Smile Esthetics from Patients’ Perspective for Faces of Varying Attractiveness

A Thesis Presented in Partial Fulfillment of the Requirements for the Degree Master of Science in the Graduate School of The Ohio State University

By

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ABSTRACT

Delivering an attractive smile is a key element to orthodontic patient-satisfaction. Smile characteristics maybe affected by the facial context. **Objective:** The purpose of this study was to investigate the layperson’s perspective on facial attractiveness and smile esthetic. **Methods:** Two attractive, average and unattractive model faces (3 males, 3 females) determined by peer ratings, were combined with ten smiles variables (buccal corridor, smile arc, maxillary gingival discrepancy, gingival display, central incisor incisal edge discrepancy, cant, overbite, central incisor gingival margin discrepancy, maxillary midline to face and mandibular midline to maxillary midline). Each smile characteristic was altered digitally and presented using emoticon slider technology to allow a continuous range of choices. Raters chose the ideal, and limits of acceptability. Variables were divided into six separate surveys (four surveys with two variables and two surveys with one variable) and rated 96 times. Power analysis (non-directional alpha of 0.05, standard deviation of 3.5 and power of 0.86) required 576 raters. Reliability was accessed by answering each question twice. **Results:** Individual smile variable reliability ranged from fair to excellent, except buccal corridor. Clinically significant values were defined as greater than 1.0mm with statistical significance (p<0.05). Rater gender did not make a difference. Clinical significance was found for buccal corridor, smile arc, gingival display and upper midline to face. For females, smaller buccal corridors and flatter smile arcs were preferred for the unattractive and attractive models compared to the average model. The opposite was found for male models. More gingival display was preferred for the unattractive and attractive male
and female models compared to the average models. Unattractive models had a smaller acceptable range compared to the other groups for gingival display. Attractive models were allowed less midline deviation. **Conclusion:** Reliability was relatively fair to excellent except for buccal corridor. It appears that facial attractiveness did not have an effect on the smile characters that were considered micro-esthetic. Facial attractiveness did affect smile characteristics were measured relative to the face. Understanding these limitations is important in the diagnosis and treatment planning.
Dedicated my family
ACKNOWLEDGEMENTS

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Chapter 1

INTRODUCTION

There are several components of the face that contribute to its attractiveness. Of particular interest to orthodontists is the smile. Laypersons, our patient pool, are an important source of information regarding what is most attractive about a smile.

Providing an attractive smile is pertinent to patient satisfaction. According to a study by Al-Omirii and colleagues,\(^1\) in a random sample of 50 patients, 17 patients were absolutely satisfied, 31 patients were relatively satisfied and two were completely dissatisfied. The amount of relatively satisfied and completely unsatisfied patient outcomes was relatively significant. The primary reason for the two completely unsatisfied patients was appearance after treatment. One portion of the appearance is the smile and many factors could have contributed to its appearance. The cause could have been due to a tooth size discrepancy, an underlying skeletal issue or a different perspective relative to esthetics between the orthodontist and the patient. With dental and skeletal limitations, there needs to be a thorough consult before rendering treatment. If a perspective issue exists, orthodontists need to understand the lay population’s perspective of an ideal and acceptable smile.

Detailed diagnosis and treatment planning is imperative to achieving desired dental esthetics. Ackerman and Proffit\(^2\) suggested using the prioritized problem list to systematically identify skeletal, dental and profile issues for an orthodontic patient. They
recommend presenting the problem list at the consult appointment and reviewing how and if a problem can be resolved with orthodontics alone or with additional restorative, interdisciplinary and/or surgical intervention. More importantly, a detailed discussion on whether the patient would like to achieve ideal or acceptable esthetics is absolutely pertinent. One problem with achieving ideal or acceptable esthetics is trying to understand the layperson’s perspective of an ideal and acceptable smile.

Several issues have arisen during past investigations of smile characteristics. First is the method of presentation. Ker et al. performed a computerized survey to identify the ideal and range of acceptability for ten smile characteristics from the layperson’s view utilizing one smile and lower face. The computerized survey allowed them to digitally modify one variable at a time. Images rated appeared in a continuously morphed stream of choices. This was an improvement compared to previous studies by eliminating the incremental nature of the choices.

A second issue is the facial perspective. Many previous studies have used the circumoral view or lower facial perspective for evaluation and presentation to the model rater. Other studies used a full face perspective which could have reduced the raters’ ability to evaluate aspects of smile esthetics or enhance it.

A third issue is the nationality and ethnicity of the model rater. Sharma et al. compared perspectives of three groups (U.S. Caucasian, U.S. American-Asian Indians and Indians residing in India) using study methods similar to Ker et al. They found differences between the three groups for certain smile variables (buccal corridor, smile arc, and upper midline). Fewer differences were found between Indians residing in the U.S. and those residing in India. McLeod et al. compared perspective differences
between U.S. (Ker et al.\textsuperscript{3} data) and Canadian residents for the following smile variables: buccal corridor, gingival display, occlusal cant, maxillary midline to face discrepancy, and lateral central gingival discrepancy. These investigators’ results concluded that clinically significant differences were present for smile variables in all dimensions, except for buccal corridor.\textsuperscript{10} Canadians were more discriminating and allowed less deviation compared to U.S. raters.\textsuperscript{10} Stockebrand et al.\textsuperscript{11} distributed a dental esthetic questionnaire with different ethnic groups residing in Germany. Subjects evaluated frontal smile photos of eight male and female models and the investigators reported differences between three ethnic groups (German, Russian and Turkish). These studies indicate that nationality and ethnicity do influence dental esthetic perception.

The fourth issue is the attractiveness of the full face. Springer et al.\textsuperscript{13} used average male and female faces for their study. Other previous full face smile studies\textsuperscript{9,10} did not identify the attractiveness of the face. Flores-Mir et al.\textsuperscript{8} found that the full face context led to few differences and almost all smile variables affected were measured relative to the face. It appeared that models did have an effect on the results. This could be due in whole or part to model attractiveness. From the full face perspective, does model gender affect the rating of smile variables? Second, does the level of attractiveness of the model affect our current perceptions of ideal and acceptable values of a smile variable?
COMPREHENSIVE LITERATURE REVIEW

Facial and dental attractiveness can significantly impact one’s life. Langois\textsuperscript{13} believed that facial attractiveness is highly correlated with a better quality of life and interpersonal success. Individuals who are more attractive are perceived as more intelligent, confident and socially acceptable. Shaw\textsuperscript{14,15} thought that facial attractiveness was the key to social success. In addition, he considered dental attractiveness an important factor contributing to social attractiveness. Shaw conducted a study comparing two boys and two girls, one attractive and one unattractive for each model gender. Five smile variations were judged—normal incisors, prominent incisors, one missing lateral incisor, severely crowded incisors and a unilateral cleft lip. Adult and children raters were asked to evaluate the facial and social attractiveness. Attractive children with normal incisors were deemed more socially pleasing—more desirable as friends and more intelligent with less aggressive behavior.\textsuperscript{14,15}

Kiyak\textsuperscript{16} reviewed the effects of a pleasing dentition on the quality of life. Contrary to Shaw’s belief, Kiyak thought that dental esthetics did not enhance social acceptance. She also reported that orthodontic intervention did not contribute much to improve oral health and function. She concluded that undergoing orthodontics improved esthetics and the psychosocial well-being of individuals. Adolescents who have completed orthodontic treatment reported less negative psychosocial influence, such as teasing and embarrassment from smiling, than those who were never treated.\textsuperscript{16} Hunt et al.\textsuperscript{17} surveyed dental professionals, general dentists and orthodontists, and determined that
dentists agreed that benefits of orthodontics were primarily self-esteem, physical and facial attractiveness.

The smile is one component of facial attractiveness. Many studies attempted to quantify the value the smile has on facial attractiveness. Hickman and colleagues\(^{18}\) looked at eye fixations on frontal facial images. Post-treatment orthodontic patients with skeletal class I profiles were used as models to eliminate any confounding factors that may be caused by an individual with distinct features. Adult subjects were recruited and an eye tracking device was used to follow eye movements, determine the area of interest and record the time fixated on the area. Six categories of interest were identified—eyes, ears, mouth, nose, chin and other (forehead, cheeks, hair, throat, neck and background). Their findings revealed that the “other” category received 50% of the attention. The mouth, area of interest to orthodontists, received only 5.1% of the attention.\(^{18}\) Kiekens,\(^{19}\) on a more optimistic level, found that smile esthetics contributed to 25-31% to facial attractiveness. These results were disappointing to orthodontists because the mouth did not receive as much attention as perceived. These data questioned the importance of the dentition or smile to an individual’s facial attractiveness and its contribution to the quality of life to an individual.

Despite Hickman’s findings, many practitioners still believe that the teeth and smile are the essence to facial attractiveness. Havens et al.\(^{20}\) study showed that dental esthetics does have an effect on facial esthetics. Their study compared opinions of orthodontists and laypersons on a female model with a posed smile. Model images consisted of pre and post-orthodontic female model with the smile view only, full face with a smile and full face with the smile blocked out. Both groups agreed that a pre-treatment face without a smile was significantly more attractive than the pre-treatment
face with a malocclusion. The presence of a malocclusion diminished the attractiveness of the model. The mouth area of the face may not receive as much attention as other areas of the face,\textsuperscript{18} but it can play a role in facial attractiveness.

Rodrigues et al.\textsuperscript{21} also had a similar finding. His study had raters judge an individual smiling with several digitally modified smiles. They looked at smiles with a small diastema, upper midline deviation, long axes lateral incisor discrepancy, reverse smile arc or no discrepancy. Perspectives were oral and full face views. Raters were asked to rank the images in order of attractiveness and on a 10 point scale. Non-ideal smiles received lower attractiveness ratings compared to the ideal smile. A midline diastema was most detrimental to dental and facial attractiveness than any other deviations. Obviously, some smile variables are more important to the smile and facial attractiveness than others.

Orthodontics can influence the smile and anterior dental esthetics. Moore\textsuperscript{22} defined the smile as a compilation of many dental variables, such as gingival display, tooth color, smile arc, buccal corridor and much more. Some dental variables, such as buccal corridor, smile arc and upper midline have been studied more extensively than others. It is important to understand the influence of each variable on the smile and their optimal characteristics from the patients’ perspective.

Defining an ideal smile and its characters has also been difficult. For certain smile variables, such as central incisor incisal edge or central incisor gingival discrepancies, it is obvious the ideal is to have no discrepancies. Others smile characteristic ideals may not be as obvious. Sarver\textsuperscript{23} defined the smile arc as the relationship between the curvature of incisal edges of the maxillary anterior teeth and the
curvature of the lower lip. He thought that ideally these two curvatures should parallel one another. His thought was in absolute agreement with layperson’s perspective from other research studies.\textsuperscript{3,6,12} Sarver also proposed that a posed smile should ideally have some gingival display. His thinking was that the gingival display made the smile look more youthful.\textsuperscript{19} Other studies that looked at smile characters from the layperson’s view found that one to two millimeter of tooth coverage on a posed smile was ideal.\textsuperscript{3,12} It is clear from the literature that dental professionals do not view all aspects of the smile similarly to patients\textsuperscript{4-5}.

Generally orthodontists are more critical than general dentists and laypersons when evaluating the components of the smile. Kokich\textsuperscript{4} and colleagues confirmed this generalization on specific dental variables. His study included eight dental variables: crown length, crown width, incisor angulation, midline, gingival embrasures, gingival margins, anterior cant and gingival display. Images were confined to the peri-oral view to minimize any distractions from the teeth. Raters use the visual analog scale to rate the attractiveness or unattractiveness of a specified dental deviation. They found that orthodontists were most critical for all variables, except for incisor angulation.
Later, Kokich and colleagues\(^5\) expanded their previous study by evaluating more smile variables—upper midline diastema, bilateral and asymmetric discrepancies of crowns and papillary heights. The materials and methods were consistent with the previous study with the improvement of decreasing the alterable increments to 0.5mm to 1.0mm. This allowed a greater freedom of choices and a more accurate recording of the dental variables. Changing the alterable increments did not affect the conclusion that orthodontists were most sensitive to dental variables, but it did affect the clinical values. This was clearly the case for gingival display which made the orthodontists more forgiving and laypersons less forgiving compared to the previous study.

Table 1. Threshold levels of significant difference Part I

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Orthodontists</th>
<th>General Dentists</th>
<th>Lay People</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crown length (mm)</td>
<td>1</td>
<td>1.5</td>
<td>2</td>
</tr>
<tr>
<td>Crown width (mm)</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Incisor angulation (mm)</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Midline (mm)</td>
<td>4</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Open gingival embrasure (mm)</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Gingival margin (mm)</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Incisal plane (mm)</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Gingiva-to-lip distance (mm)</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

\(^{ND} = non-detectable.\)
Table from Kokich et al.  

Table 2. Threshold levels of significant difference Part II

<table>
<thead>
<tr>
<th></th>
<th>Orthodontists</th>
<th>Dentists</th>
<th>Laypeople</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crown length</td>
<td>0.5</td>
<td>1.5-2.0</td>
<td>1.5-2.0</td>
</tr>
<tr>
<td>Crown width</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Crown width and length</td>
<td>3.0</td>
<td>3.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Midline diastema</td>
<td>1.0-1.5</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Unilateral papillary height</td>
<td>0.5-1.0</td>
<td>0.5</td>
<td>ND</td>
</tr>
<tr>
<td>Bilateral papillary height</td>
<td>1.0</td>
<td>ND</td>
<td>1.5</td>
</tr>
<tr>
<td>Gingiva-to-lip distance</td>
<td>3.0</td>
<td>ND</td>
<td>3.0</td>
</tr>
</tbody>
</table>

*ND*, Not detectable.

Problems with the previous Kokich et al.  studies were that surveys were incremental nature and increments were quite large and up to 2.0 mm. Kerr et al.  advanced previous studies using the slider technology to eliminate the incremental nature and created a smooth transition from one increment to the next. Each increment varied from 0.125mm to 0.5mm to improve the quantification of dental variables. It appeared that this improvement did make a difference in some smile variables and provided more precision. Results were similar when comparing a maximal gingival display and central gingival discrepancy. There was a significant difference in upper midline deviation. Kokich et al. study found that laypersons could not detect a midline deviation past 4mm and Kerr et al.  found that an upper midline deviation of 2.9 mm was the maximum acceptable limit for acceptable esthetics.
Another issue with Kokich et al.\textsuperscript{4-5} studies were that the VAS was used indirectly to determine the range of acceptability of smile variables. Acceptability ranges of smile variables may differ significantly if directly assessed. Parekh and colleagues\textsuperscript{6} were one of the first to investigate the acceptability of smile with varying smile arcs and buccal corridors. He used a similar method of presentation as previous Kokich et al.\textsuperscript{4-5} studies and modified it to include a male and female peri-oral component. Nine different permutations were created using flat, ideal and excessive smile arcs with narrow, ideal and excessive buccal corridors determined by previous studies.\textsuperscript{22} The raters were asked, “Is the smile acceptable?” Parekh et al.\textsuperscript{6} found that accentuated smile arcs were preferred over a flat smile arcs. Ideal or narrow buccal corridors were preferred over excessive buccal corridors. They found no significant differences between the orthodontists and laypersons in evaluating acceptability of these variables. This was a significant finding because it indicated that although the different groups of raters evaluated ideal or detected deviations from the ideal differently, the ranges of acceptability were similar.

A drawback to the Parekh et al.\textsuperscript{6} study was that nonideal smile arcs and buccal corridors were at a set value with no freedom of manipulation. Parekh et al.\textsuperscript{6} found that a flat smile arc was detrimental to the smile. Compared to Kerr et al’s.\textsuperscript{3} data, flat smile arcs were still considered acceptable to the laypersons. Differences in the results were possibly due to Parekh et al. survey using close-ended answers\textsuperscript{6} and Kerr et al. survey using slider technology allowing more freedom for answers.\textsuperscript{3}

Kerr et al.\textsuperscript{3} also expanded on previous smile esthetic studies by focusing on laypersons only, laypersons from three different regions of the United States and including more smile variables. Kerr et al.\textsuperscript{3} found a regional difference between
laypersons only for buccal corridor. Narrow buccal corridors were more favorable for laypersons in the west coast compared to the midwest and east coast. Smile variables in this study included buccal corridor, smile arc, maxillary anterior gingival height discrepancy, maxillary gingival display, incisal edge discrepancy, occlusal cant, overbite, central incisor gingival margin discrepancy and maxillary midline to face and to mandibular midline to maxillary midline.

Another issue with past smile research studies is that the images focused on the lower face perspective. From a realistic standpoint, judging a smile is not limited to the lower face. It is unknown whether the full face enhances or detracts from evaluation of the smile. Johnston et al. 7 studied the difference in perception between orthodontists and laypersons on midline discrepancy using the full face. The raters were shown and asked to rate the attractiveness of a full face female model with different midline deviations (0, 1, 2, 4, 6 and 8mm). A 2 mm midline deviation was found to significantly reduce the attractiveness scores for 56% of the raters. Comparing these results with the lower face image studies, 3,6 it appears that a full face perspective made it easier to detect the midline discrepancy.

Flores-Mir et al. 8 disagreed with Johnston et al.’s findings 7. They reported a difference in smile perspectives using circumoral, lower face and full face views. The results showed that the different perspectives made a difference in attractiveness. By increasing the perspective or detracting attention from the oral cavity, attractiveness rating was increased significantly. 8 Evidently, more research is indicated to determine whether the full face magnifies or detracts smile discrepancies.
The following table notes the ideal and acceptable ranges of values for various smile characteristics from different perspectives. In general, it appeared that decreasing the incremental changes of the smile variable produced results that allowed less deviation from the ideal. This was clearly the case for the Kokich et al. studies for gingival display and upper midline discrepancies. When comparing the lower vs. full face studies, it appeared that the full face made few differences in the results. The only anomalies were upper midline, lower midline and occlusal cant. The lower face studies found that range of acceptable for the upper midline ranged from 2.9mm to nondeectable. The full face studies ranged from 2.0mm to 3.2 mm. Comparing the upper to lower midline, the full face study allowed more deviation than the lower face study. Occlusal cant was the exact opposite; the full face perspective allowed less deviation. Clearly the difference in perspectives were smile variable dependent.

Springer et al. evaluated several smile variables on a full face perspective. They used average male and female model faces determined by a previous pilot survey administered in Columbus, OH. Similar to several previous smile studies, their results showed no rater gender difference. The full face perspective made a difference in few of the smile variables. A maximum allowable lower midline difference on the full face perspective was more forgiving compared to the lower face view. However, the full face perspective was less forgiving with occlusal cant.
Table 3. Comparison of smile variables ideal and acceptability between studies

<table>
<thead>
<tr>
<th>Variable</th>
<th>Study</th>
<th>Perspective</th>
<th>Sample</th>
<th>Ideal Value</th>
<th>Range of Acceptability/Perceptibility</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Crown width</strong></td>
<td>Kokich et al. (^*)</td>
<td>Lips &amp; teeth</td>
<td>Orthodontist</td>
<td>0 mm</td>
<td>3.0 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>General Dentist</td>
<td>0 mm</td>
<td>3.5 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Laypersons</td>
<td>0 mm</td>
<td>4.0 mm</td>
</tr>
<tr>
<td>Kokich et al. (^5)</td>
<td></td>
<td>Lips &amp; teeth</td>
<td>Orthodontist</td>
<td>0 mm</td>
<td>2.0 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>General Dentist</td>
<td>0 mm</td>
<td>2.0 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Laypersons</td>
<td>0 mm</td>
<td>1.5 mm – 2.0 mm</td>
</tr>
<tr>
<td><strong>Buccal Corridor</strong></td>
<td>Ioi et al. (^24)</td>
<td>Lips &amp; teeth</td>
<td>Orthodontists</td>
<td>10%</td>
<td>0% - 20%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dental Students</td>
<td>5%</td>
<td>0% - 20%</td>
</tr>
<tr>
<td></td>
<td>Moore et al. (^22)</td>
<td>Lips &amp; teeth</td>
<td>Laypersons</td>
<td>2%</td>
<td>2% - 15%</td>
</tr>
<tr>
<td></td>
<td>Kerr et al. (^3)</td>
<td>Full face</td>
<td>Laypersons</td>
<td>16%</td>
<td>11.6% - 22%</td>
</tr>
<tr>
<td></td>
<td>Springer et al. (^12)</td>
<td>Full face</td>
<td>Laypersons</td>
<td>13%</td>
<td>12% - 21%</td>
</tr>
<tr>
<td><strong>Smile Arc</strong></td>
<td>Kerr et al. (^3)</td>
<td>Lower face</td>
<td>Laypersons</td>
<td>2.7 mm</td>
<td>- 3.3 mm - 1.2 mm</td>
</tr>
<tr>
<td></td>
<td>Springer et al. (^12)</td>
<td>Full face</td>
<td>Laypersons</td>
<td>-2.0 mm</td>
<td>-4.0 mm - 1.5mm</td>
</tr>
</tbody>
</table>
Table 3 continued

<table>
<thead>
<tr>
<th></th>
<th>Kokich et al. 4</th>
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A drawback to the Springer et al.\textsuperscript{12} study was that smile esthetics values were only applicable to average faces. Several studies in the literature have evaluated the association between facial attractiveness and smile attractiveness.\textsuperscript{14,15,25} It is still unknown whether facial attractiveness will enhance, detract or neutralize smile characters from the smile.

**STATEMENT OF PROBLEM**

Numerous studies in the past have evaluated smile esthetics from the lower face perspective,\textsuperscript{3-7} but few investigated the interactions of the full face with smile esthetics. The purpose of this study is to investigate the effects of varying facial attractiveness on smile esthetics from the layperson’s perspective. This study will compare smile

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esthetics of average faces from Springer et al.\textsuperscript{12} study with smile esthetics of attractive and unattractive faces.

The specific aims of this research project are to compare the ideal and range of acceptability of specific smile characteristics when using faces of varying facial attractiveness. For the purposes of this study, smile characteristics include buccal corridor, smile arc, maxillary anterior gingival height discrepancy, maxillary gingival display, incisal edge discrepancy, cant, overbite, central incisor gingival margin discrepancy and maxillary midline to face and to mandibular midline.

Hypotheses:

$H_01$: There is no difference between male and female model raters when rating ideal and acceptability limits of smile characteristics.

$H_02$: There is no difference when comparing the ideal and acceptability limits of smile characteristics between average male and attractive male model faces.

$H_03$: There is no difference when comparing the ideal and acceptability limits of smile characteristics between average male and unattractive male model faces.

$H_04$: There is no difference when comparing the ideal and acceptability limits of smile characteristics between attractive male and unattractive male model faces.

$H_05$: There is no difference when comparing the ideal and acceptability limits of smile characteristics between average female and attractive female model faces.
H₀₆: There is no difference when comparing the ideal and acceptability limits of smile characteristics between average female and unattractive female model faces.

H₀₇: There is no difference when comparing the ideal and acceptability limits of smile characteristics between attractive female and unattractive female model faces.
References


Chapter 2

MATERIAL AND METHODS

This was an observational cross-sectional study. The focus of this study was to
determine whether interactions exist between model faces (unattractive, average and
unattractive), model raters (gender) and selected smile characteristics.

Model identification and image manipulation

Twenty male and female model volunteers were selected to participate in part
one of this study. All male and female models consented and signed a model release
form approved by the Institution Review Board (IRB), which allowed frontal posed
smiling facial images to be obtained.

The frontal images were bisected and mirrored to eliminate any minor facial
asymmetries using Adobe Photoshop CS2 (Adobe Systems Incorporated, San Jose,
CA) similar to those procedures used by Parekh and colleagues.  The twenty symmetric
male and twenty female full smiling faces were surveyed based on their attractiveness
using a visual analog scale (VAS) anchored from “highly unattractive” (scale rating= 0) to
“highly attractive” (scale rating= 100). Model faces were presented in random order.
Twenty percent of model face images were repeated for reliability purposes.

One hundred model raters, who were at least 18 years of age and nondental
professionals, made the judgments. Average ratings for all model faces were analyzed
and three representative males (unattractive, average and attractive) and three representative females (unattractive, average and attractive) were selected.

Model faces and smile characteristics manipulation and data collection

The six model faces (three males and three females) had their smiles blocked out using Adobe Photoshop CS2 and a modification of the procedure from Parekh and colleagues. The smile characteristics evaluated in this study were similar to other previous studies. For each measured smile characteristic, the smile characteristic was altered using digitally modified templates separated from the initial image. This method eliminated any obvious incremental changes of dental variations and allowed a continuous gradient of changes.

The main threats to this study were model rater reliability and fatigue. These were addressed in the design of the study. Model rater reliability was assessed by randomly repeating each question twice. Model rater fatigue was managed by dividing the smile characteristics into six different surveys. To compensate for model rater fatigue, each model rater judged one or two smile characteristics for all model faces of varying attractiveness (attractive, average and unattractive). Each smile characteristic had either one or three questions per model face. Six of the ten smile characteristics had three questions (large variable), smile at ideal, upper and lower limits of acceptability. This generated 36 questions per smile characteristic including model rater reliability. Four of the ten smile characteristics had one question (small variable), deviation from the ideal, because no deviation was considered ideal. This generated 12 questions per smile characteristic including model rater reliability. Surveys were divided such that four surveys contained one large and small variable and two surveys.
contained one large variable only. Each model rater answered fewer than 50 questions per survey.

Selective smile characteristics evaluated in this study were similar to those used by Kerr et al.\textsuperscript{2}

1. Buccal corridor\textsuperscript{2}

Buccal corridor is defined by the amount of dark space displayed between the inner corner of the mouth and the buccal surfaces of the most distal molars. Moore et al.\textsuperscript{4} found that a broad smile or narrow buccal corridors were most favorable among both men and women. The amounts of minimal, moderate, and large buccal corridors were established by a pilot study of orthodontists with greater than five years of experience. Parekh et al.\textsuperscript{1} also found that orthodontists and laypersons preferred smiles with narrow buccal corridors. Frush et al.\textsuperscript{5} stated that a smile that is too broad (absence of buccal corridors) gives an unnatural denture appearance. In general, broad smiles are more favorable, but a smile too broad can be detrimental. Buccal corridor images in this study were presented as a series of images representing the spectrum of corridors from almost nothing to large. Buccal corridors were increased or decreased in increments of approximately 0.25 mm. This study expressed buccal corridor in percentages due to the differences in models’ smile width. This was calculated by adding the amount of black space on the right and left sides between the molar buccal surfaces to the adjacent commissure of the mouth. This value was then divided by the measured width between the commissures. There were three ratings for this variable: ideal, upper and lower range of acceptability.
2. Smile arc

Sarver defined smile arc as the curvature formed by the incisal edges of the anterior teeth relative to the curvature of the lower lip. According to Hulsey, he noted that orthodontic treated patients tend to have flatter smile arcs than those who were untreated. Previous dental or smile studies showed that a flat smile arcs were judged as unattractive and accentuated smile arcs were preferred over flat smile arcs. Since the degree of curvature in relationship to the lower lip is difficult to quantify, the degree of curvature was progressively increased or decreased. There were three ratings for this variable: ideal, upper and lower range of acceptability.

3. Maxillary anterior gingival height discrepancy

This variable represents the relationship in the height difference between the gingival zeniths of the six maxillary anterior teeth. Previous studies found that ideally the maxillary lateral incisor gingival should be slightly incisal to the maxillary central incisor gingival. The range of modification for this study was symmetrical and alterations occur at the gingival zenith of the maxillary lateral incisors. These incremental changes were approximately 0.25 mm. There were three ratings for this variable: ideal, upper and lower range of acceptability.

4. Maxillary gingival display

Maxillary gingival display is defined as the amount of gingival show between the zenith of the crown (central incisor) and the lower curtain of the upper lip. Sarver proposed that a posed smile should ideally have some gingival display. His thinking was that the gingival display made the smile look more youthful.
Other studies that looked at smile characteristics from the layperson’s view found that one to two millimeter of tooth coverage on a posed smile was ideal. The range of modification for this variable presented as the upper and lower dentition moving upward or downward. Incremental changes were approximately 0.125 mm. Negative values indicate gingival display and positive values indicate tooth coverage. There were three ratings for this variable: ideal, upper and lower range of acceptability.

5. Incisal edge discrepancy

This variable evaluated the difference between the incisal edges of the central and lateral incisors. McLaughlin et al. believed that a 0.5 mm lateral step was ideal. Other studies thought an approximately 1.5 mm was ideal. The variable was modified by moving the entire maxillary lateral incisor up or down in approximately 0.125 mm increments. The gingival levels between the central and lateral incisors remained constant. There were three ratings for this variable: ideal, upper and lower range of acceptability.

6. Overbite

The overbite is defined as the projection of the upper anterior teeth overlapping the lower anterior teeth. Few investigations have data on ideal overbite. Some studies considered ideal overbite to be approximately 2.5 mm. This variable was modified incrementally by moving the mandibular arch up and down the vertical dimension. The vertical movement will produce an increased or decreased overbite. The arch was moved incrementally in approximately 0.25 mm. Negative values indicate an open bite, where there is no overlap present.
Positive values indicate incisor overlap. There were three ratings for this variable: ideal, upper and lower range of acceptability.

7. Cant

Cant is defined as the transverse rotation of the occlusal plane. According to Profitt and et al., laypersons are able to detect an occlusal cant. This variable was modified by gradually rotating the occlusal plane at the pivot point located between the central incisors in a clockwise direction. The rotation of the plane was in 0.25° increments. In an ideal situation, there is no cant. There was one rating for this variable: deviation from the ideal (no cant).

8. Central incisor gingival margin discrepancy

Central incisor gingival margin discrepancy refers to the gingival margin difference between the maxillary central incisors. Lower face studies and one average full face studies showed that a 2.0 mm discrepancy was the maximal allowable limit. In this study, the left maxillary central incisor gingival margin was altered in approximately 0.25 mm increments. The incisal edges were maintained at the original height. Ideally, there should be no discrepancy. There was one rating for this variable: deviation from ideal.

9. Maxillary midline to face

This variable is defined by the horizontal discrepancy between the central incisors and the philtrum of the upper lip. Several studies evaluated the maximum allowable upper midline deviation for laypersons. Acceptability range ranged from 2.0 mm to nondetecable past 4.0mm. The maxillary and
mandibular midline was moved to the left of the face by rotation of both arches in approximately 0.25 mm increments. The right and left buccal corridors were maintained throughout the movement of the dentition. The ideal was defined as no midline deviation for this variable. There was one rating for this variable: deviation from ideal.

10. Maxillary to mandibular midline discrepancy

Maxillary to mandibular midline discrepancy is defined by the horizontal discrepancy between the lower midline (between the two lower central incisors) and the upper midline (between the two upper central incisors). Past research studies found that a clinically significant lower midline deviation was acceptable to the layperson’s perspective. For this variable, the maxillary midline was maintained as the mandibular arch was adjusted incrementally by rotation to the left. The transverse relationship with the maxilla and buccal corridors were maintained. The ideal for this variable was determined to be 0 mm deviation. There was one rating for this variable: deviation from ideal (no maxillary to mandibular midline deviation).

Five hundred and seventy six model raters were included in this study. This sample size requirement was determined by power analysis. Clinical significance in this study was defined by one millimeter or greater difference. For an experiment-wise, non-directional alpha risk of 0.05 and assuming a standard deviation of 3.5, a sample size of 87 model raters per smile characteristic yielded a power of 0.86. To accommodate a nonparametric analysis, ten percent was added to this calculated sample size. The final sample size needed to assess model rater, model faces and smile characteristics and
their interactions was 96 per smile characteristic and model face. There were six different surveys and each survey had to be rated 96 times. Therefore, a total of 576 model raters were required to complete this study.

The survey was conducted at a central campus facility. Model raters were volunteer adults (greater than 18 years of age) recruited using a poster approved by the IRB. Model raters were not approached or solicited. Prior to beginning the survey, volunteers were provided with a brief oral introduction to the survey. All model rater consented to participation by agreeing with the terms of the waiver of informed consent. Age, gender, ethnicity and socio-demographic status (SDS) were voluntarily provided. Upon completion of the survey, a $10 gift card was provided.

Data were presented, collected and partially analyzed on laptop computers with MATLAB Software Suite (Mathworks, Inc., Natick, MA). This program randomly displayed model faces with smile variable characteristics that were adjusted using an on-screen slider. The slider motion adjusted the smile characteristic at an increment of one-eighth to one-half of a millimeter, depending of the smile variable. This appeared to morph the smile in a continuous manner.

Model raters answered the following one to three questions per model face depending on the smile characteristic in question.

- “Please move the slider to the LEFT to select the first image you find unattractive.”

- “Please move the slider to the RIGHT to select the first image you find unattractive.”
• “Select the image you find MOST IDEAL. Move the slider to the extreme to see the possible range of options, and then choose the most appropriate position.”

MATLAB Software Suite was programmed to repeat every question twice in random order for reliability purposes. This program recorded an assigned value appropriate to the ratings which were converted to the corresponding millimeter measurement.

The time to complete each survey ranged from 10 to 20 minutes.

Data storage and analysis

Data was stored on locked computers using a secure database and server. Any information transferred from the server was stored on password protected equipment. Hard copies of any data were contained in locked storage at The Ohio State University, Division of Orthodontics.

Statistical analysis:

Reliability for all smile arch measurements was evaluated using the Fleiss-Cohen weighted kappa statistic.

Medians and their corresponding ranges were calculated for ideal, upper and lower limits of acceptability for all smile characteristics. Comparisons between model gender and among attractiveness levels were assessed using multiple Wilcoxon matched-pairs, signed-ranks tests with p-values adjusted using the step-down, Bonferroni method of Holm.
References


Chapter 3

MANUSCRIPT

Introduction

There are several components of the face that contribute to its attractiveness. Of particular interest to orthodontists is the smile. Many authors have strived to identify what laypersons find most attractive about a smile and how to quantify its attributes.

Facial / dental esthetics appear to play a role in the quality of life. Langois\(^1\) believed that facial attractiveness was highly correlated with an increased quality of life and interpersonal success. Individuals who were more attractive were perceived as more intelligent, confident and socially acceptable. Shaw\(^2,3\) thought that facial attractiveness was the key to social success. He considered dental attractiveness an important factor contributing to facial and social attractiveness. Kiyak\(^4\) reviewed the effects of a pleasing dentition on the quality of life. Contrary to Shaw’s\(^2,3\) belief, Kiyak\(^4\) believed that dental esthetics did not enhance social acceptance. She did, however, conclude that orthodontics did improve esthetics and the psychosocial well-being of individuals. Adolescents who have completed orthodontic treatment reported less negative psychosocial influence, such as teasing and embarrassment from smiling.\(^4\)

Past investigations of smile characteristics have raised several issues. First is the method of presentation. Ker et al.\(^5\) performed a computerized survey to identify the
ideal and range of acceptability for ten smile characteristics from the layperson’s view utilizing a single image of the lower face. The computerized survey allowed the raters to digitally modify one variable at a time. Images rated appeared in a continuously morphed stream of choices. This was an improvement compared to previous studies, eliminating the incremental nature of the choices and providing more precision.

A second issue is the facial perspective. Many previous studies used the circumoral or lower facial perspective for evaluation by the model raters, which may have focus intensively on the smile. Other studies have used a full face perspective, which could either reduce or enhance the raters’ ability to evaluate aspects of smile esthetics. Springer et al. addressed this issue in part by using similar material and methods as Ker et al.’s lower face study. Springer et al. found statistical differences between the perspectives for several variables, but only five were clinically significant (ideal smile arc, ideal buccal corridor, upper midline to face, lower midline to upper midline and occlusal cant). Of the five smile variables, only one was relative to the teeth (lower midline to upper midline) --the rest had a facial context.

A third issue is the nationality and ethnicity of the model rater. Sharma et al. compared perspectives of three groups (U.S. Caucasian, U.S. American-Asian Indians and Indians residing in India) using study methods similar to Ker et al. They found differences between the three groups for certain smile variables (buccal corridor, smile arc, and upper midline). Fewer differences were found between Indians residing in the U.S. and those residing in India. McLeod et al. compared perspective differences between U.S. (Ker et al. data) and Canadian residents (predominantly Caucasians) for
the following smile variables: buccal corridor, gingival display, occlusal cant, maxillary midline to face discrepancy, and lateral central gingival discrepancy. These investigators’ results concluded that clinically significant differences were present for smile variables in all dimensions, except for buccal corridor. Canadians were more discriminating and allowed less deviation compared to U.S. raters. Stockebrand et al. distributed a dental esthetic questionnaire with different ethnic groups residing in Germany. Raters evaluated frontal smile photos of eight male and female models and the investigators reported differences between three ethnic groups (German, Russian and Turkish). These studies indicate that nationality and ethnicity do influence dental esthetic perception.

The fourth issue is the attractiveness of the full face. Springer et al. used average male and female faces for their study. Other previous full face smile studies did not identify the attractiveness of the face. Flores-Mir et al. found that the full face context led to few differences and almost all smile variables affected were measured relative to the face. It appeared that models did have an effect on the results. This could be due in whole or part to model attractiveness. From the full face perspective, does model gender affect the rating of smile variables? Second, does the level of attractiveness of the model affect our current perceptions of ideal and acceptable values of a smile variable?

The purpose of this study was to investigate the effects of varying facial attractiveness (unattractive, average and attractive) and gender of the model on smile esthetics from the layperson’s perspective.
Materials and Methods

This was an observational cross-sectional study approved by a university Institutional Review Board (IRB) with data collection at a central campus facility. The first part of the study was identification of model faces (unattractive, average or attractive) for each gender. The second part of this study focused on interactions between model faces (unattractive, average and attractive), model raters (gender), model gender and selected smile characteristics.

Model identification and image manipulation.

Twenty male and female model volunteers were selected to participate in the first portion of this study. All male and female models consented and signed a model release form, which allowed frontal posed smiling facial images to be obtained.

The frontal images were bisected and mirrored to eliminate any minor facial asymmetries using Adobe Photoshop CS2 (Adobe Systems Incorporated, San Jose, CA) similar to those procedures used by Parekh et al. These images were assayed for attractiveness using a visual analog scale (VAS) anchored from “highly unattractive” (scale rating= 0) to “highly attractive” (scale rating=100). Model faces were presented in random order. Twenty percent of model face images were repeated for reliability purposes.

One hundred model raters who were at least 18 years of age and nondental professionals made the judgments. Average ratings for all model faces were analyzed
and three representative males (unattractive, average and attractive) and three females 
(unattractive, average and attractive) were selected.

Model faces and smile characteristic manipulation and data collection.

The six model faces (three males and three females) had their smiles blocked 
out using Adobe Photoshop CS2 in a modified procedure from Parekh et al. The smile 
characteristics evaluated in this study were similar to other previous studies. Each 
smile characteristic was altered using digitally modified templates separated from the 
initial image. This method eliminated any obvious incremental changes of dental 
variations and allowed a continuous gradient of changes.

The ten smile variables accessed in this survey were identical to the ones 
examined by Springer et al., but with different model faces. These included: buccal 
corridor (the amount of dark space displayed between the inner corner of the mouth 
and the buccal surface of the molars); smile arc (the curvature formed by the incisal 
edges of the anterior teeth relative to the curvature of the lower lip); maxillary anterior 
gingival height discrepancy (the relationship in the height difference between the 
gingival zeniths of the six maxillary anterior teeth); maxillary gingival display (the 
amount of gingival show between the zenith of the crown (central incisor) and the lower 
curtain of the upper lip); incisal edge discrepancy (the difference between the incisal 
edges of the central and lateral incisors); overbite (the projection of the upper front 
teeth overlapping the lower teeth); cant (the transverse rotation of the occlusal plane); 
central incisor gingival margin discrepancy (Central incisor gingival margin discrepancy 
refers to the gingival margin difference between the maxillary central incisors); maxillary
midline to face (the horizontal discrepancy between the central incisors and the philtrum of the upper lip); and maxillary to mandibular midline discrepancy (the horizontal discrepancy between the lower midline (between the two lower central incisors) and the upper midline (between the two upper central incisors).

Model raters answered the following one to three questions per model face depending on the smile characteristic in question.

- “Please move the slider to the LEFT to select the first image you find unattractive.”
- “Please move the slider to the RIGHT to select the first image you find unattractive.”
- “Select the image you find MOST IDEAL. Move the slider to the extreme to see the possible range of options, and then choose the most appropriate position.”

The main challenges in this study were model rater reliability and fatigue. Model rater reliability was assessed by randomly repeating each question twice. Model rater fatigue was managed by dividing the smile characteristics into six different surveys. Each model rater judged one or two smile characteristics for all model faces of varying attractiveness (unattractive, average and attractive). Six of the ten smile characteristics had three questions, smile at ideal, upper and lower limits of acceptability. This generated 36 questions per smile characteristic including model rater reliability. Four of the ten smile characteristics had one question, deviation from the ideal. This generated 12 questions per smile characteristic including model rater reliability. Surveys were
divided such that four surveys contained one large and one small variable and two surveys contained one large variable only. Each model rater answered fewer than 50 questions per survey.

The model raters were recruited using a poster. All model raters consented to participation by agreeing with the terms of the waiver of informed consent. Age, gender, ethnicity and socio-demographic status (SDS) were voluntarily provided. Upon completion of the survey, a $10 gift card was provided.

**Statistical analysis**

Five hundred and seventy six adult (18 years or older) model raters were included in this study.\(^5\) This sample size requirement was determined by power analysis. For an experiment-wise, non-directional alpha risk of 0.05 and assuming a standard deviation of 3.5, a sample size of 87 model raters per smile characteristic yielded a power of 0.86.\(^5\) To accommodate a nonparametric analysis, ten percent was added to this calculated sample size. The final sample size needed 96 raters per smile characteristic and model face. There were six different surveys and each survey had to be rated 96 times. Therefore, a total of 576 model raters were required to complete this study.

Reliability for all smile variables measurements was evaluated using the Fleiss-Cohen weighted kappa statistic.\(^16\)

Medians and their corresponding ranges were calculated for ideal, upper and lower limits of acceptability for all smile characteristics. Comparisons between model gender and among attractiveness levels were assessed using multiple Wilcoxon
matched-pairs, signed-ranks tests with p-values adjusted using the step-down, Bonferroni method of Holm.

**Results**

There were no statistically significant differences between ratings for male and female model raters (p>0.13). Fleiss-Cohen weighted kappa statistic showed that reliability was fair to excellent when judging individual smile variables, except for buccal corridor which was slightly reliable (Table 1).

In this study, an alpha level less than 0.05 was considered statistically significant and a difference of 1.0 mm or greater was considered clinically meaningful. Since buccal corridor was expressed in percentages, a 2% difference was considered clinically meaningful. Differences which were both statistically significant and clinically meaningful were designated by the term clinically significant.

There were clinically significant differences between the model genders and among the levels of facial attractiveness. For all smile variables, there were no differences between the male and female models with average facial attractiveness.

Table 2 refers to the five smile variables that had no facial context—variables that could be judged only in the context of the dentition or surrounding soft tissue. Although some statistically significant differences appeared with maximum overbite, none were clinically meaningful. Model gender and model attractiveness did not have a clinically significant effect on these dental smile variables.
Table 3 refers to smile variables that had a facial context—variables that could only be judged relative to the face. Of these facial smile characteristics, only occlusal cant was not affected by model gender or model attractiveness. All others were affected by either, model gender, attractiveness, or both. Attractiveness demonstrated more statistical and clinical significance than model gender.

The following smile variables with a facial context demonstrated clinically significant difference among model gender and attractiveness:

Buccal corridor- Clinically significant differences existed between model gender and model attractiveness. Female models were favored with smaller buccal corridors compared with male models. Unattractive and attractive female models were considered more acceptable with smaller buccal corridors compared with the average female models. Unattractive and attractive male models were considered to be more acceptable with more buccal corridor when compared to the average male models (Figure 1). However, these results must be interpreted with caution because this variable exhibited only slight reliability (Table 1).

Smile arc- Model gender made a significant clinical difference for the attractive group for ideal and maximum (flattened) smile arcs and for the unattractive group for ideal and minimum (accentuated) smile arcs. Unattractive and attractive female models were considered to be more acceptable with flattened smile arcs (but not flat smile arcs) compared with the average female models. Unattractive and attractive male models were considered to be more acceptable with accentuated smile arcs compared with the average male models (Figure 2).
Maxillary gingival display- There were no clinically significant differences between model gender. Model raters preferred attractive and unattractive female models with less tooth coverage (more gingival display) compared to average models for all smile characteristics. Unattractive males were considered to be more acceptable with more gingival display compared to average males for all characteristics. Unattractive male model showed more gingival display compared with attractive male for the maximum limit (Figure 3).

Upper midline to face- There were no model gender differences for this variable. Clinically significant differences were only present when comparing the attractive models with the average and unattractive models. Model raters marked smaller midline deviations for attractive faces as acceptable compared with average and unattractive faces (Figure 4).

Discussion

This study focused on laypersons’ judgments of young adults so the data and results are most relevant to this group. This study clearly focuses on specific patient types and potentially makes the data applicable to a smaller range of patients because the context of attractiveness, gender and even age are relevant. This study demonstrated that model gender and model attractiveness can have a clinically significant influence on rating esthetics when the smile variables (buccal corridor, smile arc, gingival display and upper midline to face) are judged in the context of the full face.

The results are in agreement with the results of Shaw et al.\textsuperscript{2,3} and Flores Mir et al.\textsuperscript{10} who suggested that facial attractiveness has an influence on judgment of oral
esthetics. These results confirmed that suggestion for the smile variables (buccal corridor, smile arc, gingival display and upper midline to face)

It appears that for several of the variables without facial context, attractive and unattractive models are judged similarly as opposed to average models. But neither these variables nor model rater gender reach clinical significance which is similar to the findings in many previous studies.\textsuperscript{5, 8, 11}

Previous studies stated that smaller buccal corridors were viewed more favorably.\textsuperscript{8} Moore et al.\textsuperscript{17} reported that 2\% buccal corridor was most favored compared to larger buccal corridors. Conversely, it has been stated that minimal or no buccal corridor gives the patient an unnatural denture look.\textsuperscript{18} Springer et al.\textsuperscript{11} used a method similar to this study focusing on average faces. They concluded that the acceptable range for buccal corridor was 12-21\% and 13\% was considered ideal. Smaller buccal corridors were preferred for the unattractive (9.7\%-18.3\%) and attractive (10.6\%-20.2\%) female models compared to the Springer et al’s\textsuperscript{11} average models. Unattractive (12.0\%-21.8\%) and attractive (15.9\%-24.8\%) male models were considered more acceptable larger buccal corridors compared to their average male models. However, Springer et al.\textsuperscript{11} pointed out in the companion study to the current study, that variance among the models was low leading to a smaller kappa statistic and lower reliability. Other explanations were related to the high number of choices available and detractions from the full face perspective. Therefore, these values for buccal corridor must be interpreted with caution.
Smile arc, parallelism of the curvature of the lower lip to the incisal edges of the teeth,\textsuperscript{15} was also another variable that was dependent on facial attractiveness. Parekh et al.\textsuperscript{8} determined that truly flat smile arcs were unacceptable. More recent studies, full face and circumoral view, found that a slightly flattened smile arc (but not flat) was still considered acceptable.\textsuperscript{5,11} Compared to the average models,\textsuperscript{11} flatter smile arcs were preferred for unattractive and attractive female models and accentuated smile arcs were preferred for the unattractive and attractive male models.

Sarver\textsuperscript{15} thought that gingival show in a female was most ideal due to its youthful appearance. Recent studies showed that slight tooth coverage on a posed smile was considered ideal.\textsuperscript{5,11} In the current study, tooth coverage (less gingival display) was considered ideal for the all groups, except for the unattractive female, for which 0.5 mm of gingival display was ideal. Less tooth coverage (more gingival display) was preferred for the attractive and unattractive male and female models compared with the average models.\textsuperscript{11}

The contour of the lips may have an effect on smile arc and gingival display. The lower lip may be different in contour among individuals, but approximate tracking of the lower lip with the incisal edges of the teeth appeared to be most critical. With gingival display, the upper lip is the most important. Gingival display was measured from the zenith of the upper central incisor gingival margin to the upper lip curtain. Gingival display for the adjacent teeth was not measured or considered. It is possible that no gingival display was present at the central incisor region, while more was evident at the lateral, canine and premolar regions depending on the upper lip contour.

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There have been a number of previous reports regarding upper midline to the face discrepancy. Previous studies showed conflicting data ranging from 2.0 mm to nondetectable, but few were full face studies. Johnston et al.’s full face study reported a 2.0 mm upper midline deviation as the acceptable limit. However, their study did not take into consideration model attractiveness. Springer et al. evaluated average male and female models and reported that 3.3 mm upper midline deviation as the maximum acceptable limit. The results from Springer et al. were in agreement with recent studies for the average and unattractive models. Surprisingly, less upper midline deviation was acceptable for the attractive models, 2.0 mm for the attractive females and 2.3 mm attractive male versus 3.3 mm for the average and unattractive models.

Occlusal cant was the only smile variable related to the face that was not affected by model gender or model attractiveness. Approximately three degrees was the acceptable limit.

Variables that only related to the oral soft tissue and teeth were not influenced by the model gender and model attractiveness (Table 2). This was not an unexpected finding since these micro-esthetic smile variables did not make a difference when comparing the circumoral and the average male and female full face perspective.

Central-lateral gingival discrepancy ideal and acceptability limits were similar to reported by Springer et al. study. Ideal was 0.4 mm incisal to the central incisor gingiva. Ranges were approximately 0.4 mm above the central gingival and 2.0 mm below the central gingival.
Lateral incisal step is considered ideal at 0.5 mm gingival to the central incisor by certain practitioners.\textsuperscript{19} Reports of layperson’s ideal incisal step differed from these clinical guidelines.\textsuperscript{5, 11} Compared to other lower and full face studies,\textsuperscript{5, 11} ideal lateral incisor step was approximately 1.0 mm with an upper limit of 2.0 mm.

Overbite evaluation was also comparable to previous studies.\textsuperscript{5, 11} Ideal was considered 2.0 mm and acceptability ranges were from 0.9 mm to 6.0 mm.

Central-central gingival discrepancy limit was a consistent finding with several previous studies.\textsuperscript{5, 6, 7, 11} A maximum deviation of 2.0 mm was the limit.

Similar to Springer et al’s\textsuperscript{11} findings, a lower midline discrepancy up to 3.6 mm was acceptable.\textsuperscript{11}

Model selection in the study was based on facial attractiveness and there was no mention of the teeth in the assessment nor was there any attempt to standardize or quantify the dental esthetics of the models when that judgment was made. It was possible that smile/dental attractiveness of the models could have affected the overall attractiveness rating. However, based on Kiekens et al’s study,\textsuperscript{20} dental esthetics does not affect facial attractiveness by more than approximately 25%. We are not certain how the model smile attractiveness affected facial attractiveness. Further, this study did not attempt to assess the portion of facial attractiveness that the dental esthetics contributed.

The clinical implications of this study are relevant to orthodontic diagnosis and treatment planning an orthodontic patient. If the chief complaint is a smile variable that varies in its perception between full face and lower face, the clinical approach toward it
should be modified with the patient. This perspective influence should be accounted for in the discussion of the issue. As pointed out in Springer et al’s\textsuperscript{11} study, some smile variables (buccal corridor, smile arc, gingival display, upper to lower midline and occlusal cant) made a clinical difference in the full face perspective. If one of these variables is a complaint of the patient, they should view themselves in a full face mirror at approximately a conversational distance (~2 feet) with queries about what they find problematic. They should be informed of the range of acceptability that applies to that variable and informed that this is the way most people will experience them in daily life. They can then reassess their concerns. Patients need to understand that only the patient and the dentist are likely to be aware of imperfections in the acceptable range at a conversational distance—in other words, in daily life. Further, the patient also needs to understand that only those problems that are in the context of the face will be at issue with most of those they encounter during routine interactions.

If they are worried about other smile variables, they can view those in either a full face or a close up (hand mirror) perspective and be equally effective and valid in their assessments. Again, the range of acceptability should be included in the discussion. This is not an attempt to dismiss patients’ micro-esthetic concerns, but to place them in a realistic context. Because clinically acceptability varied with model attractiveness and gender, the sometimes subtle differences may be cumbersome to apply. It may also be difficult to categorize an individual’s facial attractiveness. This study’s findings may be most simply applied by focusing on the values that were found within the acceptable range for all levels of background facial attractiveness. This more broad advice appears advisable and is based on the values displayed in Figure 5, which shows the extent of
acceptability for all genders and attractiveness levels and the zone that is acceptable for all levels of attractiveness. Values are shown for all facial context variables, except gingival display for the unattractive female model. This approach provides good generalization and ample range for most variables.

Conclusion

1. Similar to many previous studies, there were no differences in rater gender.
2. Reliability was fair to excellent for individual smile variables, except for buccal corridor.
3. Smile variables without a facial context were not affected by facial attractiveness: central-central gingival discrepancy, central-lateral gingival discrepancy, central-lateral incisor discrepancy, overbite and lower midline to upper midline deviation.
4. Smile variables with a facial context were affected by model gender facial attractiveness (buccal corridor, smile arc, gingival display and upper midline to face), except for occlusal cant.
5. Smaller buccal corridors, flattened smile arcs, more gingival display were preferred for unattractive and attractive female models compared to average female models.
6. Unattractive and attractive male models were preferred with larger buccal corridors, accentuated smile arcs and more gingival display when compared to average male models.
7. Smaller buccal corridors and flattened smile arcs were preferred for unattractive and attractive female models compared to unattractive and attractive male models.
8. Model raters were more critical on attractive models when evaluating the upper midline to face.

Acknowledgments

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References


Chapter 4

CONCLUSION

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7. Smaller buccal corridors and flattened smile arcs were preferred for unattractive and attractive female models compared to unattractive and attractive male models.
8. Model raters were more critical on attractive models when evaluating the upper midline to face.
Bibliography


APPENDIX

LEGEND

Table 4. Reliability

Table 5. Smile variables for non-facial related characteristics

Table 6. Significant differences facial smile variables
Table 4. Reliability

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<sup>1</sup> Fleiss-Cohen weighted kappa  
<sup>2</sup> Landis and Koch
Table 5. Smile variables for non-facial related characteristics

**Central-Lateral Gingival Difference Ideal**

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Table 6. Significant differences facial smile variables

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Table 6 continued

Smile Arc Ideal

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\[ \Delta \quad 1.5 \]
\[ P \quad 0.017 \]

Smile Arc Minimum

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\[ \Delta \quad 0.5 \]
\[ P \quad 1         \]

Smile Arc Maximum

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#### Gingival Display Ideal

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#### Gingival Display Minimum (Gum show)

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Upper Midline to Face

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67
Figure 1. Median Buccal Corridor Value by Model Gender and Attractiveness
A negative value corresponds to an accentuated smile arc.

Figure 2. Median Smile Arc Value by Model Gender and Attractiveness
A negative value corresponds to gingival display.

Figure 3. Median Gingival Display Value by Model Gender and Attractiveness
Figure 4. Median Upper Midline deviation value by Model Gender and Attractiveness
Figure 5. Buccal Corridor, Acceptability for model gender and attractiveness
Figure 6. Smile Arc, Acceptability for model gender and attractiveness
Figure 7. Smile Arc, Acceptability for model gender and attractiveness
Figure 8. Upper midline deviation, Acceptability for model gender and attractiveness
Figure 9

Unattractive  Average  Attractive
A. Ideal Central-Lateral Gingival Difference

Unattractive  Average  Attractive
B. Minimum Central-Lateral Gingival Difference
Figure 10

C. Maximum Central-Lateral Gingival Difference

A. Ideal Lateral Step
Figure 11

A. Ideal Overbite

B. Maximum Lateral Step
Unattractive

Average
B. Minimum Overbite

Attractive

Unattractive

Average
C. Maximum Overbite

Attractive
Figure 12

Unattractive  Average  Attractive

Central-Central Gingival Discrepancy

Figure 13

Unattractive  Average  Attractive

Lower midline to Upper midline

80
Figure 14

A. Ideal Buccal Corridor

B. Minimum Buccal Corridor
C. Maximum Buccal Corridor

A. Ideal Buccal Corridor
A. Minimum Buccal Corridor

B. Maximum Buccal Corridor
Figure 15

A. Ideal Smile Arc

B. Minimum (Up) Smile Arc
C. Maximum (Down) Smile Arc

A. Ideal Smile Arc
Unattractive  Average  Attractive

B. Minimum (Up) Smile Arc

Unattractive  Average  Attractive

C. Maximum (Down) Smile Arc
Figure 16

A. Ideal Gingival Display

B. Minimum (Up) Gingival Display
Unattractive
Average
Attractive

C. Maximum (Down) Gingival Display

Unattractive
Average
Attractive

A. Ideal Gingival Display
Unattractive  Average  Attractive

B. Minimum (Up) Gingival Display

Unattractive  Average  Attractive

C. Maximum (Down) Gingival Display
Figure 17

Unattractive Average Attractive
Upper midline deviation

Unattractive Average Attractive
Upper midline deviation
Figure 18

Unattractive | Average | Attractive

Cant