Position of the lips and facial profile: Preferences of orthodontists versus lay people

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Abstract

Introduction: The purpose of this study was to assess and compare the esthetic lip preferences of orthodontists and the lay public in straight, retrognathic and prognathic Caucasian profiles.

Methods: The profile images of two Caucasian subjects, male and female, having normal cephalometric values were digitally altered. The chin was moved to create straight, retrognathic and prognathic profiles for both subjects. The position of the upper and lower lips were then horizontally protracted and retracted in two millimeter increments in each profile to a maximum distance of six millimeters. The profile images were assembled into a booklet and distributed to 50 orthodontists and 100 lay people who evaluated the attractiveness of the profiles by marking a Visual Analogue Scale (VAS). Thirteen orthodontists and 18 lay people repeated the survey a month later to assess reliability. Factorial ANOVAs with repeated measures and Bonferroni multiple comparison tests were conducted to determine differences in attractiveness preferences. All tests were set at a significance level of .05 (p=.05).

Results and Conclusions: Lay people and orthodontists did not differ significantly in their preferred lip positions for both the male (p=.058) and female profiles (p=.134). The straight profiles for both sexes had the highest overall ratings. Lip retrusion was preferred for the retrognathic profiles, while greater lip protrusion for the prognathic profiles. Minimal lip retrusion was deemed more acceptable in the male profiles. Both rater groups were tolerant of changes in lip position between two and four millimeters from their original positions, depending upon on the facial profile. Lay people and orthodontists were reliable in their assessments of facial profile attractiveness.

Introduction

The esthetic aspects of the face have become a primary area of focus in our society as people search for ways to improve their facial beauty in the present and over the long-term. Facial cosmetic surgery involving skin tightening, widening of the eyes and augmentation of the lips are particularly common. Due in part to this relatively recent surge in beauty and esthetics, orthodontists have begun to pay particular attention to the facial profile and soft tissues when evaluating a patient for treatment. However, the concern for facial esthetics is not a new concept to the orthodontic specialty. Angle and Tweed both believed orthodontic treatment affected the patient's facial profile, although their treatment objectives happened to differ.

Currently, orthodontists analyze the patient's facial profile prior to deciding on a treatment plan with the intention of improving or maintaining it. The clinician often decides the final treatment objectives he/she would like to achieve for the patient, frequently using cephalometric measurements developed in the previous century while diagnosing and treatment planning (Holdaway 1983; Ricketts 1968). Due to changing societal ideals of beauty, some have shown these analyses to be outdated and not representative of current trends (Peck and Peck 1970). Most would consent that agreement between the orthodontist and patient with regard to final treatment objectives is essential, implying the need for similar ideas of facial beauty. Therefore, this study investigated facial attractiveness as judged by orthodontists and lay people in order to determine overall congruity.

As stated above, orthodontists strive to provide a satisfactory facial result for their patients. In most situations, treatment planning to correct the malocclusion and maintain

facial esthetics is fairly straightforward. However, deciding upon an appropriate treatment plan for the patient with a retrusive profile can be difficult, especially if there is crowding and a risk of causing excessive lip retraction. Visual Treatment Objective (VTO) computer programs such as those offered by Quick Ceph® and Dolphin Imaging® can help the clinician predict facial outcomes due to incisor retraction. However, predicting the final position of the lips following treatment is challenging due to variations in lip thickness, soft tissue contour and musculature. Despite this unpredictability, research has shown that in some patients the movement of the incisors can produce statistically significant changes in the position of the lips which affect the facial profile (Drobocky and Smith 1989). For this reason, it is valuable to know whether the average person is able to discern these small, but statistically significant, changes in lip position.

In many situations, orthodontists use dental compensation to avoid orthognathic surgery in patients with skeletal disharmonies. For the skeletal Class III patient, incisor and lip retraction may enhance an already large mandible, giving the appearance of a concave profile. Furthermore, excessive lip protrusion may add to the facial convexity of a Class II patient exhibiting a retrusive mandible. Thus, projected changes in the position of the lips may minimize the apparent severity of a skeletal discrepancy and may assist the practitioner in deciding on a treatment plan to help restore facial balance. To investigate this approach, this study evaluated the lip preferences of orthodontists and lay people in the straight, retrognathic and prognathic profiles to determine if, in fact, preferences changed with varying profiles.

Orthodontists devote considerable attention to evaluating facial profile changes occurring during treatment. One can detect these changes attributable to growth or orthodontic treatment with a simple side-by-side comparison of facial profiles. However, such comparisons are not possible in reality and whether people are reliable in their assessments of facial profile attractiveness remains unknown. This study examined the consistency of orthodontists and lay people for judging facial beauty over time.

The following questions were addressed in this study. Are the average individual and orthodontist able to recognize small changes in the position of the lips? What are the most desirable lip positions in individuals with straight, retrognathic or prognathic profiles? Do gender and profession influence the preferred lip positions in the above profiles?

The purpose of this study was to (1) compare the preferred lip positions of lay people and orthodontists in straight, retrognathic and prognathic Caucasian profiles, (2) determine if gender and profession contribute to lip position preferences (3) define points at which the position of the lips becomes significantly unattractive and (4) determine how reliable orthodontists and lay people are in evaluating facial profiles.

Literature Review

Esthetics

Historical Review

Achieving facial balance and dental stability have been long-standing objectives of orthodontics since the specialty's establishment by Edward Angle in the early 1900s (Angle 1899). As in other aspects of cultural progression, society's preference for facial esthetics and the interpretation of facial balance have evolved with time and civilization. Consequently, orthodontic treatment philosophies have also progressed throughout history to parallel changes in society's esthetic preferences.

The value of facial beauty dates historically to ancient civilizations. Janson (Janson 2001) describes the ideal Egyptian as having a weak brow ridge, a round, broad face with a sloped forehead, evenly contoured nose, thickened lips and a mild yet positive chin. Comparing this description to the renowned bust of Queen Nefertiti (Figure 1), one can appreciate the standard of beauty that was perhaps admired at the time.

Figure 1. Bust of Queen Nefertiti (Lewis 2007)

Succeeding the Egyptians, the ancient Greeks also valued the beauty of the face and body as a whole. Unlike the Egyptians, classic Greek sculptures depict an anteriorly positioned forehead, with a lack of concavity between the glabella and nasal dorsum. The classic Greek mouth exhibits an undulating upper lip and slightly rolled lower lip (Peck and Peck 1970).

From the Renaissance to the present, through sculpture and paintings, artists have continued to express that which was considered beautiful at the time. Sandro Botticelli's classic painting, Venus and Mars, depicts Venus with a high forehead, sharply defined chin, pale skin, high eyebrows, strong nose, narrow mouth and full lips (Haughton 2004). Regarding harmony, Leonardo da Vinci notably stressed the importance of congruity between the respective parts and the whole. He emphasized the divine proportion as described by Luca Pacioli in the *De Divina Proportione* and advocated its application to yield pleasing, harmonious proportions (Pacioli 1509; Pedretti 2001). The divine proportion, or golden rule, is approximately 1.618 and results if the ratio between the sum of two quantities and the larger one is the same as the ratio between the larger one and the smaller. Many believe the ratio to be aesthetically pleasing and speculation exists about its presence in prominent architecture and artwork.

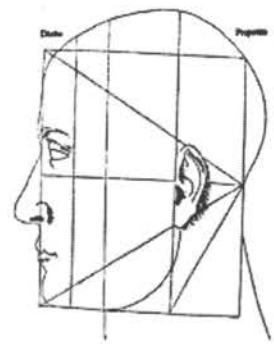

Figure 2. Woodcut from De divina proportione illustrating the golden ratio as applied to the human face (Wikipedia 2007)

Figure 3. Bust of Apollo Belvedere (Cinoa 2007)

Moving ahead to the 20th century, the founder of orthodontics, Edward H. Angle, believed the bust of Apollo Belvedere signified the ideal in facial esthetics and sought to achieve its likeness for his patients (Angle 1968).

Angle deemed that the full complement of teeth would achieve the best balance and proportions of the mouth and its relation to other features for all cases.

However, a memorable event occurred when Calvin Case vocalized his opposition to Angle's nonextraction principles in Chicago at the National Dental Association's annual meeting in July of 1911 (Case 1964). Case, concerned about dental stability, found himself outnumbered and suppressed by Angle's dedicated nonextraction supporters and such treatment continued to be the mainstay of orthodontics through the 1940's. Yet Case was not the only proponent of extractions. Angle's student and colleague, Charles Tweed, also thought extractions were necessary in some patients. Unlike Case however, Tweed formed his belief after reviewing many of his cases treated without extractions and being dissatisfied with the poor facial results (Tweed 1944; Tweed 1945; Tweed 1954). To aid in diagnosis and treatment planning for stability and facial esthetics, Tweed developed his diagnostic facial triangle incorporating the Frankfort horizontal plane, mandibular plane and lower incisor angulation.

Figure 4. Case treated by Charles Tweed (Tweed, 1945). Pre-treatment (top), post non-extraction treatment (center), retreatment with extraction of four premolars (bottom)

Riedel held a similar notion of treatment, indicating that the underlying skeletal and dental relationships impacted the facial profile. However, Riedel argued that the position of the upper incisor was a greater diagnostic tool for the face than the lower incisor, as Tweed believed (Riedel 1950; Riedel 1952). He found orthodontists judged the most pleasing profiles to have skeletal elements oriented in a straight line with little or no dental protrusion (Riedel 1950). Conversely, poor profiles demonstrated convex skeletal patterns with increased dental protrusion. Ricketts (1968)

held a similar view of ideal facial esthetics; proposing his esthetic plane or E-plane; a line drawn from the nose to the chin that he used to evaluate lip position. As shown in Figure 5, Ricketts described an ideal lower lip distance of 2 mm with a standard deviation of 3 mm behind the E-plane. He further advised that the upper lip should be slightly posterior to the lower lip and closure of the mouth should occur with no lip strain.

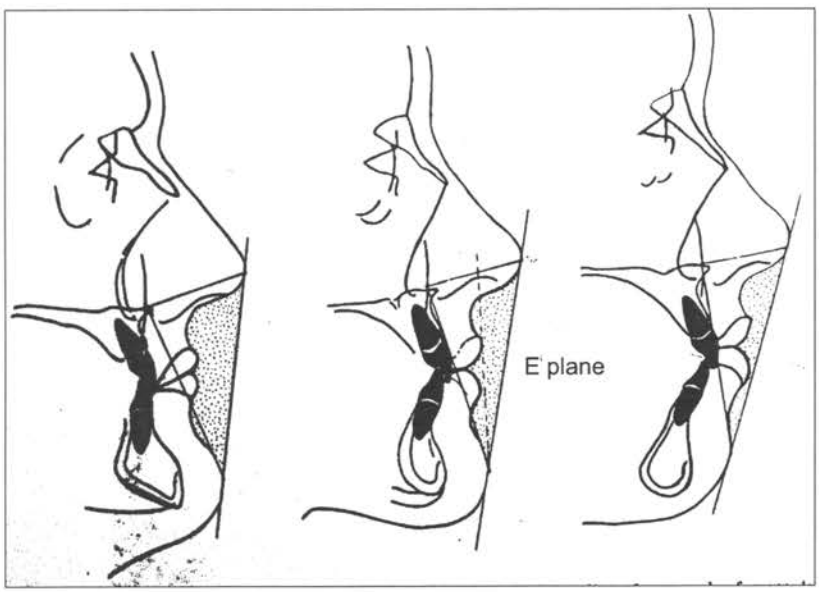

*Figure **5**. Drawings representing research on the esthetic plane.* Adapted from Ricketts (Ricketts 1968). Middle drawing represents ideal well-formed face in normal 26-year-old woman; mouth is in good harmony, lips are in good balance, and chin is prominent. Left drawing is at the lower end of range. Right drawing represents the protrusive end of the range.

Present

Current studies indicate social preferences toward fuller, more anteriorly positioned lips (Auger and Turley 1999; Hier et al 1999; Matoula and Pancherz 2006; Nguyen and Turley 1998). Auger and Nguyen (Auger and Turley 1999; Nguyen and Turley 1998) separately evaluated changes in female and male profiles as depicted in fashion magazines over the 20th century. Both found that the esthetic profile changed with time, particularly in the area of the lips, suggesting a preference toward fuller lips.

Also studying profiles, Czarnecki et al (1993) created silhouettes altering facial features such as the nose and chin which were then evaluated by dental professionals. The results indicated that dental professionals generally preferred a straighter profile with a more prominent chin in males. In females, preferences leaned towards a slightly convex profile with more lip protrusion. In addition, more lip protrusion was acceptable in both males and females when either a large nose or chin was present.

Agreement between clinicians and lay people

Despite evidence of these changing esthetic ideals, the orthodontic profession has continued to use cephalometric and soft tissue standards that were developed during the previous century (Downs 1948; Downs 1956; Holdaway 1983; Holdaway 1984; Ricketts 1968; Steiner 1953; Tweed 1954). Peck and Peck (1970) compared the cephalometric values of the most esthetically pleasing faces to commonly used cephalometric analyses. They discovered the general public preferred a more protrusive dentofacial pattern than that considered acceptable by traditional cephalometric standards. The results of their study indicate a need for the orthodontic community to reevaluate the accepted cephalometric and soft tissue standards used to diagnose and treatment plan.

The perception of beauty transcends national and ethnic borders. Iliffe (1960) and Udry (1965) conducted separate studies using the same twelve photographs in Britain and the United States. The results clearly indicated national and international consensus with regard to facial attractiveness. However, despite the relative agreement among the general public, evidence of consensus between dental professionals and the general public with regard to esthetics appears to be inconclusive. Some researchers have indicated agreement between the lay public and dental clinicians (Coleman et al 2007;

Cox and van der Linden 1971; Maple et al 2005). Yet, others have found both groups to view ideal esthetics differently (Bell et al 1985; Cochrane et al 1999; Lines et al 1978; Prahl-Andersen et al 1979). It seems logical that the patient's opinion be considered in the overall treatment decision.

The facial profile

Some of the oldest cephalometric standards were developed in the early to mid-1900s. Created with the intent of providing the clinician with quantitative measurements to assist in diagnosing and treatment planning, these values were based on straight Caucasian skeletal patterns and often related the soft tissue profile to the underlying dental structures (Downs 1948; Downs 1956; Holdaway 1983; Holdaway 1984; Ricketts 1968; Steiner 1953; Tweed 1954). With the continual additions of new diagnostic measurements and analyses the orthodontic clinician has come to rely heavily on the facial profile and cephalometric headfilms as essential diagnostic tools.

In understanding the importance of the profile in treatment decisions, Kerr and O'Donnell (1990) questioned a panel of raters including orthodontists, dental students and the parents of orthodontic patients regarding their esthetic preferences after viewing frontal and profile images. The results revealed that full frontal photographs were generally rated more attractive than profile images, as evaluators were more perceptive of skeletal disharmonies and inconsistencies in profile. Baumrind et al (1996) conducted a study evaluating the reasons orthodontic clinicians treatment planned for extractions. Improvement in facial profile was indicated in 27% of the decisions, following crowding and incisor protrusion in percentage. Thus, research has demonstrated the value of the

facial profile in orthodontic treatment planning and the belief that clinicians have the ability to improve or worsen it.

Lips

Esthetic preferences

The orthodontic literature is replete with studies indicating the various factors that play a role in affecting facial and smile esthetics. Kokich et al (1999) verified that the human eye is able to detect minute deviations in symmetry and normality, especially by trained dental professionals. Numerous studies have shown that factors involving the teeth, gingiva and buccal corridors are all significant in determining smile esthetics (Ackerman 2005; Anderson et al 2005; Geron and Atalia 2005; Isiksal et al 2006; Kokich et al 1999; LaVacca et al 2005; Mahshid et al 2004; Moore et al 2005; Ritter et al 2006; Roden-Johnson et al 2005; Sabri 2005; Valiathan and Gandhi 2005). Until recently, research on lip position has focused on mean group values as opposed to that which is considered attractive (Auger and Turley 1999; Bisson and Grobbelaar 2004; Hier et al 1999; Nguyen and Turley 1998; Peck et al 1992). However, with current trends favoring a youthful appearance, research has shifted toward determining social standards of attractiveness to assist in synchronizing the clinician's treatment objectives to that of the patient's.

With regard to lip fullness, Bisson and Grobbelaar (2004) investigated the esthetic properties of lips, comparing Caucasian models found in popular fashion magazines to nonmodels undergoing lip augmentation. Measurements of vertical, horizontal and angular relationships were taken. The results indicated no significant differences in overall lip width between the two groups, but the group of models did have significantly

greater upper and lower lip heights than their counterparts. Correspondingly, the angles of the upper and lower lips were also statistically greater in the model group. By comparing the two groups, the authors concluded that fuller lips are more esthetically beautiful. It should be noted, however, that the subjects composing the nonmodel group were about to undergo lip augmentation procedures and may have had thinner lips than the average population.

Scott et al (2006) studied the impact of the lips and malocclusion on smile esthetics by surveying lay people and dental professionals. Thick and medium upper and lower vermilions were rated as significantly more attractive than thin vermilions for both lips. Occlusal traits, such as a midline deviation, small lateral incisors, and crowding were all perceived as more attractive with a thicker vermilion border. The images with thicker vermilions were also perceived as being friendly, honest, intelligent and feminine. In contrast, those with thin vermilions were associated with aggressiveness and masculinity. Orthodontists tended to prefer a lip profile more retrusive than those preferred by untreated individuals. In agreement with others, Scott et al suggested that the orthodontic standards for the Caucasian lip profile favoring more lip retrusion may be outdated and not representative of existing social preferences (Auger and Turley 1999; Nguyen and Turley 1998).

Age changes

With the average American living longer than ever before, there is a general desire to maintain beauty over a longer length of time (Davis 2006; Franzoi and Koehler 1998; Friedman 2005; Hoyert et al 2006; Minino et al 2006). Studies have shown that as the human ages, specific soft tissue changes usually occur.

Anderson et al (1973) evaluated the cephalometric headfilms of 70 orthodontically treated cases before treatment, after treatment and at least ten years post-retention. A reduction of the dentofacial protrusion with a decrease in lip procumbency was seen following orthodontic treatment. After the completion of treatment, continued flattening of the soft tissue profile occurred with additional nasal and chin growth, particularly in male subjects. In addition, the upper lip thickness increased with orthodontic incisor retraction and decreased during and after retention.

Nanda et al (1990) found that in adolescence, nose measurements account for the largest increase in relative size and in males continues to grow well into the latter teens. Adolescent males also show significantly greater growth in upper lip thickness than their female counterparts. Following the adolescent growth spurt and maturation into adulthood, additional facial changes usually occur with aging. Studies demonstrate small decreases in mandibular prominence, while skeletal convexity and anterior facial height continue to increase (Bishara et al 1994; Bishara et al 1998; Zierhut et al 2000).

Bishara (1994, 1998) and Formby (1994) concluded that generally in both sexes, the lips become significantly more retruded in relation to the esthetic plane and nose dimensions increase. Females tend to show a decrease in soft tissue thickness at pogonion, while just the opposite is seen in males.

Gonzalez-Ulloa (1975) identified specific lip changes that occur with aging including the loss of lip volume, architecture and gradual lip lengthening. All contribute to decreasing maxillary incisor display and flattening of the facial profile.

Thus, when treatment planning for an adolescent, it is important to recognize and take into account the remaining growth of the nose and chin, while also anticipating the effect of aging on the lips.

Incisor position

Research has shown that in some patients, the movement of the incisors can produce statistically significant changes in the position of the lips (Bowman and Johnston 2000; Bravo 1994; Brock et al 2005; James 1998; Ramos et al 2005; Scott Conley and Jernigan 2006; Stephens et al 2005; Talass et al 1987; Valentim et al 1994). Evaluating the amount of lip movement following the extraction of four first premolars, Drobocky and Smith (1989) found that the upper and lower lips retracted an average of 3.4 mm and 3.6 mm to E-line, respectively.

Similarly, Bravo (1994) studied 16 female patients and found the upper and lower lips moved back an average of 3.4 mm and 3.8 mm to E-line respectively after having four premolars extracted. Comparing profiles of patients having four first premolar extractions with those who did not, Bishara et al (1995) showed that the soft tissue and skeletal convexities became straighter following extractions. The upper and lower lips became more retrusive in the extraction groups and more protrusive in the nonextraction groups. The upper and lower incisors also retracted and uprighted more in those having extractions.

Erdinc et al (2007) retrospectively compared nonextraction and extraction groups to determine the effects of premolar extractions on the adolescent facial profile during treatment and at least four years post-retention. The extraction group showed greater protrusion of the lower lips prior to treatment (T1). Following treatment (T2), the

extraction and nonextraction groups did not exhibit significantly different lip angulations. The upper lip vermilion and superior thicknesses increased during treatment, while the lower lip vermilion decreased in both groups. The nonextraction group also showed an increase in lower lip thickness. Notably, significant growth of the nose occurred from T1 to T2 and also into retention. The extraction and nonextraction groups demonstrated similar soft tissue facial profile measurements at four years postretention (T3), and no correlations between the hard and soft tissue variables were found at all three time points.

Current literature indicates that incisor retraction or proclination may produce significant changes in the facial profile. In patients presenting with dental and facial protrusion, extractions provide the lip retraction necessary to improve the facial profile. However, deciding on the appropriate treatment for a borderline case exhibiting moderate crowding and a retrusive profile entails predicting the final position of the lips. Variations in lip thickness, contour and musculature make this very challenging (Basciftci and Usumez 2003; Brock et al 2005; Katsaros et al 1996; Kokodynski et al 1997). Studying the relationship between lip position and incisor retraction, Kokodynski et al (1997) concluded that "although a ratio for predictive purposes was determined, their absolute value is questionable because no apparent pattern exists between them."

Skeletal pattern and lip position

As might be expected, anteroposterior and vertical variations in skeletal patterns are directly related to the attractiveness of facial profiles and preferred lip positions. A study conducted by Ioi et al (2005) evaluating skeletal convexity and lip position in Japanese subjects revealed that as the mandible assumed a more posterior position, raters

preferred more protruded lip positions. As facial convexity decreased, raters favored more retruded lip positions.

Maple et al (2005) compared orthodontists, oral surgeons and lay people in their profile preferences after images had been altered to represent varying anteroposterior and vertical skeletal relationships. The positions of the lips were not altered in this study in order to evaluate the effects of horizontal and vertical facial changes. The three rater groups tended to favor the straight profile, as attractiveness decreased when the profile deviated away from the Class I profile. Interestingly, the straight profiles with increased or decreased vertical facial heights were still considered more attractive than the retrognathic and prognathic profiles with normal vertical heights.

In a similar study, Czarnecki et al (1993) assessed the Caucasian profile preferences of dental professionals. The results showed that when either a large nose or chin was present, more lip protrusion was favored. In addition, more lip protrusion was acceptable for females than males. A straighter profile with a more prominent chin was also preferred for males rather than females.

Recently, Coleman et al (2007) investigated the effect on chin prominence on esthetic lip profile preferences between groups of patients, patient parents and orthodontists. Raters were allowed to alter the position of the upper and lower lips to their preferences. In patients with extreme prognathic and retrognathic profiles, all of the groups preferred fuller lip positions and the authors suggested this may be an attempt to compensate for larger skeletal discrepancies. In patients with average Class I profiles, more retrusive lip positions were favored. There were no differences between the group preferences nor between male and female raters. This finding is in agreement with

previous studies (Cox and van der Linden 1971) indicating esthetic goals to be similar between clinicians and patients.

Few studies have investigated the relationship between the position of the chin and lips on facial attractiveness as assessed by both orthodontists and lay people. The designs of these studies have consisted of raters comparing and ranking facial profiles (Czarnecki et al 1993) and manipulating the position of the lips to determine the most attractive arrangements (Coleman et al 2007). Research has yet to demonstrate the threshold of lip movement that is tolerated when raters are unable to compare profiles to each other, such as they would encounter in reality. Therefore, the purpose of this study was to determine and compare the lay person's and orthodontist's assessment of altered chin and lip positions on facial attractiveness. The following hypotheses were tested:

1. Lay people and orthodontists will not differ in their lip protrusion preferences in straight, retrognathic and prognathic Caucasian profiles.
2. The rater's gender will not be correlated to profile preferences.
3. Both rater groups will prefer lip protrusion over straight and retrusive lip positions.
4. Raters will be consistent in their assessments of attractiveness.

Materials and Methods

Sample

Two groups of raters were used in this study; 50 orthodontists (25 female, 25 male) and 100 lay people (50 female, 50 male). The group of orthodontists was comprised of practicing orthodontists and orthodontic residents at the Oregon Health & Sciences University (OHSU) School of Dentistry. The lay group consisted of individuals having no prior dental background or training.

Survey instrument and variables

The survey instrument was a three-ringed binder containing the profile images of two Caucasian adolescent subjects, male and female, having cephalometric measurements within acceptable limits of the Class I Caucasian standards. Their records were acquired from the Department of Orthodontics at OHSU. The care givers of both subjects signed consent forms releasing their records for research purposes.

The methodology was similar to a study conducted by Maple et al (2005). The profile photographs of the male and female subjects were altered using Dolphin Imaging Software v. 10 (Chatsworth, CA). After the profile image was linked to the cephalometric radiograph, changes in chin position, simulating mandibular retrognathia and prognathia, were made by moving the soft tissue chin anteriorly and posteriorly five millimeters creating two new profile images, one retrognathic and one prognathic. To each of these three profile images both the upper and lower lips were protruded and retruded horizontally in increments of two millimeters (Czarnecki et al 1993). The lips were moved a maximum of six millimeters in each direction, creating six additional profiles. As a point of reference, Ricketts' E-plane was utilized to determine the actual

position of the lips. No direct changes were made to the relationship between the upper and lower lips, however the nasolabial angle did increase or decrease depending on the direction of lip movement. As noted previously, only the chin was moved when creating the retrognathic and prognathic profiles. Consequently, in the retrognathic profile, facial convexity and relative lip protrusion were increased, while both were decreased in the prognathic profile. As a result, compared to the straight profile, the 0-mm lip position in the retrognathic profile was more protrusive, and was more retrusive in the prognathic profile. The changes made in lip position were digitally concealed to eliminate any unnatural transitions in the profile. All vertical relationships were unaltered in order to attempt to isolate only the anteroposterior aspects of the profile. The images used in the survey instrument are shown in Figures 6 and 7 in smaller dimensions.

Each profile measured 5 x 7 inches and was printed in color on white paper measuring 8.5 x 11 inches. A total of 42 unique images were created, 21 each of male and female. To account for intra-rater reliability at one sitting, 14 of the 42 images were duplicated, seven of each sex, and were randomly added to the 42 images. To avoid the bias of image order, these 56 images were randomly distributed for each sex. Ten uniquely ordered booklets were created, five with the female images at the beginning and vice versa. These were distributed equally to each rater group.

Participants were given the instructions for the survey verbally and in writing. Raters provided their sex and dental education background before beginning the study. Subjects were asked to view each image once to observe the variability in facial profiles and establish a baseline for evaluating attractiveness. After returning to the first image, raters were instructed to indicate the attractiveness of each profile by marking a Visual

Analogue Scale (VAS). The VAS consisted of a 50-millimeter horizontal line in which the left border of the line stated "Least Attractive", while the right border stated "Most Attractive" (Kokich et al 1999). The VAS was printed on a removable white label and placed at the same location beneath each image. Raters were asked to rate their initial impression and not return to previous pages to compare images.

As noted previously, consistency of profile evaluation was assessed at one time period via duplicated images within the survey booklet. To evaluate intra-rater reliability between time periods, 13 orthodontists and 18 lay people repeated the study a month later using the same booklets.

A calibrated electronic caliper (Fisher Scientific Pittsburgh, PA) was used by one operator (S.S.) to measure the distance from the left vertical line to the mark made by the rater for each image to the nearest millimeter.

Analysis of Data

To test the hypotheses that there were no differences between orthodontists and lay people, and females and males, with regard to facial profile preferences, multi-factorial repeated measures analysis of variance (ANOVA) tests were conducted. Tests for sphericity were performed to determine if the variances of the differences between profile preferences were equal. In instances when equal variances could not be determined, the Greenhouse-Geisser correction, which does not assume sphericity, was utilized. Between group factors evaluated were rater profession and gender. One-way repeated measures ANOVA and Bonferroni post-hoc tests were conducted within each group to test the hypothesis that fuller lip positions were preferred in both rater groups and to determine the threshold at which profiles became significantly less attractive for

each group. Intra-rater reliability was determined using the Intraclass Correlation Coefficient (ICC). The level of significance was set at $p = .05$ for all analyses.

Results

Between Group Comparisons

Multi-factorial repeated measures ANOVA were used to find significant relationships between rater groups and between sexes. No significant differences were found between the two rater groups for both the male *(p*=.058) and female profiles *(p*=.134). The averages of both groups are shown in Tables 1 and 2. In addition, no significant differences were found between male and female raters for the male *(p*=.098) and female *(p*=.144) profiles.

Within Group Comparisons

Within group one-way ANOVAs for both rater groups showed an interaction between chin and lip positions and facial attractiveness for the male *(p*=.00) and female *(p*=.00) profiles, with no other significant interactions. Post-hoc Bonferroni multiple comparison tests were conducted to reveal differences between each individual profile and are detailed below.

Lay people: When judging the female straight profile, there was no significant difference between the 0 mm and +2 mm lip positions (Table 3). However, for the retrognathic profile, lay people preferred the -2 and 0 mm lip positions with no significant differences between the two. No differences between the 0 and +2 mm lip positions were found for the prognathic images. The -2, 0 and +2 mm lip positions were equally significant for the male straight profile (Table 4). For the retrognathic image, the -4, -2 and 0 lip positions showed no significant differences, with the greatest mean being for the -2 mm image. The 0, +2 and +4 mm lip positions were all significantly favored in the male prognathic profiles.

Table 1. *Lay People and Orthodontists: Female Attractiveness Scores*

Mandibular Position	Lip Position (mm)	Lay People			Orthodontists		
		Mean (mm)	95% Confidence Interval		Mean (mm)	95% Confidence Interval	
			Lower Bound	Upper Bound		Lower Bound	Upper Bound
Class II (-5 mm)	- 6	16.9	15.1	18.7	12.7	10.1	15.2
	- 4	23.0	20.7	25.3	22.7	19.5	25.9
	- 2	29.3	27.3	31.3	29.2	26.4	32.1
	0	28.2	26.0	30.4	31.4	28.3	34.6
	+ 2	22.4	20.2	24.6	26.8	23.7	29.9
	+ 4	17.4	15.6	19.3	17.3	14.7	19.8
	+ 6	9.6	7.9	11.3	10.0	7.7	12.4
Straight (0 mm)	- 6	9.1	7.6	10.5	7.9	5.8	9.9
	- 4	19.5	17.3	21.7	18.7	15.6	21.9
	- 2	27.8	25.5	30.1	29.2	26.0	32.5
	0	36.0	34.3	37.7	40.6	38.2	43.0
	+ 2	32.4	29.8	34.9	34.1	30.5	37.7
	+ 4	22.2	20.0	24.3	22.6	19.6	25.6
	+ 6	10.4	8.7	12.1	10.2	7.9	12.5
Class III (+5 mm)	- 6	5.4	4.5	6.3	3.0	1.7	4.2
	- 4	9.0	7.5	10.6	6.9	4.7	9.0
	- 2	15.8	14.0	17.7	14.9	12.3	17.5
	0	28.1	25.8	30.3	27.4	24.2	30.6
	+ 2	30.7	28.6	32.8	27.7	24.7	30.7
	+ 4	23.4	20.7	26.0	24.8	21.1	28.5
	+ 6	10.2	8.6	11.8	9.1	6.9	11.3

Table 2. *Lay People and Orthodontists: Male Attractiveness Scores*

Mandibular Position	Lip Position (mm)	Lay People			Orthodontists		
		Mean (mm)	95% Confidence Interval		Mean (mm)	95% Confidence Interval	
			Lower Bound	Upper Bound		Lower Bound	Upper Bound
Class II (-5 mm)	- 6	24.4	22. 3	26.4	20.8	17.9	15.2
	- 4	30.6	28.4	32.7	32.0	29.0	25.9
	- 2	32.0	30.0	34.0	37.7	35.0	32.1
	0	29.0	26. 9	31.1	36.5	33.6	34.6
	+ 2	22.6	20.4	24.9	22.6	19.4	29.9
	+ 4	14.9	12.9	17.0	13.6	10.7	19.8
	+ 6	8.7	7.4	9.9	9.3	7.6	12.4
Straight (0 mm)	- 6	15.4	13.6	17.2	14.5	12.0	9.9
	- 4	20.3	18.2	22.3	18.4	15.6	21.9
	- 2	30.0	27.9	32. 2	33.1	30.1	32.5
	0	32.7	30.8	34.7	37.3	34.5	43.0
	+ 2	30.5	28.4	32.6	35.9	32.9	37.7
	+ 4	20.9	18.5	23.2	17.7	14.5	25.6
	+ 6	11.3	9.7	12.9	10.1	7.9	12.5
Class III (+5 mm)	- 6	6.5	5.3	7.7	5.9	4.2	4.2
	- 4	10.70	9.1	12.2	9.0	6.8	9.0
	- 2	15.9	13.9	18.0	15.3	12.4	17.5
	0	21.7	19. 5	23.9	23.0	20.0	30.6
	+ 2	25.3	23.0	27.6	27.4	24.2	30.7
	+ 4	24.6	22.2	26.9	22.2	19.0	28.5
	+ 6	16.4	14.4	18.5	17.4	14.5	11.3

Table 3. *Female Profile: Laypersons Preferred Lip Positions*

		Lip Position (mm)						
		-6	-4	-2	0	+2	+4	+6
Chin Position (mm)	-5	**	**	ns□	ns	**	**	**
	0	**	**	**	ns□	ns	**	**
	+5	**	**	**	ns	ns□	**	**

p-values from Bonferroni post-hoc tests □Highest average for chin position
ns=no significant difference from □ **p<.01

Table 4. *Female Profile: Orthodontists Preferred Lip Positions*

		Lip Position (mm)						
		-6	-4	-2	0	+2	+4	+6
Chin Position (mm)	-5	**	**	ns	ns□	ns	**	**
	0	**	**	**	ns□	ns	**	**
	+5	**	**	**	ns	ns□	ns	**

p-values from Bonferroni post-hoc tests □Highest average for chin position
ns=no significant difference from □ **p<.01

Orthodontists: For both the female and male profiles, orthodontists generally preferred the same lip positions as the lay group (Tables 5 and 6). Differences were found in the female retrognathic profile, in which orthodontists preferred the +2 mm lip positions while the lay persons group did not. The second dissimilarity was for the female prognathic profile with the orthodontists, and not the lay people, preferring the +4 mm lip position.

Table 5. *Male Profile: Laypersons Preferred Lip Positions*

		Lip Position (mm)						
		-6	-4	-2	0	+2	+4	+6
Chin Position (mm)	-5	**	ns	ns□	ns	**	**	**
	0	**	**	ns	ns□	ns	**	**
	+5	**	**	**	ns	ns□	ns	**

p-values from Bonferroni post-hoc tests □Highest average for chin position
ns=no significant difference from □ **p<.01

Table 6. *Male Profile: Orthodontists Preferred Lip Positions*

		Lip Position (mm)						
		-6	-4	-2	0	+2	+4	+6
Chin Position (mm)	-5	**	ns	ns□	ns	**	**	**
	0	**	**	ns	ns□	ns	**	**
	+5	**	**	**	ns	ns□	ns	**

p-values from Bonferroni post-hoc tests □Highest average for chin position
ns=no significant difference from □ **p<.01

Reliability

Intraclass Correlation Coefficients (ICC) were used to test intra-rater reliability at one sitting and between time periods. ICC measurements for one sitting were similar for orthodontists (0.69) and lay people (0.68). ICCs calculated between time periods were slightly higher for the group of lay people (.88) than for the orthodontist group (.80).

Discussion

Orthodontists encounter a multitude of facial profile types when diagnosing and treating patients. Variations in profiles range from extreme concavity to convexity and may be attributed to the presence of a skeletal discrepancy and/or anatomical soft tissue variations. A large nose and chin may contribute to a skeletally normal individual appearing concave or "dished in", whereas copious soft tissue at the chin may mask a retrognathic mandible.

Aside from those patients in whom orthognathic surgery is unquestionably indicated, clinicians use orthodontic tooth movements to compensate for these skeletal and soft tissue discrepancies while attempting to maximize function and facial esthetics. Such treatment involves altering the location of the incisors, thereby changing the position of the lips to mask skeletal disharmonies. This study found that horizontal lip position preferences do change with varying anteroposterior mandibular positions. As a result, specific treatment objectives should be tailored to the individual's profile when orthodontic camouflage is necessary to provide the greatest facial balance.

Facial profile attractiveness findings

In this study, it was hypothesized that lay people and orthodontists would not differ in their lip position preferences in the straight, retrognathic and prognathic Caucasian profiles. Orthodontists and lay people generally preferred the same facial profiles despite lay people averaging lower ratings than orthodontists for the male profiles (Figures 8 and 9). The orthodontists' higher attractiveness scores may be due to clinicians being more tolerant of facial discrepancies due to the wide range in severity that is typically encountered in clinical patients. Despite lay people rating certain profiles

more critically, no significant differences between the rater groups were found when analyzing the effects of the chin and lip positions together in the female (p=.134) and male subjects (p=.058). Permitting raters to view the extremes of the chin and lip alterations prior to marking the VAS enabled them to establish a baseline and may explain the overall preference for the straight facial profile. This finding is in agreement with similar studies that also showed consistency in lip profile preferences between clinicians and lay people (Coleman et al 2007; Cox and van der Linden 1971; Maple et al 2005). This result is encouraging, as it demonstrates both groups share similar notions of attractiveness, thereby increasing the likelihood of patient satisfaction following treatment.

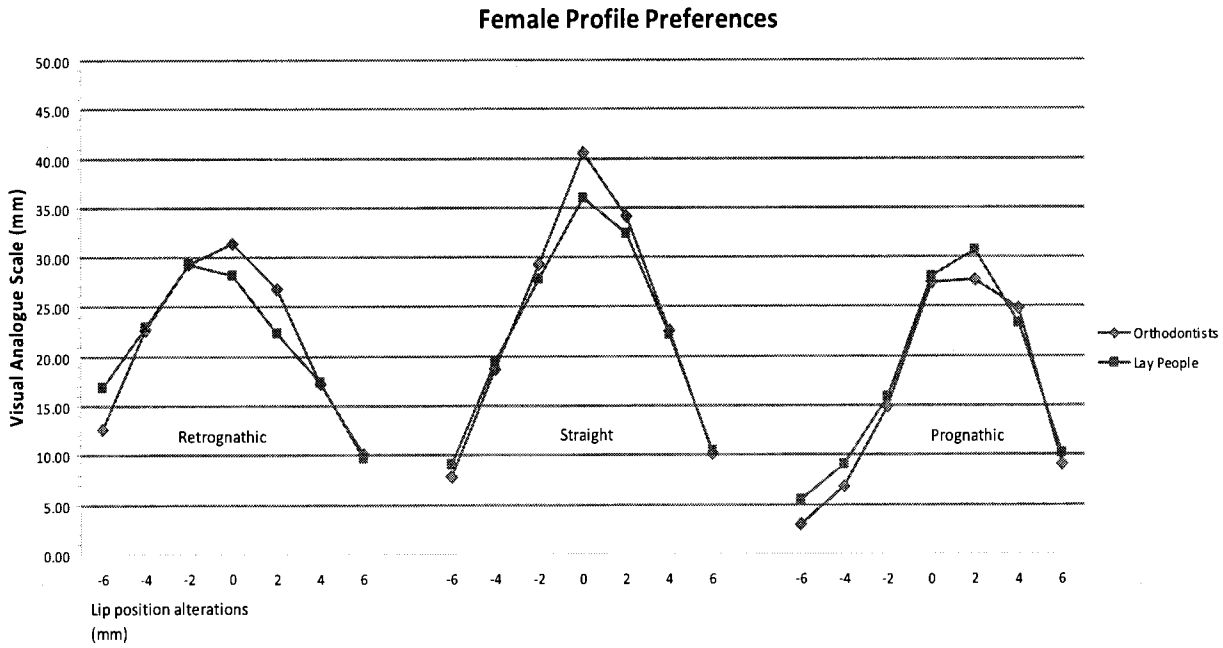

Figure 8. Female profile preferences: Orthodontists vs lay people

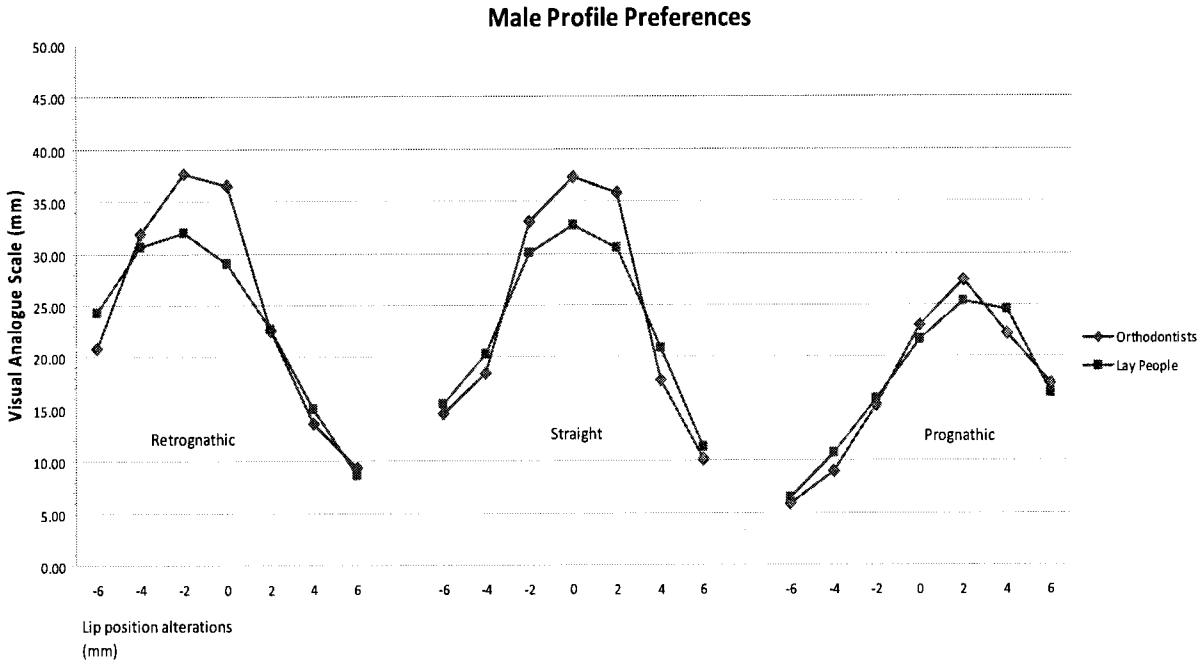

Figure 9. Male profile preferences: Orthodontists vs lay people

The second hypothesis stated that the sex of the rater would not be correlated to profile preferences. Compared to females, males tended to rate the profiles more critically, particularly the male profiles (Figures 10 and 11). A possible explanation for this latter tendency is that some males may be uncomfortable rating the attractiveness of other members of the same sex. Despite the lower scores given by the male raters, rater sex did not significantly influence the perception of attractiveness for the male (p=.098) and female (p=.144) profiles and the overall trends in preferences were similar. Coleman et al (2007) also studied rater gender and did not find differences in preferred lip position between the male and female evaluators.

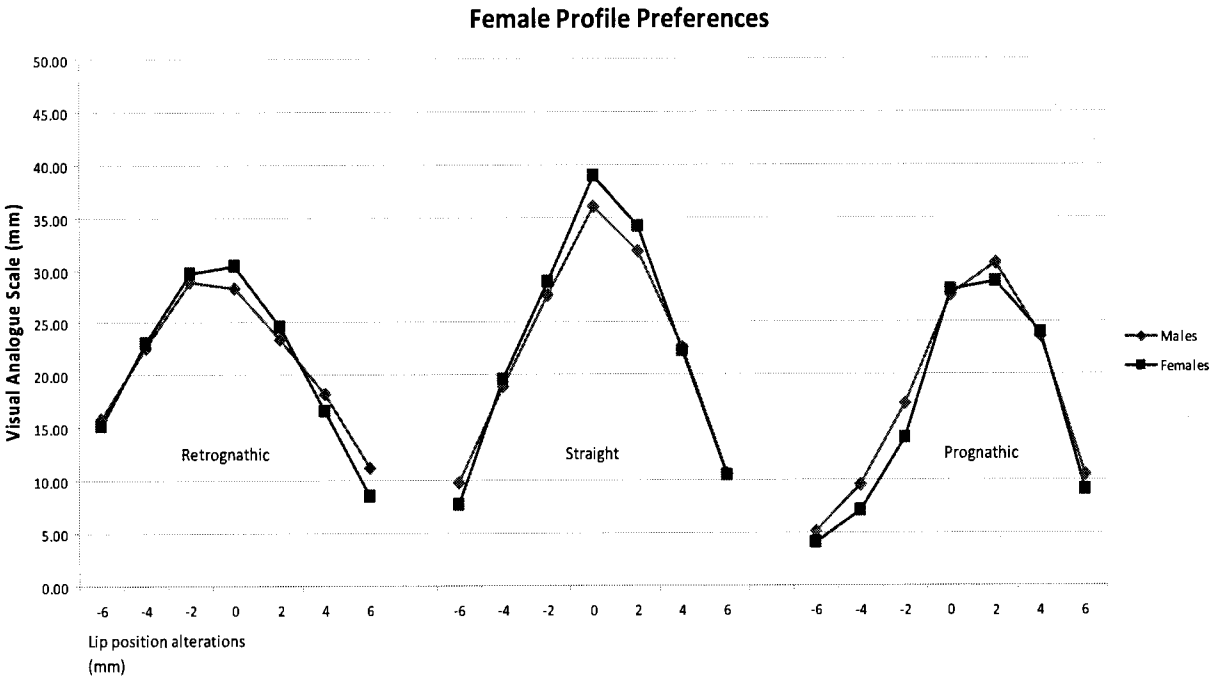

Figure 10. Female profile preferences: Males vs females

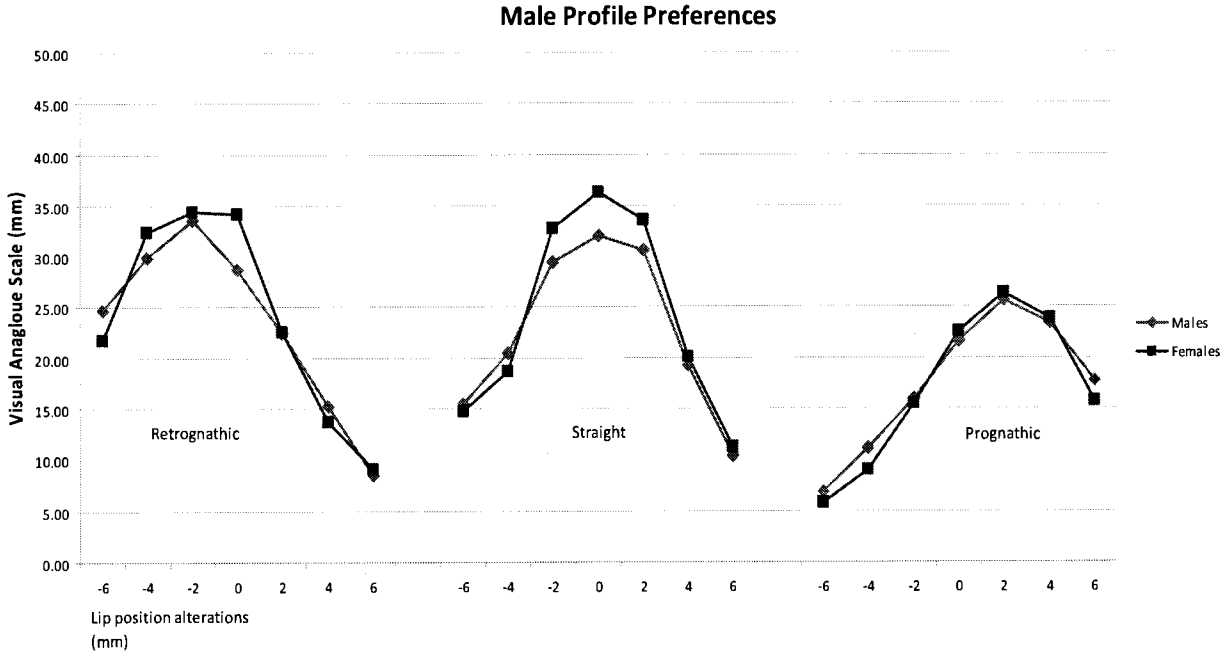

Figure 11. Female profile preferences: Males vs females

The third hypothesis speculated that protrusive lip positions would be significantly more attractive in both rater groups. The greatest VAS means for each rater group were for the straight profiles with unaltered lip positions (0 mm) that were within the normal values of Ricketts' E-plane. Past studies have demonstrated a general inclination towards straight profiles (Czarnecki et al 1993; De Smit and Dermaut 1984; Johnston et al 2005; Kerr and O'Donnell 1990; Maple et al 2005; Phillips et al 1995; Riedel 1957). No significant differences were found between the 0 mm and +2 mm lip positions for the female straight profiles, indicating a small degree of lip protrusion was deemed acceptable. For the male straight image, no significant differences were found between the -2 mm, 0 mm and +2 mm lip positions. This suggests a greater range of acceptable lip positions in males with straight profiles.

Studies have shown lip preferences for males to vary between retrusion and protrusion, both at minimal levels, whereas in females more protrusion is generally favored ((Auger and Turley 1999; Coleman et al 2007; Czarnecki et al 1993; Hier et al 1999; Nguyen and Turley 1998).

In the female retrognathic images, as the mandible retruded and facial convexity increased, raters preferred the 0 mm and -2 mm lip positions. The 0 mm lip position corresponded to a slightly protrusive lip position with respect to Ricketts' E-plane, though still within the normal range. Comparing the retrognathic preferences to that of the straight profile, raters favored the original lip positions and some lip retrusion in the retrognathic images, possibly because any additional lip protrusion would tend to accentuate the overall facial convexity. In the male retrognathic subject, the -4 mm, -2

mm and 0 mm lip positions were preferred; indicating slight lip retrusion to protrusion was acceptable. Thus, similar to the straight profiles, a greater range of acceptability was found for the male retrognathic profiles than for the female profiles. With increased facial convexity, the overall trend indicated a preference toward lip retrusion, as raters did not tolerate further lip protrusion beyond the 0 mm lip position.

When rating the prognathic male and female subjects, both rater groups preferred the +2 mm lip position which fell within the normal range of the E-plane and received the highest scores. Statistically, both groups found the 0 mm, +2 mm and +4 mm male prognathic profiles to be equally attractive. The two groups differed on the female prognathic profile, with the orthodontists, and not the lay group, deeming the +4 mm lip position as attractive. Due to the current trends in facial esthetics emphasizing lip fullness, it may be the case that orthodontists are more tolerant and less critical of varying lip positions than lay people; more so than may actually be justified.

As might be expected, the trend for the prognathic profile favored greater lip protrusion. This finding has been demonstrated in other studies as such lip protrusion aids in camouflaging the extent of facial concavity and mandibular prognathia, reestablishing facial balance (Coleman et al 2007; Czarnecki et al 1993). In the prognathic profile however, excessive lip protrusion, beyond four millimeters from the original position, was considered unattractive. This may be the result of a decrease in the nasolabial angle beyond normal values and an unnatural appearance of the lips.

This study found the most attractive profiles to be straight with minimal to no lip protrusion. For the female retrognathic profiles, minimal to no lip retrusion was accepted and lip protrusion beyond the original position was not preferred. For the male

retrognathic profiles, raters tolerated a greater range of lip positions from minimally retrusive to minimally protrusive. As facial concavity increased with greater mandibular prominence, raters preferred more lip protrusion beyond the original location.

Range of preferred lip positions

In determining the range of tolerance for alterations in lip positions, it was found that deviations of no more than two to four millimeters were tolerated from the original location, depending upon the subject's sex and mandibular position. As shown in Table 3, lay people evaluating the female subject accepted only two millimeters of change from the 0 mm position. Orthodontists accepted up to four millimeters of change in the retrognathic and prognathic female profiles, but tolerated no lip retraction and only two millimeters of protrusion in the straight female profile. This finding is significant, as Drobocky and Smith (1989) found the lips retracted between three and four millimeters in cases involving the extraction of four first premolars.

Lay people and orthodontists evaluating the male profile were tolerant of lip changes within a range of four millimeters. Thus, concern regarding lip retraction in certain patients following orthodontic treatment is warranted and should be discussed with the patient as part of facial treatment planning. It is also important to consider changes in the facial profile following adolescence. As mentioned previously, the face matures over time and increasingly more lip retrusion, flattening and lengthening is common throughout the adult years (Bishara et al 1994; Bishara et al 1998; Formby et al 1994). Therefore, a clinician treating a teenager must also consider the facial changes that will continue to occur in later years and it may be advisable to err on the side of more, rather than less, lip protrusion.

Reliability: Intra-rater and survey instrument

This study hypothesized that raters would be consistent in their assessments of attractiveness. ICCs were calculated to determine intra-rater reliability at one sitting and between time periods. ICC measurements for one sitting were similar for orthodontists (0.69) and lay people (0.68). ICCs calculated between time periods were slightly higher for the group of lay people (.88) than for the orthodontist group (.80). Due to the minimal discrepancy between the two groups, it is likely that the two groups are similar in judging attractiveness over time. The higher ICC calculations for the two administrations of the survey may be attributed to prior experience and memory of the images following completion of the initial survey. Overall, both groups demonstrated consistency with assessing facial profile attractiveness.

Maple et al (2005) showed ICCs to be relatively high for the VAS (0.710), though lay people demonstrated a higher ICC than orthodontists (0.784 and 0.621, respectively). Coleman et al (2007) found patients, parents and orthodontists did have significantly different lip position preferences between two time periods. However, these differences averaged 0.72 mm, a small enough discrepancy that they were considered clinically unimportant.

Other considerations

Possible limitations of this study may be the overall sample sizes of the two groups and the sample population of the lay persons group. Due to the small size of the groups, differences between the two groups may not have been detected. However, when evaluating the overall trends of preferred attractiveness, both groups demonstrated similar preferences (Figures 10 and 11). Members of the lay persons group were recruited by various methods and included the parents and acquaintances of patients at OHSU. Thus, the subject population may not be representative of the population as a whole. Obtaining such a population would be difficult and was beyond the capacity of this study.

Color digital photographs were used in this study in order to present subjects as they would be seen in person. Although black and white profile silhouettes remove subjective variables and enable the rater to solely evaluate the alterations made, facial attractiveness is a balance between all of the facial features (eyes, nose, hair, etc.). Providing colored profile images is essential in assessing overall attractiveness. In addition, consideration was given to rater sensitivity, whereby viewing numerous black and white images might contribute to evaluator fatigue.

This study asked raters to evaluate each profile individually, as opposed to comparing and rank ordering them to each other. As in live situations, people are unable to compare two or more versions of the same person side-by-side. Although comparing images simultaneously allows the rater to choose which profiles are the least and most attractive, the objective of this study was to determine if individuals could, in fact, distinguish small changes in profile. By not having adjacent profiles to compare to, the

former could be determined in addition to the change in lip positions that was tolerated by raters.

Though the repeatability and simplicity of the VAS have been documented and it is widely utilized (Cochrane et al 1999; Kokich et al 1999; Maple et al 2005), there continue to be concerns regarding its validity. Specifically, the VAS may not be used in its entirety by all raters and perceptions of attractiveness vary between individuals. For example, the attractiveness that is marked at fifteen millimeters may differ from that of another rater. However, the VAS is currently one of the most common methods of quantifying subjective responses to facilitate statistical analysis and its use seems to be appropriate to this study.

This study utilized the profiles of two subjects, male and female. Due to the inherent variability in soft tissue profiles and the differences in anatomical features between patients, the results of this study cannot be generalized to all Caucasian male and female subjects. A thorough analysis of the dentoalveolar complex, soft tissue components and expected facial changes following treatment should be conducted for each patient, resulting in a treatment plan tailored to accomplish specific dental and facial objectives. Rather than identifying specific values that should be achieved, the results of this study are useful in disclosing trends in lip position preferences relative to mandibular changes.

Further research in this area of facial esthetics may include the evaluation of lip preferences with consideration of the nasolabial angle and vertical height alterations. The inclusion of other ethnic populations and cultural backgrounds would also be beneficial in investigating attractiveness as it varies across races. In addition, with Visual

Treatment Objectives (VTO) becoming increasingly prevalent in treatment planning and predicting facial profile results, further studies should test the accuracy of these predictions and determine if the expected facial changes approximate actual outcomes. With regard to understanding the relationship between hard and soft tissues, further research investigating three-dimensional radiography would be advantageous.

Summary and Conclusions

The results of this study indicated that lip position preferences of Caucasian lay people and orthodontists changed with altered chin positions in the male and female subjects. These findings suggest there is a limited range of acceptability in which alterations in lip positions continue to be attractive. Clinically, the prominence of the mandible is an important factor in treatment planning and should be taken into consideration along with the anticipated position of the lips. It is crucial for the clinician to treat the patient's malocclusion while ensuring stability and maintaining facial harmony for the long-term.

1. Lay people and orthodontists, and males and females, did not differ in their assessment of attractiveness in straight, retrognathic and prognathic profiles.
2. The overall trends for orthodontists and lay people were for lip retrusion in the retrognathic profile and lip protrusion in the prognathic profile. Slight lip protrusion was accepted for the female and male straight profiles. More lip retrusion was tolerated for all the male profiles.
3. Orthodontists and lay people were tolerant of changes in lip position between two and four millimeters from the original position, depending upon the facial profile.
4. Lay people and orthodontists were reliable in their assessments of facial profile attractiveness.

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