three groups. The groups exhibited significant differences only on tooth color ($\chi^2 = 10.99$, $df = 2$, $p < .004$) and tooth position ($\chi^2 = 32.77$, $df = 2$, $p < .0001$). General dentists, followed by orthodontists, rated tooth color more noticeable than other features. In contrast, lay people rated mouth expression and lip shape as more noticeable than either dental characteristic. Orthodontists rated tooth position as the most noticeable dental or perioral feature, whereas lay people assigned this dental feature lower rankings.

Pearson chi-squared tests were conducted to compare the highest and lowest ranked facial and dental features across the three groups. A significant association was seen between group membership and the most commonly chosen number 1 rank ($\chi^2 = 41.82$, $df = 18$, $p < .001$). Tooth position was the most frequently chosen number 1 rank by orthodontists (41.4%) and general dentists (22.6%), whereas lay people chose tooth position as most noticeable only 7.8% of the time. Hairstyle was chosen most frequently as the highest rank by the lay group (34.4%). No significant differences were found when comparing the three groups on their respective number 10 ranks. All

three groups were most likely to select eyebrow expression as their number 10 rank: orthodontists (43.1%), general dentists (43.4%), and lay people (40.6%).

Covariates

Years in Practice. An ANCOVA was conducted to determine the association between number of years in practice and perception of esthetic discrepancy. The range was 1 to 27 years for orthodontists and 1 to 39 years for general dentists. Despite this wide range for both groups, years of professional experience had no effect on their esthetic perceptions.

Personality Evaluation. Obsessive-compulsive personality tendencies were analyzed as a covariate, using the factor scores for the obsessive-compulsive dimension obtained from the MMPI. Nonsignificant results of the analysis of covariance led the researchers to conclude that obsessive-compulsive personality styles are unrelated to perceptions of esthetics for orthodontists, general dentists, or lay people.

DISCUSSION

This study has shown significant group differences for several esthetic discrepancies. No previous studies have established threshold levels of noticeability of various esthetic discrepancies by orthodontists, general dentists, and the general public. Several studies have evaluated esthetic perception of different malocclusions.[2,8–12] Indices also have been created to measure dental esthetics based on a relatively standardized set of variables. These esthetic indices assess treatment need according to occlusal health but do not focus directly on anterior dental esthetics. Few studies have compared group perceptions of common anterior esthetic discrepancies. Padwa and colleagues attempted to establish a threshold level of occlusal cant that would be considered unesthetic by panels with differing dental backgrounds.[13]

The present study has shown that orthodontists recognize specific dental esthetic discrepancies more readily than lay people, with the exception of gingival margin discrepancies. General dentists and lay people have similar threshold levels for assessing midline deviation, gingival margin discrepancy, and gingiva-to-lip distance. Orthodontists and general dentists were able to detect discrepancies on half of the dimensions at the same level. However, orthodontists were able to identify crown length, midline, open gingival embrasure, and gingiva-to-lip distance at a smaller level of deviation than general dentists.

The level of detection of various anterior esthetic discrepancies differed according to the dimension and responding group. Which discrepancies were most and least noticeable? The findings revealed that orthodontists and general dentists rated incisal plane asymmetry as the most noticeable dimension, whereas lay people rated incisor angulation as the most noticeable. None of the groups could detect gingival margin discrepancies. General dental and lay respondents also were unable to detect midline deviation at any level. All groups found one discrepancy most noticeable. General dentists and lay people were unable to detect two large deviations.

If certain discrepancies are nondetectable at any level, what does this mean to the clinician? Is it necessary to correct subtle variations if they are undetectable by the average patient? If they are not likely to be noticed by the patient, is it necessary to bring them to their attention? These are questions that are of obvious importance to the clinician, especially since some of these problems (or discrepancies) are difficult to correct. On the other hand, the present study has demonstrated that certain anterior esthetic discrepancies are noticeable by the average patient if not corrected, whereas others, such as midline deviations, will be undetectable by patients or their dentists.

The present data show an interesting interaction between midline deviation and incisor crown angulation. A 4-mm maxillary midline deviation was not detected by general dental or lay populations. Orthodontists also had difficulty identifying subtle midline discrepancies. However, all groups rated a 2-mm deviation in incisor angulation as noticeably unattractive.

Why was midline deviation relatively undetectable, whereas incisor crown angulation was so easily noticed? Previous studies have claimed that a significantly slanted dental midline is displeasing and tends to induce visual tension.[14,15] However, no data were presented to support this statement. Frush stated that the vertical relationship of the dental midline appears to be much more critical than the mediolateral position of the incisors.[16] However, others have argued that a precise dental midline may appear artificial.[16,17] These conclusions are supported by the current research, which challenges the necessity of a precise dental midline for optimal esthetics. A mild midline discrepancy is acceptable to the majority of lay people, if the incisal crown angulation is not canted more than 2 mm. However, these conclusions are limited by the design of the current study. The manner in which the midline deviations were displayed was not necessarily representative of a naturally appearing midline discrepancy. For example, the photographs do not reflect the shadowing that is caused by the resultant arch-form asymmetry.

The distance from gingiva to lip during smiling was not noticeable by the general dental or lay population until it was at least 4 mm. Orthodontists were more discriminating. Although they did not distinguish between too little and no gingival display, orthodontists rated 2 mm of visible gingiva as excessive and noticeably unattractive. Several articles have discussed treatment options for correction of excessive gingiva-to-lip discrepancies.[1,18–21] Janzen evaluated correction of "gummy smiles" with orthognathic surgery.[21] Although he showed a significant reduction of the gingiva-to-lip distance, he did not discuss the method used to determine the desired amount of visible gingiva. Chiche and Pinault stated that the esthetically ideal amount of visible gingiva is about 1 mm, although 2 to 3 mm of gingiva may be esthetically acceptable.[14] However, these views were not supported by scientific data. A common treatment option for patients with vertical maxillary excess and increased gingiva-to-lip distance is a combination of orthodontics and maxillary impaction surgery. This study has shown that there is a significant difference in esthetic perception of the "gummy smile" between lay and professional raters. Because of the potential for patients to have greater tolerance, orthodontists and surgeons must be aware of these differences in perception of gingiva-to-lip distance when planning maxillary impaction surgery to correct a "gummy smile." Practitioners' goals may not be in harmony with patients' goals.

This investigation has shown that orthodontists identified a 2-mm midline open gingival embrasure as unattractive. However, general dentists and lay people were unable to detect an open gingival embrasure unless it was 3 mm long. This esthetic problem is often observed postorthodontically in patients with pretreatment overlapping of incisors or triangularly shaped incisor crowns. Burke and colleagues examined the incidence of overlapped maxillary incisors, incidence of resultant open gingival embrasures, and width of the gingival base below the interproximal contact.[22] Their results indicated that 42% of these patients had open gingival embrasures between the central incisors after orthodontic treatment, and the average width of the base of the triangle was 0.43 mm. They concluded that in a similar patient population, one-third would have crowded central incisors, and 40% of those would result in an open gingival embrasure after orthodontic treatment. The size of the space is largely dependent on the extent of pretreatment incisor overlap. Patients with wide gingival embrasures may benefit from composite restoration or reshaping of the crowns adjacent to the space. However, small spaces may not be noticeable enough by the average patient to justify their correction.

Incisal plane asymmetry was the most easily detected discrepancy by orthodontists and general dentists. Both professional groups were able to detect a 1-mm asymmetry. In contrast, lay people were unable to detect incisal plane asymmetry until it reached 3 mm. Chiche and Pinault claimed that a canted incisal plane is esthetically displeasing due to median asymmetry.[14] However,

they did not present a threshold value at which this variation becomes unattractive. Padwa and associates evaluated a threshold of perceived noticeability for occlusal plane cant.[13] Trained and untrained groups of observers evaluated occlusal cants by rating facial photographs. The researchers concluded that untrained, lay observers could detect 90% of occlusal cants greater than four degrees, and trained observers could detect 98%. One problem with that study was the sample size: five oral surgeons (trained group) and four medical residents (untrained group). An additional point of concern is the composition of their lay group. Medical residents cannot be considered untrained because of their advanced educational background and their training to focus on body features. Non-medically trained raters may have been more appropriate evaluators. In the present study, the lay population had no dental or medical training.

Orthodontists and general dentists were able to detect a 3-mm narrowing of lateral incisor crown width, but lay people did not notice a significant change until the lateral incisor was narrowed by 4 mm. From a restorative standpoint, anterior tooth position is a critical factor for proper denture esthetics.[23–26] The most consistently applied principle is the "golden proportion." One of the first to describe the golden proportion and its importance to restorative dentistry was Lombardi.[18] Since then, several others, including Levin,[23] Brisman,[24] and Qualtrough and Burke,[25] have reinforced its application to anterior esthetics. Kokich applied the rule to orthodontics by describing the proper restoration of peg-shaped lateral incisors in orthodontic patients.[26] The golden proportional value for this tooth is 0.618 or approximately two-thirds the width of the adjacent maxillary central incisor. In the present study, none of the respondents detected a pegged lateral incisor until it was 3 mm narrower than its ideal proportional width. Opening space to restore a narrow lateral incisor requires a final restoration and thus increases costs. Therefore, leaving symmetric narrow lateral incisors may be acceptable in some situations.

The questionnaire used to evaluate individual esthetic focus showed that dental professionals focus on tooth position, whereas lay people focus on hairstyle. This finding is consistent with the ratings of individual variations by the dental and lay groups. The dental groups were generally sensitive to minor dental disharmonies, whereas the lay group was unable to detect disharmonies in several of the esthetic variables.

The present study showed that crown length and gingival margin discrepancies often were not noticed by dental professionals or lay people. Yet these are considered to be important aspects of a smile. Kokich described these deviations and explained the rationale for their orthodontic and restorative correction.[27] However, no studies have evaluated the patient's perspective; the degree or amount of discrepancy that requires correction is not known. Are all gingival margin discrepancies unesthetic? The results of the present study suggest that symmetrically altered gingival margins are undetectable by orthodontists, general dentists, and lay people. However, it is possible that symmetric problems are rated more attractive than asymmetric problems. Since asymmetric discrepancies are commonly found in the general population, a second study is being conducted to evaluate perception of unilateral alterations in crown length, crown width, and gingival margin. This information should provide a stronger basis for making treatment recommendations about the wisdom of correcting these nonideal relations.

CONCLUSIONS

Hypotheses 1 (orthodontists will be more perceptive than general dentists in minor degrees of discrepancy from ideal) and 2 (lay people will be less discerning of specific dental esthetic discrepancies than general dentists or orthodontists) were supported on four dimensions: crown length, midline, open gingival embrasure, and gingiva-to-lip distance. These hypotheses were not supported on the remaining four dimensions: crown width, incisor angulation, gingival margin, and incisal plane. Hypothesis 3 (the

rankings of most and least noticeable dental or facial features will differ significantly between orthodontists, general dentists, and lay people) was partially supported by the findings. However, hypothesis 4 (respondents with strong obsessive-compulsive tendencies will be more perceptive in detecting minor degrees of dental esthetic discrepancies) was not supported. Orthodontists and general dentists ranked tooth position as the most noticeable facial or dental feature, and lay people ranked hairstyle as most noticeable. All groups ranked eyebrow expression as least noticeable. No correlation was found between obsessive-compulsive tendencies and individual group ratings. The results of this study have shown that orthodontists, general dentists, and lay people detect specific dental esthetic discrepancies at varying levels of deviation. Lay people were less discerning than orthodontists in all of the discrepancies except incisor angulation and gingival margin. General dentists were more discerning than lay people only for crown length, crown width, and incisal plane. Orthodontists were more discriminating than the other groups on all deviations except gingival margin. The differing levels of detectability demonstrate that minor variations in specific dental esthetic discrepancies may not be an important concern to most patients. Therefore, it is the responsibility of general dentists initially and orthodontists secondly to inform the patient of the noticeable deviations and then allow the patient to make his or her own determination as to the overall esthetic significance of each discrepancy.

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REFERENCES

1. Miller CJ. The smile line as a guide to anterior esthetics. Dent Clin North Am 1989; 33:157–164.
2. Katz RV. Relationships between eight orthodontic indices and an oral self-image satisfaction scale. Am J Orthod 1978; 73:328–334.
3. Graber LW, Lucker GW. Dental esthetic self-evaluation and satisfaction. Am J Orthod 1980; 77:163–173.
4. Espeland LV, Stenvik A. Perception of personal dental appearance in young adults: relationship between occlusion, awareness, and satisfaction. Am J Orthod Dentofacial Orthop 1991; 100:234–241.
5. Burden DJ, Pine CM. Self-perception of malocclusion among adolescents. Community Dent Health 1995; 12:89–92.
6. Vallittu PK, Vallitu ASJ, Lassila VP. Dental aesthetics: a survey of attitudes in different groups of patients. J Dent 1996; 24:335–338.
7. Hathaway SR, McKinley JC, Butcher JN. Minnesota Multiphasic Personality Inventory-2. Minnesota: University of Minnesota Press, 1942.
8. Howitt JW, Stricker G, Henderson, R. Eastman Esthetic Index. N Y State Dent J 1967; 33:215–220.
9. Lobb WK, Ismail AI, Andrews CL, Spracklin TE. Evaluation of orthodontic treatment using the Dental Aesthetic Index. Am J Orthod Dentofacial Orthop 1994; 106:70–75.
10. Cons NC, Jenny J. Comparing perceptions of dental aesthetics in the USA with those in eleven ethnic groups. Int Dent J 1994; 44:489–494.
11. Jenny J, Cons NC, Kohout FJ, Jakobsen J. Predicting handicapping malocclusion using the Dental Aesthetic Index (DAI). Int Dent J 1993; 43:128–131.
12. Evans R, Shaw W. Preliminary evaluation of an illustrated scale for rating dental attractiveness. Eur J Orthod 1987; 9:314–318.
13. Padwa BL, Kaiser MO, Kaban LB. Occlusal cant in the frontal plane as a reflection of facial asymmetry. J Oral Maxillofac Surg 1997; 55:811–816.
14. Chiche GJ, Pinault A. Esthetics of anterior fixed prosthodontics. Chicago: Quintessence, 1994.
15. Rufenacht CR. Fundamentals of esthetics. Chicago: Quintessence, 1990.
16. Frush J. Swissdent technique and procedure manual. Los Angeles: Swissdent Corp., 1971.
17. Golub J. Entire smile pivotal to teeth design. Clin Den 1988; 33.
18. Lombardi RE. The principles of visual perception and their clinical application to denture esthetics. J Prosthet Dent 1973; 29:358–382.
19. Mackley RJ. An evaluation of smiles before and after orthodontic treatment. Angle Orthod 1993; 63:183–190.
20. Kokich VG. Esthetics and anterior tooth position: an orthodontic perspective. Part II: vertical position. J Esthet Den 1993; 5:174–178.
21. Janzen EK. A balanced smile: a most important treatment objective. Am J Orthod 1977; 72:359–372.
22. Burke S, Burch JG, Tetz JA. Incidence and size of pretreatment overlap and post-treatment gingival embrasure space between maxillary central incisors. Am J Orthod Dentofacial Orthop 1994; 105:506–511.
23. Levin EI. Dental esthetics and the golden proportion. J Prosthet Den 1978; 40:244–252.
24. Brisman AS. Esthetics: a comparison of dentists' and patients' concepts. J Am Dent Assoc 1980; 100:345–352.
25. Qualtrough AJE, Burke FJT. A look at dental esthetics. Quintessence Int 1994; 25:7–14.
26. Kokich VG. Esthetics and anterior tooth position: an orthodontic perspective. Part III: mediolateral relationships. J Esthet Dent 1993; 5:200–207.
27. Kokich VG. Esthetics and anterior tooth position: an orthodontic perspective. Part I: crown length. J Esthet Dent 1993; 5:19–23.

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