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ESTHETIC PREFERENCES OF MAXILLARY INCISOR LABIOLINGUAL INCLINATION ACROSS RACES

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A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Dentistry at Virginia Commonwealth University.

by

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Abstract

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Major Director: Bhavna Shroff, D.M.D., M.Dent.Sc, Program Director, Orthodontics

Objective: To determine if people of different racial backgrounds prefer different amounts of maxillary incisor labiolingual inclination from a smiling profile view.

Materials and Methods: An electronic survey was created with smiling profile images of an African-American female and a White female with varying degrees of maxillary incisor labiolingual inclination. Images were ranked from most attractive to least attractive.

Results: There was no statistically significant difference in the overall preference for maxillary incisor labiolingual inclination between African-American and White evaluators or between genders. The estimated optimal incisal inclination across races was -8.1°.

Conclusions: There was no clinically significant difference in the estimated optimal inclination across races or between genders. The average of the top three maxillary incisor inclinations ranged between -10° and -5°. The majority of evaluators preferred retroclined maxillary incisors over proclined maxillary incisors.

Introduction

The motivation to seek orthodontic treatment often stems from the desire to improve the esthetic appearance of one's smile rather than the functional benefits. According to Baldwin et al, 80% of adults seeking orthodontic care for themselves or their children are motivated by a desire to improve appearance, regardless of structural or functional consideration.[1] Therefore it is of the utmost importance for orthodontists to be knowledgeable of overall facial esthetics and current societal preferences for facial attractiveness.[2]

Many aspects of a smile can affect its attractiveness: incisor angulation in the mesio-distal dimension, incisor labiolingual inclination, lip-to-tooth relationship, buccal corridors, teeth shape and color, symmetry, etc.[3-6] A smile's attractiveness can also vary depending on the angle of observation. Kerns et al found that profile views were rated higher in esthetics than frontal views of the same smile.[7] Therefore it is important to evaluate smile esthetics from the profile, frontal, and 45 degree views to optimize both dental and facial appearances in orthodontic planning and treatment.[6]

Numerous studies involving smile esthetics have clearly emphasized the importance of incisor positioning from the smiling profile view. Incisor labiolingual inclination, or the amount of incisor flare, contributes greatly to the attractiveness of a patient's smile.[8-10] Most orthodontists tailor their treatment plans to account for the predicted amount of flare that will result post-treatment. The predicted amount of incisor labiolingual inclination post-treatment

could affect whether a treatment plan would involve extractions or interproximal reduction to reduce incisor proclination in order to enhance esthetics, occlusion, and long-term stability.

Previous studies have looked at preferences in incisor labiolingual inclination and yielded inconsistent results. Ghaleb et al. surveyed Lebanese laypeople and found severe lingual inclination to be less esthetic than severe labial inclination, and incisor inclination with proclination greater than standard values was preferred by panel participants for optimum smile esthetics.[10] Similarly, Mackley et al. found labial crown torque of the maxillary incisors to be generally preferred and reported that lingual inclination due to loss of torque resulted in a decrease in esthetic ratings.[11] In contrast, Isiksal et al. compared smile esthetics between extraction and non-extraction groups and reported the need for more labial crown torque in the extraction group after retraction, but the study also stated that excessive maxillary incisor proclination as a result of non-extraction treatment could deteriorate the smile.[12] While previous studies have looked at the preferences of orthodontists and the general public, none of them have looked at preferences across different races.

Although cephalometric studies have established average values for maxillary incisor inclination across races, traditional cephalometric measurements do not take into account all of the esthetic considerations of the face and dentition.[13] Cephalometric analyses should diagnostically aid in treatment planning, but treating patients to achieve cephalometric norms should not be the orthodontist's main goal. Due to inherent limitations of cephalometric analyses, simply "treating to the numbers" could result in poor esthetics.[14] One of the most notable limitations is the variability in cephalometric measurements among ethnic groups. For many consecutive studies, researchers have referred exclusively to the cephalometric norms of Western Europeans and have applied these data across ethnic groups.[15,16] This is especially

problematic in studies of African-Americans whose facial features differ considerably from other races.[16]

The average maxillary incisor position greatly differs between Whites and African-Americans. African-Americans demonstrate significantly greater UI-SN angle, or maxillary incisor proclination, than Whites. In addition, African-Americans have more procumbent and protrusive upper lips.[15-17] Although these studies took a step in the right direction by establishing cephalometric norms specifically for African-Americans, treating patients simply to achieve average cephalometric values does not necessarily result in optimum esthetics. People's tastes and preferences are affected by their cultural and societal backgrounds and are subject to change throughout time.[18]

Previous studies aimed at determining esthetic preferences for maxillary incisor labiolingual inclination involved surveying professionals and laypeople in Lebanon and China.[9,10,19] No previous studies have assessed the African-American preference for maxillary incisor labiolingual inclination from the smiling profile view. Previous studies have shown African-Americans to prefer more procumbent lips than Whites, and it would be reasonable to assume that fuller lips may be a result of more labially-inclined incisors. However, separate studies conducted by Fields et al. and Kuyl et al. agreed that soft tissue structures do not reliably convey the position of the maxillary incisors in profile.[20,21] Kasai et al. also reported difficulty in predicting the response of the upper lip to changes in incisor positioning due to a weak association between soft and hard tissues.[22] Therefore, it is possible that less-proclined maxillary incisors in African-Americans could still yield an esthetic result from both a soft tissue and hard tissue standpoint.

The specific aims of this study were to:

1) Determine if evaluators of various racial backgrounds have different preferences in labiolingual incisor inclination.
2) Determine if people have different preferences in labiolingual incisor inclination for images of African-Americans as compared to Whites.
3) Determine whether there are differences in the degree of labiolingual incisor inclination preferred between male and female evaluators.
4) Determine how much labiolingual incisor inclination (in degrees) is considered most esthetic by each race and gender.

Hypothesis

There is a difference in the esthetic preference for the degree of maxillary incisor labiolingual inclination across races from a smiling profile view

Material and Methods

An electronic survey consisting of smiling profile images of an African-American model and a White model with variation in maxillary incisor labiolingual inclination was created. Each model was chosen based on the following parameters: a harmonious smile from frontal and profile views, Class I molars and canines, appropriate overbite and overjet, and profilometric measurements within normal range for her race.[10] Each model had her own set of images that included a control image which was altered to display the model's maxillary central incisors in their most esthetic anteroposterior position according to Andrews with the labial surface of the central incisors tangent to a vertical line perpendicular to Frankfort horizontal passing through glabella.[23] The maxillary incisors in each control image were altered to have excessive proclination (+5°, +10°, +15°) and excessive retroclination (-5°, -10°, -15°) from the vertical line. Therefore, each set of images included a control image plus six altered images for a total of seven images per set. A random letter generator was used to present the seven images in random order: A=0 (control), B=+15°, C= –10°,D= –5°, E= –15°, F=+10°, G=+5°.

Evaluators were undergraduate students and passers-by at the Monroe Park Campus at Virginia Commonwealth University. Each evaluator assessed the set of White images and ranked each image from most attractive to least attractive. Afterwards, evaluators were asked to identify any images that were unacceptable in terms of attractiveness. The evaluators were then asked to repeat the same tasks for the set of African-American images. Lastly, they were asked to answer

demographic questions about age, race, gender, and number of years living in Unites States, area of the Unites States, education, and career.

The rankings and the unacceptability marks were combined to calculate a preference score for each image. The preference scores ranged from 7 (most preferred) to 1 (least preferred). For example, an image ranked first (most attractive) was given a preference score of 7 (most preferred) while an image ranked second was assigned a preference score of 6. The images that were marked as unacceptable in terms of attractiveness were given lower preference scores. Any photo marked as unacceptable was given a lower preference score regardless of the photo's initial ranking. In other words, if a photograph that was initially ranked lower than another photograph that was later ranked as unacceptable, the photograph marked as unacceptable was given the lower preference score.

The numerical ranks or preferences were summarized using percentages, means and standard deviations. The test of the first three specific aims was accomplished using a repeated-measures mixed-model ANOVA to account for the multiple ratings provided by each evaluator. The average preference was tested for differences due to: race of the evaluator, race of the image, and gender of the evaluator. To estimate the optimal inclination, a random-coefficients mixed-model regression was used to estimate a 3rd order trend of the preferences versus incisal inclination. The evaluator-specific and image-specific coefficients were used to estimate the optimal preference. That is, if preference is *y* and inclination is *x* and the form of the function is $y = a + b \cdot x + c \cdot x^2 + d \cdot x^3$, then setting the first derivative to zero and solving for the maximum preference yields the optimum inclination. The estimated optimum is thus $\frac{-c \pm \sqrt{2c^2 - 12db}}{6d}$. To test for differences in the optimum inclination, a multi-way ANOVA used the following explanatory

factors: race of the evaluator, race of the image, and gender, age, education, and years in the US of the evaluators.

Results

The survey was completed by 307 evaluators. Twenty four evaluators were excluded because they provided duplicate rankings, rankings that were in the order presented on screen, or because of a software error. The demographic characteristics of the evaluators are shown in Table 1. There was an almost equal distribution of male and female evaluators, 52.1% and 47.9% respectively. There was also a good distribution of racial backgrounds: white, non-Hispanic (41.7%), Asian-Pacific Islander (20.1%), African-American (18.7%), Hispanic (4.9%), Native American (1.8%), and Other (12.7%). The majority of the evaluators (83.0%) were in the age range of 18-21.

Table 1. Demographics (N=283)

Characteristic	N	Percent
Gender		
Female	135	47.9
Male	147	52.1
Race		
African American	53	18.7
Asian-Pacific Islander	57	20.1
Hispanic	14	4.9
Native American	5	1.8
Other	36	12.7
White, non-Hispanic	118	41.7
Age		
18-21	235	83.0
22-25	38	13.4
26-30	8	2.8
31-40	1	0.4
51-60	1	0.4
Area of the USA		
East Coast	252	89.4
Midwest	2	0.7
Northeast	9	3.2
South	11	3.9
West Coast	8	2.8
Education		
High School	90	31.9
2-year college (Associate's Degree)	35	12.4
4-year college (Bachelor's Degree)	21	7.4
Some College	132	46.8
Master's	3	1.1
Doctoral	1	0.4
Career		
No	267	96.0
Yes	11	4.0

* Not all 283 evaluators provided information on all the demographic characteristics.

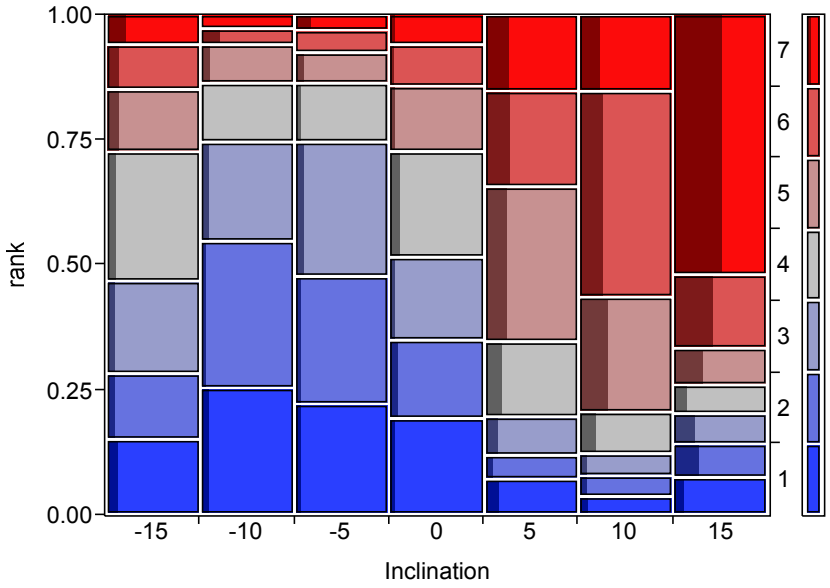
The counts of the rank ordering of each of the photographs are shown in Table 2. For example, on the 566 occasions where the –15° photograph was ranked, it was ranked as most attractive (rank 1) 85 times (15%). The most common ranking for the –15° photograph was 4, which occurred 26% of the time. The median rank of the –15° photograph was 4, and it was marked as unacceptable 10.6% of the time.

Table 2. Raw Ranks and Indications of Unacceptability versus Inclination

	Rank (1=most attractive, 7=least attractive)									Unaccept-
Inclination	1	2	3	4	5	6	7	Total	Median	able
–15°	85	75	105	147	70	50	34	566	4	10.6%
–10°	143	168	112	67	42	19	15	566	2	6.4%
–5°	125	146	151	68	33	25	18	566	3	7.1%
0°	109	89	94	119	75	46	34	566	3	7.8%
+5°	40	28	44	84	176	108	86	566	5	21.6%
+10°	21	23	25	48	129	235	85	566	6	23.3%
+15°	43	37	35	33	41	83	294	566	7	41.0%
	566	566	566	566	566	566	566	3962		

Figure 1 displays both the information from the ranks and the unacceptability graphically. The columns in the stacked bar chart correspond to each photograph and the area of the bar is proportional to the number of times each rank was given. The desirable rankings are shaded blue and the undesirable rankings red. The proportion of each ranking that was marked as unacceptable is shown by darker shading. As may be seen, the –15°, –10°, –5°, and 0° photographs received a larger number of dark blue ranks (rank=1) and the +5°, +10°, and +15° photographs received a larger number of red ranks (rank=7), especially the +15° photograph which is least attractive 52% of the time. A chi-square test of association clearly indicates that inclination and rank are not randomly associated (chi-square = 2038, $P < .0001$) and that each inclination is not equally unacceptable (chi-square= 394, $P < .0001$).

Figure 1. Raw Ranks and Indications of Unacceptability versus Inclination

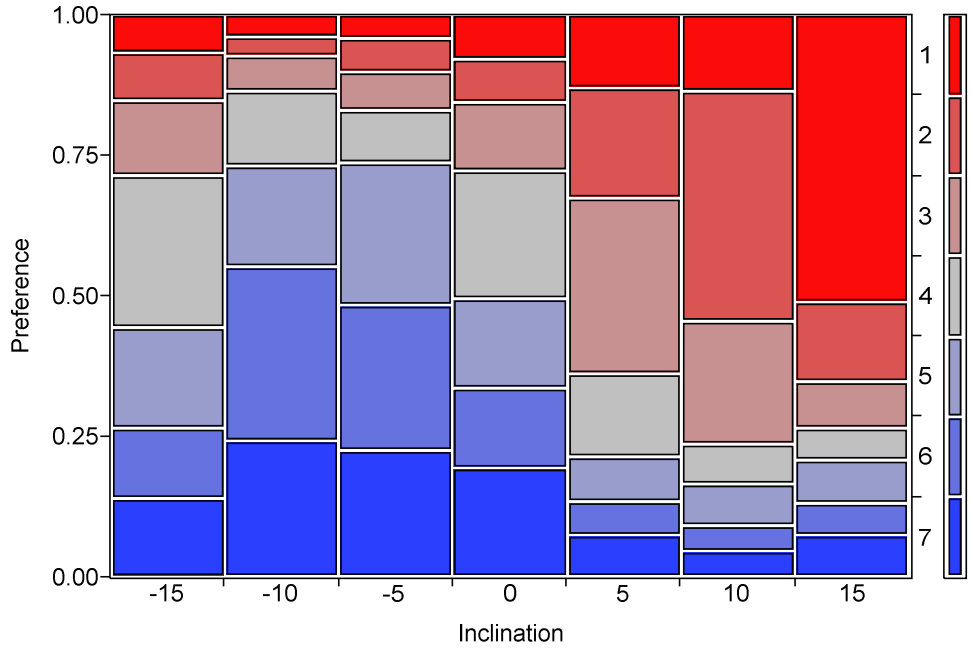


The ranks and indication of unacceptability were combined into a single preference score where 7 is the most desirable and 1 is the least. The result of combining indication of unacceptability and ranks is shown in Table 3 and Figure 2. The raters strongly preferred the (blue) negative inclinations to the (red) positive inclinations.

Table 3. Preference versus Inclination

	Preference (7=Most attractive, acceptable; 1=Least attractive, unacceptable)									
Inclination	7	6	5	4	3	2	1	Median	Mean	SD
–15°	80	71	101	153	75	48	38	4	4.35	1.71
–10°	138	174	102	75	36	20	21	6	5.28	1.58
–5°	128	146	143	54	38	33	24	5	5.14	1.65
0°	110	80	91	128	70	43	44	4	4.52	1.83
+5°	42	35	45	83	177	111	73	3	3.33	1.68
+10°	26	27	41	41	123	231	77	2	2.86	1.57
+15°	42	33	43	32	47	80	289	1	2.52	2.01
	566	566	566	566	566	566	566			

Figure 2. Preference Versus Inclination



The repeated-measures mixed model indicated that there were different preferences between the seven inclinations ($P < .0001$). These preferences varied by the race of the image ($P < .0001$) and the race of the rater ($P = 0.0074$), but they did not vary by the gender of the rater ($P = 0.1802$). The race of image differences did not depend upon the race of the rater ($P = 0.2741$). Table 4 shows that each of the preferences of inclination were significantly different from one another ($P<0.05$) by Tukey's HSD except that the –10° and –5° preferences were not different from each other and the –15° and 0° preferences were not different from each other ($P>0.05$).

Table 4. Estimated Preference for each Inclination

Inclination	Preference	SE	95% CI	
–15°	4.38	0.079	4.23	4.54
–10°	5.23	0.081	5.07	5.39
–5°	5.14	0.083	4.98	5.30
0°	4.52	0.072	4.38	4.66
+5°	3.29	0.073	3.15	3.44
+10°	2.89	0.082	2.73	3.05
+15°	2.54	0.114	2.32	2.77

Note: Repeated-measures mixed-model results indicated that each preference was different from all the others (alpha = 0.05) except that the –10° and –5° preferences were not different from each other and the –15° and 0° preferences were not different from each other.

Figure 3 shows the preference difference depending upon the race of the image ($P <$ .0001). The asterisks in the figure indicate when the two images were different for a fixed inclination. That is, the –10° image was more highly preferred in the African-American image than in the White image (5.41 vs. 5.05). And the 0° image had a lower preference score in the African-American image than in the White image (4.12 vs 4.92). The figure gives the sense that an inclination of –10° was preferred in the African-American image and inclinations between -10° and 0° were preferred in the White image.

Figure 3. Estimated Preference for each Inclination, for Each Photograph

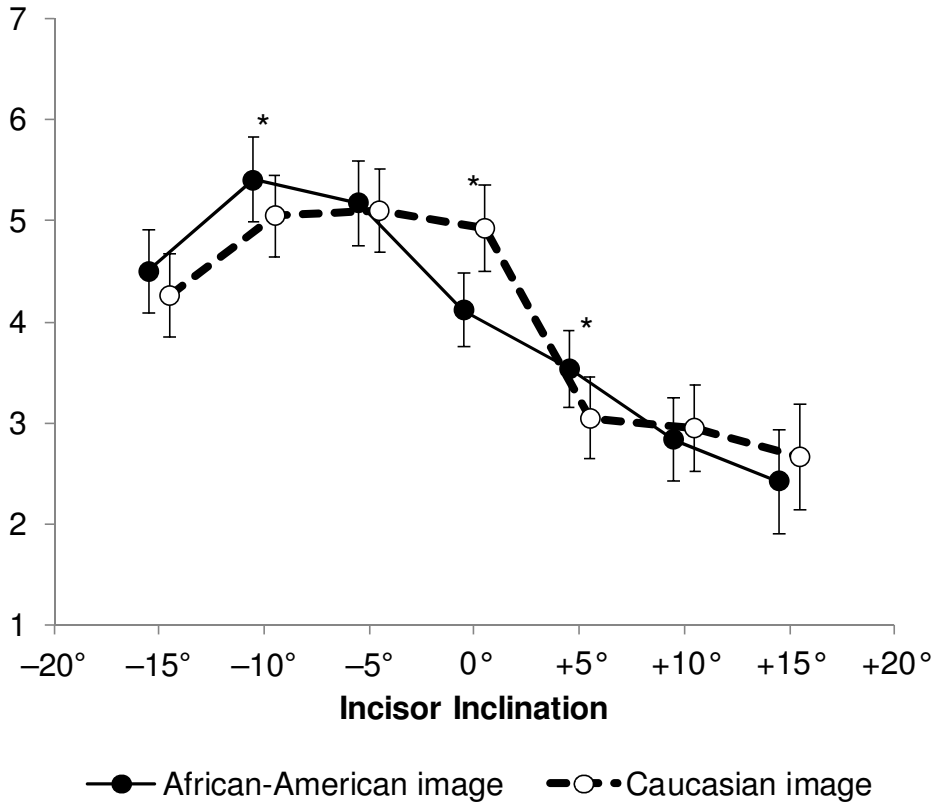
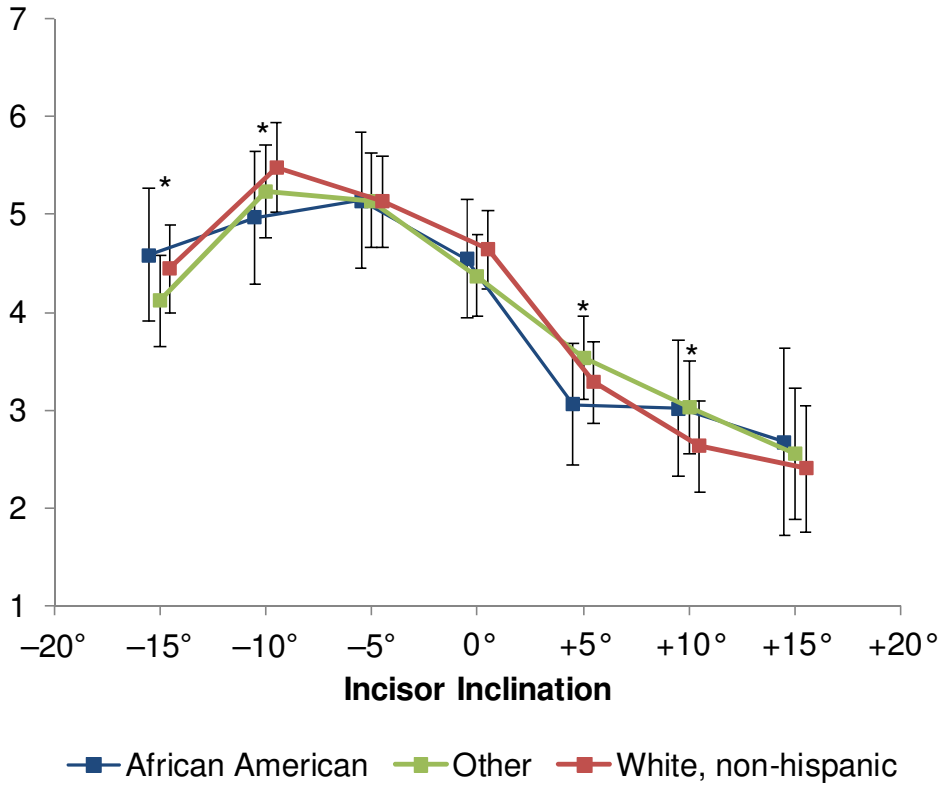


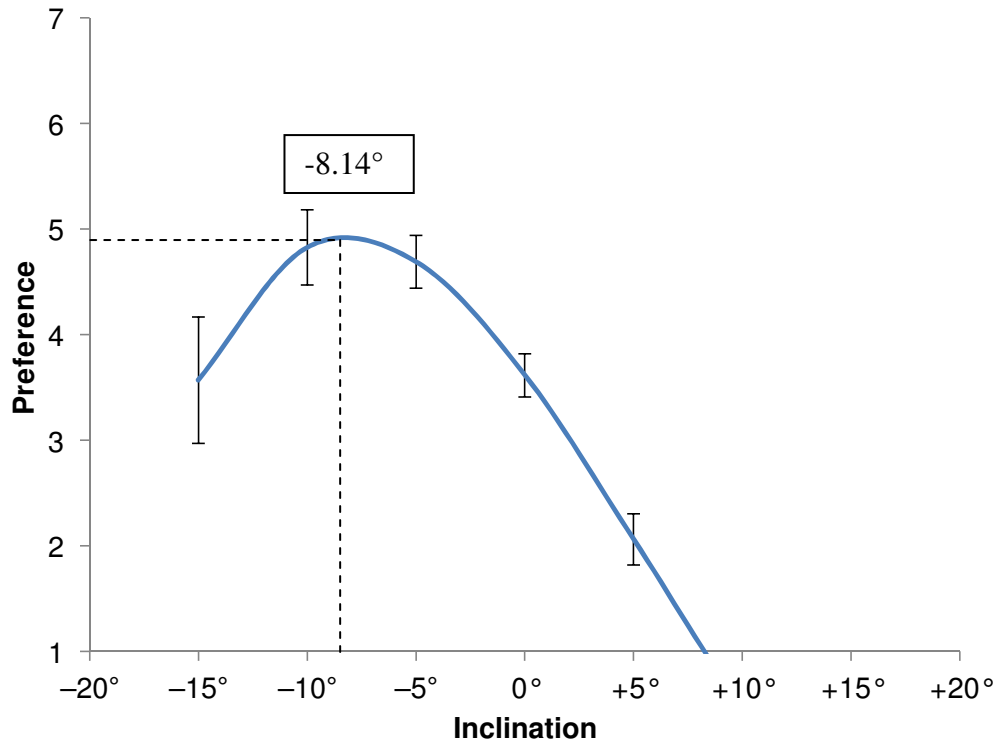
Figure 4 shows the average preferences depending upon the race of the rater. Raters who indicated anything else other than African-American or White non-Hispanic were collapsed into Other.

Figure 4. Estimated Preference for each Inclination, for Each Evaluator Race



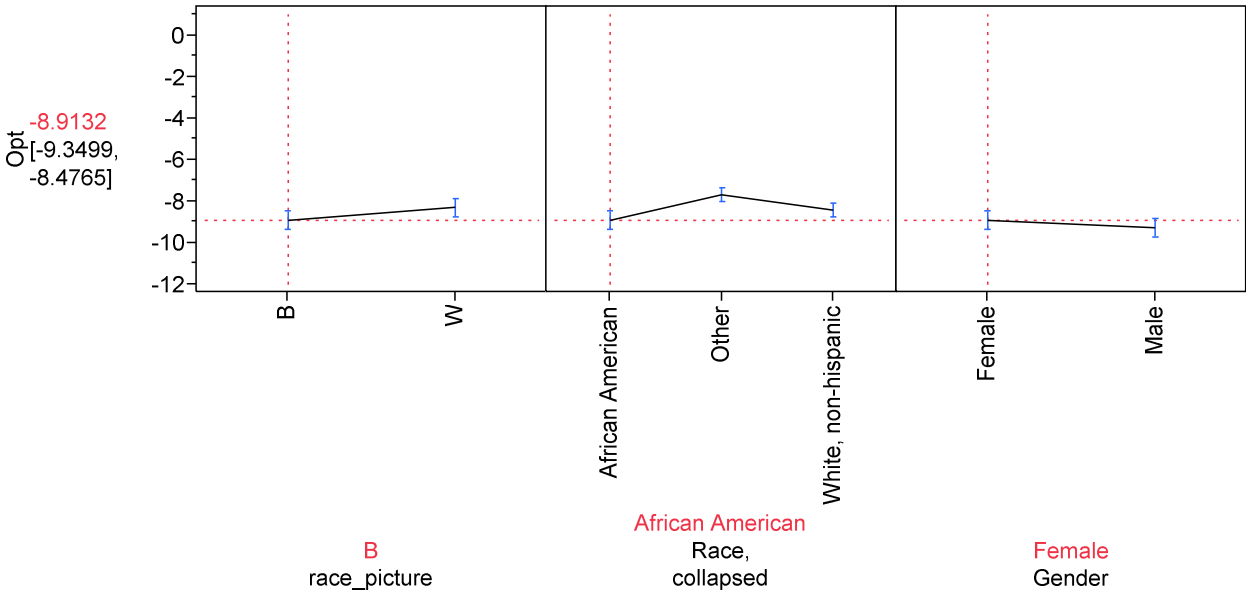
All of the above analyses aimed to estimate the average preference for each fixed inclination. To estimate the most preferred inclination, a cubic trend was used to fit the data. The results of fitting all of the data in a single model are shown in Figure 5. All of the model parameters were significantly different than zero ($P < .0001$). Using algebra, the peak preference was estimated. Overall the top of the preference curve was located at –8.14 (SD = 2.0) which means that the respondents preferred the maxillary incisors to be retroclined between –5° and –10°.

Figure 5. Estimating the Optimum Incisal Inclination



In addition, each evaluator's estimated optimum preference was estimated in a similar manner. An ANOVA model was used to test whether the optimum preference varied by the race of the image, or by the evaluator demographics. The optimum inclination varied by the race of the image ($P < .0001$), race of the rater ($P < .0001$), and by the gender of the rater ($P = 0.0319$). It did not vary by age ($P= 0.14$), area of USA ($P=0.15$), education ($P=0.6$), or years in the USA ($P=0.3$). The group differences are shown in Figure 6. The optimal inclination for the African-American image was –8.5° versus –7.9° for a White image (difference = 0.635, 95% CI = 0.318 to 0.952). White raters had a preference for –8.3° and this was not significantly different than African-American raters' (–8.8°). Other raters had a significantly different preference at –7.5°. Female raters preferred an inclination -8.0° versus male raters who preferred –8.4° (difference = 0.348, 95% CI = 0.030 to 0.666).

Figure 6. Optimum Incisal Inclination by Demographics



Discussion

Studies involving smile esthetics and the preferences of laypeople and dental professionals continue to have a strong presence in current orthodontic research. It is important for orthodontists to understand all aspects of smile esthetics, especially the sagittal and vertical position of the maxillary incisors which is considered to be one of the most important features of a smile.[2,13] In order to establish the maxillary incisors in their most esthetic position, it is important to evaluate the smile from the frontal and profile views.[23] Maxillary central incisors should be at a proper position relative to the smile line with appropriate mesiodistal angulation and labiolingual inclination for optimum esthetics.[6,24]

Previous studies that have focused on the esthetic implications of maxillary incisor inclination have not looked at preferences across races. In addition, previous studies have not investigated whether laypeople prefer different amounts of incisor inclination for different races. Because of the vast cultural and ethnic diversity found in the United States, previous research involved cephalometric studies to determine average measurements for each race. However, treating patients to simply achieve cephalometric norms does not guarantee esthetic results.[13] Therefore, it was important to survey people of diverse ethnic backgrounds in order to determine whether or not race of the evaluator has an influence on the esthetic preferences of maxillary incisor inclination. In addition, it was important to use models of different races to determine if the race of the individual influences the evaluator's preferred incisal inclination.

In this study, the evaluators found all degrees of proclination to be less esthetic than retroclined maxillary incisors. This was in agreement with Isiksal et al. who compared smile attractiveness of treated versus untreated smiles. Isiksal et al showed that in the non-extraction group, increasing the U1-SN angle would lead to a decrease in smile esthetics. One explanation could be that the labial surface of proclined maxillary incisors is more anterior than what Andrews describes as the optimal position of the teeth. Andrews advocated that in order to achieve the most esthetic outcome, the labial surface of the maxillary incisors should lie along a vertical line perpendicular to Frankfort horizontal passing through glabella.[23] Another explanation could be that laypeople might associate flared teeth with excess overjet and lip incompetence.

The laypeople in this study preferred maxillary incisors with greater retroclination than expected. Orthodontists often emphasize the importance of maintaining labial crown torque on anterior teeth during orthodontic treatment, especially while closing extraction spaces. However, the results of this study indicated that retroclined incisors may not be negatively viewed by the general public. Ghaleb et al. found that dental professionals considered 5° of labial proclination relative to a line drawn from subnasale to pogonion (Sn-Pg') to be most esthetic and that orthodontists preferred even more labial crown torque than both dentists and laypeople. The current study showed that laypeople prefer retroclined teeth at an average of -8.14° from a line perpendicular to Frankfort horizontal passing through glabella. Because the two studies used different soft tissue landmarks to measure the incisal inclination, it is unsurprising that the studies yielded different results. The current study did not use Sn-Pg' to measure incisal inclination because it would have been difficult to compare the preferred incisal inclinations between the African-American and White models since the angle of facial convexity and the

prominence of pogonion differed between the two subjects. Another explanation for the difference in preference between the two studies could be the mean age of the respondents. Most of the laypeople in this study were between the ages of 18-21 versus the laypeople in the Ghaleb et al. study whose mean age was 32.47 years, SD = 9.605. A slightly older age group may prefer greater incisor proclination in favor of greater lip support and the appearance of a fuller smile. The older group may also prefer greater incisor flare since previous studies on facial esthetics performed in the 1990s-2000s shed light on the public's preference for fuller profiles and greater maxillary incisor proclination.[10-12]

Li et al. also investigated the esthetic preference of maxillary incisor inclination and reported similar results to the current study. Both studies used the same method to alter the maxillary incisor inclination. Similar to the Ghaleb et al. study, Li et al. surveyed dental professionals and undergraduates from Sichuan University who served as "non-experts" or laypeople. However, unlike in the Ghaleb et al. study, there was no significant difference in preference between the evaluators. Both panels rated the smiling profile picture with 5° of lingual inclination relative to a vertical line drawn through glabella perpendicular to Frankfort horizontal to be the most esthetic, followed by maxillary incisor lingual inclination (within 10°) and a small degree of labial inclination. Fifteen degrees of proclination was rated least esthetic by the majority of respondents which agreed with the results of this study. Li et al. also looked at anteroposterior maxillary incisor movement without changes in inclination. The study reported maxillary incisor retrusion greater than 1 mm would result in a less esthetic smile, however, protrusion of less than 3 mm did not affect smiling esthetics. Li et al concluded that maxillary incisor lingual inclination and protrusion were more acceptable than labial inclination or retrusion.[9] Another previous article reported the effects of anteroposterior maxillary incisor

movement, without changes in labiolingual inclination, on facial esthetics. The results of the study mirrored previous reports of retrusive maxillary incisors to be less desirable than protrusive maxillary incisors. Schlosser et al. supported the notion that it is preferable to either maintain a normally protrusive maxillary dentition or advance, rather than retract, the maxillary anterior teeth.[2]

Because the methods of this study differed from previous studies, it was not entirely surprising to have found different results. The current study looked at maxillary incisor inclination from a smiling profile view using colored pictures rather than silhouettes. In some previous studies, silhouettes have been advocated in order to eliminate distractive variables such as hair, skin color, and makeup which could influence the evaluators' preferences.[25] However, the current study was in agreement with the notion that the entire face may be necessary to judge overall facial attractiveness.[26] Furthermore, Hockley et al. demonstrated that when asked to rate photographs, evaluator preferences were closer to the established esthetic norm than were their preferences when asked to rate silhouettes. The study concluded that using silhouettes to evaluate patient esthetics could influence clinicians or researchers to select profiles that are flatter than the established esthetic norm thus affirming the decision to use colored pictures of real-life models.[27]

Another difference between the current study and previous studies was the use of rank ordering instead of a visual analog scale. The evaluators in this study were asked to rank the photographs in order of "most attractive" to "least attractive." Most previous studies involving evaluation of facial esthetics used the visual analog scale (VAS) because of the notion that it avoids bias towards preferred values found with numeric or interval scales and allows a better examination of the amount and significance of differences.[28] However, the digital alterations in maxillary incisor inclination were designed to be subtle and somewhat inconspicuous, and the

results from a visual analog scale may have masked differences in preferences among the evaluators. In order to address numerical bias associated with rank ordering, the altered photographs were labeled using letters instead of numbers.

The results of this study yielded 343 different rank orders. This could be an indication that the perceptual task for evaluators was difficult. In order to identify a pattern of preference, the data were analyzed to determine the top three choices, the middle three choices, and the bottom three choices. Despite the wide variability, the data showed that the most preferred inclination was in the moderately negative range. All degrees of maxillary incisor retroclination were rated higher than 0° and all degrees of maxillary incisor proclination. Overall, evaluators in the current study rated the most esthetic maxillary incisor inclination to be -10° for the African-American image and -5° for the White image. More specifically, African-Americans showed the highest preference for -5° of incisor inclination while all other races showed the greatest preference for -10° of incisor inclination. While the majority of evaluators, regardless of race, preferred retroclined teeth over proclined teeth, Whites preferred more retroclination than African-American evaluators. This agrees with previous studies citing African-Americans to prefer fuller lips and more protrusive profiles than Whites.[29,30] In addition, Sutter and Turley evaluated White and African-American models and concluded that the esthetic standard for African-Americans has become somewhat flatter over time but still with fuller profiles and fuller lips than for Whites.[31] An interesting trend seen in the data showed that when African-American evaluators rated the African-American image, they preferred even greater retroclination than when they rated the White image. This trend, although not statistically significant, could reflect African-Americans' current preference for flatter profiles than previously reported. This finding agrees with the study conducted by Nomura et al. which demonstrated that while African-

Americans prefer more protrusive profiles than other races, their preference for lip position was still well behind the esthetic line.[30]

Many previous studies have also investigated the position of the maxillary incisors as a result of extraction versus non-extraction treatment. In the 1950s, Charles Tweed was a well-known proponent of extraction therapy. The relapse he witnessed in patients originally treated without extractions sparked his emphasis on four premolar extractions not only to decrease dental protrusion and unsatisfactory facial esthetics, but also to increase the long-term stability of orthodontic treatment. Tweed seemed to be less concerned about the resulting lingual inclination of the maxillary and mandibular incisors following extractions.[32-33] While the results of this study support lingually-inclined maxillary incisors as an esthetically acceptable position, this study did not address the effect of maxillary incisor retroclination on the soft-tissue profile. Retroclination of the maxillary incisors should not be at the expense of soft-tissue support and overall profile esthetics.

Previous studies of smile esthetics have also emphasized the importance of maxillary incisor positioning and its relation to the soft tissue profile. Societal preference for fuller lips was another reason non-extraction treatment has gained widespread popularity in recent years. While it is true that incisor inclination directly influences the position of the lips, other factors such as lip thickness, tonicity, length, and lower lip proximity decrease the accuracy of predicting soft tissue changes post-orthodontic treatment.[34-35] This means that it is important for clinicians to weigh the benefits against the risks when deciding on non-extraction treatment. Greater lip support as a result of non-extraction treatment could lead to excessively flared teeth that would ultimately decrease overall smile attractiveness. The reverse could be said for extraction treatment resulting in teeth at an appropriate inclination but with minimal lip support.

Ethnic differences in soft tissue composition could also affect the soft tissue response to hard tissue changes. The current study used models of different races to determine if the soft tissue differences between African-Americans and Whites would have an influence on the preferred amount of maxillary incisor inclination. The results of this study showed that an inclination of -10° was preferred in the African-American image and inclinations between -10° and 0° were preferred in the White image. Incisors with slightly greater lingual inclination were possibly preferred in the African-American image since African-Americans tend to have thicker soft tissue which is less affected by hard tissue changes. A study by Brock et al showed that ethnic differences in initial lip thickness and incisor inclination affected the soft-tissue response to changes in hard tissue.[35] The study showed the soft-tissue changes after incisor retraction were more downward for African-Americans, while Whites showed more backward movement. However, ethnicity added no increase to the predictability of the soft tissue response, rather it was the initial lip thickness and incisor inclination of the individual. Differences between Whites and African-Americans in maxillary incisor inclination changes did not produce differences in upper lip length and thickness. The study postulated that greater pre-treatment lip thickness in the African-American group might have masked the treatment changes, and patients with thin lips exhibit significantly greater correlations between osseous and soft-tissue changes. This implies that retroclination of incisors in patients with flat, thin lips would be more detrimental to the soft-tissue profile than in patients with full, thick lips. Therefore, although this study reported a preference for retroclined incisors, it is important to ensure that the hard-tissue changes we make during orthodontic treatment do not compromise a patient's soft-tissue profile.

This was the first study in the United States to shed light on laypeople's preference for retroclined maxillary incisors and dislike for excessive proclination. Since the advent of self-

ligating brackets and the increasing popularity of non-extraction treatment, many clinicians still hold a strong preference for non-extraction treatment to achieve broader arches reminiscent of the "Hollywood smile" despite the findings of a previous study that found no significant difference in buccal corridors before and after extraction treatment.[36] Rather, one of the most significant differences between extraction and non-extraction treatment is the resulting maxillary and mandibular incisor inclination.[12] According to the results of this study, laypeople prefer retroclined maxillary incisors over excessively proclined maxillary incisors. This information would be useful to clinicians when treatment planning borderline cases that could be successfully treated both with or without extractions. Following a non-extraction treatment approach in a universal manner simply to avoid extractions could result in the deterioration of overall smile and facial esthetics.

Conclusion

Studies investigating smile esthetics and the preferences of various cultural and ethnic groups are important to the advancement of the dental field, and it is equally important to determine the functional and esthetic needs of our patients on an individual basis. It is beneficial to possess an in-depth knowledge of racial norms and preferences, but simply "treating to the numbers" will not guarantee optimal results. Discussing various treatment options and weighing the risks versus the benefits with each individual patient will pave the road for a successful treatment outcome. And although our study reported a preference for retroclined incisors, it is important that the changes in incisor positioning during orthodontic treatment do not compromise soft-tissue esthetics. The data gathered in this study supports the following conclusions:

- The average of the top three inclinations ranged between -10° and -5° from a vertical line passing through glabella perpendicular to Frankfort horizontal.
- The majority of evaluators preferred retroclined maxillary incisors to proclined maxillary incisors.
- There were no statistically significant differences in the preference for maxillary incisor inclination between African-American and White evaluators.
- There were no clinically significant differences in the preference for maxillary incisor inclination between males and females.

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Appendix: Rankings of Participants

Preference Order	N	Percent
0, +5, –5, –10, +10, +15, –15	1	0.18
0, +5, –5, –10, –15, +10, +15	3	0.53
0, +5, +10, +15, –10, –5, –15	1	0.18
0, +5, +10, –10, –5, –15, +15	1	0.18
0, +5, –10, –5, +10, –15, +15	1	0.18
0, +5, –10, –5, –15, +15, +10	1	0.18
0, +5, –15, –10, –5, +10, +15	1	0.18
0, –5, +5, –10, –15, +10, +15	1	0.18
0, –5, +10, +15, +5, –15, –10	1	0.18
0, –5, +15, –10, –15, +5, +10	1	0.18
0, –5, –10, +10, +5, –15, +15	1	0.18
0, –5, –10, +10, –15, +5, +15	2	0.35
0, –5, –10, +15, –15, +10, +5	1	0.18
0, –5, –10, –15, +5, +10, +15	5	0.88
0, –5, –10, –15, +5, +15, +10	2	0.35
0, –5, –10, –15, +10, +5, +15	1	0.18
0, –5, –10, –15, +10, +15, +5	3	0.53
0, –5, –10, –15, +15, +10, +5	3	0.53
0, –5, –15, +10, +5, –10, +15	1	0.18
0, –5, –15, –10, +5, +10, +15	2	0.35
0, –5, –15, –10, +5, +15, +10	1	0.18
0, +10, +5, –10, –5, –15, +15	1	0.18
0, +15, –5, +10, +5, –15, –10	1	0.18
0, +15, –5, –15, +5, +10, –10	1	0.18
0, +15, –5, –15, –10, +10, +5	1	0.18
0, +15, +10, –10, –15, –5, +5	1	0.18
0, +15, –10, –5, –15, +10, +5	2	0.35
0, –10, +5, +10, +15, –15, –5	1	0.18
0, –10, +5, +15, –5, –15, +10	1	0.18
0, –10, –5, +5, –15, +15, +10	2	0.35
0, –10, –5, +10, –15, +5, +15	1	0.18
0, –10, –5, +15, –15, +5, +10	1	0.18
0, –10, –5, +15, –15, +10, +5	3	0.53
0, –10, –5, –15, +5, +10, +15	14	2.47
0, –10, –5, –15, +5, +15, +10	3	0.53
0, –10, –5, –15, +10, +5, +15	7	1.24
0, –10, –5, –15, +10, +15, +5	1	0.18
0, –10, –5, –15, +15, +10, +5	3	0.53
0, –10, +10, +5, –15, –5, +15	1	0.18
0, –10, +10, –5, +15, +5, –15	1	0.18
0, –10, +10, +15, +5, –15, –5	1	0.18
0, –10, +10, –15, –5, +15, +5	1	0.18
0, –10, +15, +5, –5, –15, +10	2	0.35

Preference Order	N	Percent
0, –10, +15, –5, +10, +5, –15	1	0.18
0, –10, +15, +10, +5, –5, –15	1	0.18
0, –10, +15, –15, –5, +10, +5	1	0.18
0, –10, –15, +5, +10, +15, –5	1	0.18
0, –10, –15, –5, +5, +10, +15	3	0.53
0, –10, –15, –5, +10, +5, +15	2	0.35
0, –10, –15, –5, +15, +5, +10	1	0.18
0, –10, –15, –5, +15, +10, +5	1	0.18
0, –10, –15, +10, –5, +15, +5	1	0.18
0, –15, –5, +5, +10, –10, +15	1	0.18
0, –15, –5, +10, –10, +5, +15	1	0.18
0, –15, –5, –10, +5, +10, +15	3	0.53
0, –15, –5, –10, +10, +5, +15	1	0.18
0, –15, –5, –10, +10, +15, +5	2	0.35
0, –15, –10, –5, +5, +10, +15	2	0.35
0, –15, –10, –5, +10, +5, +15	3	0.53
0, –15, –10, +10, +5, +15, –5	1	0.18
+5, 0, –5, –10, +10, –15, +15	1	0.18
+5, 0, –5, –10, +15, +10, –15	1	0.18
+5, 0, –5, –10, –15, +10, +15	2	0.35
+5, 0, –5, –15, –10, +10, +15	1	0.18
+5, 0, –5, –15, –10, +15, +10	1	0.18
+5, 0, +15, +10, –5, –10, –15	1	0.18
+5, 0, +15, –10, –5, –15, +10	1	0.18
+5, 0, +15, –15, +10, –5, –10	1	0.18
+5, 0, –10, –5, –15, +10, +15	3	0.53
+5, 0, –10, +15, –5, +10, –15	1	0.18
+5, 0, –10, +15, +10, –15, –5	1	0.18
+5, –5, 0, –10, –15, +10, +15	1	0.18
+5, –5, +15, 0, +10, –10, –15	1	0.18
+5, –5, +15, 0, –10, –15, +10	1	0.18
+5, –5, +15, 0, –15, –10, +10	1	0.18
+5, –5, –10, –15, 0, +10, +15	2	0.35
+5, –5, –10, –15, +10, 0, +15	2	0.35
+5, –5, –15, +15, +10, 0, –10	1	0.18
+5, +10, 0, –5, –10, –15, +15	1	0.18
+5, +10, +15, 0, –5, –10, –15	1	0.18
+5, +10, +15, 0, –15, –10, –5	1	0.18
+5, +10, +15, –5, –10, –15, 0	1	0.18
+5, +10, +15, –10, –15, –5, 0	3	0.53
+5, +10, +15, –15, –5, 0, –10	1	0.18
+5, +10, –15, –5, +15, –10, 0	1	0.18
+5, +15, –5, –10, +10, –15, 0	1	0.18
+5, –10, 0, +15, –5, –15, +10	1	0.18
+5, –10, –5, 0, –15, +10, +15	1	0.18

Preference Order	N	Percent
+5, –10, –5, +15, +10, 0, –15	1	0.18
+5, –10, –5, –15, 0, +10, +15	3	0.53
+5, –10, +15, –15, –5, +10, 0	1	0.18
+5, –10, –15, +10, +15, –5, 0	1	0.18
+5, –15, +10, –5, –10, 0, +15	1	0.18
–5, 0, +5, +10, +15, –10, –15	1	0.18
–5, 0, +5, –10, –15, +10, +15	2	0.35
–5, 0, +5, –15, –10, +10, +15	1	0.18
–5, 0, +10, –10, +15, +5, –15	1	0.18
–5, 0, +15, –15, +5, –10, +10	1	0.18
–5, 0, –10, +5, +10, +15, –15	1	0.18
–5, 0, –10, +5, –15, +10, +15	1	0.18
–5, 0, –10, +5, –15, +15, +10	1	0.18
–5, 0, –10, +10, +5, –15, +15	1	0.18
–5, 0, –10, +15, –15, +10, +5	2	0.35
–5, 0, –10, –15, +5, +10, +15	5	0.88
–5, 0, –10, –15, +5, +15, +10	1	0.18
–5, 0, –10, –15, +10, +5, +15	4	0.71
–5, 0, –10, –15, +15, +10, +5	1	0.18
–5, 0, –15, +5, –10, +10, +15	1	0.18
–5, 0, –15, –10, +5, +10, +15	3	0.53
–5, 0, –15, –10, +15, +10, +5	1	0.18
–5, +5, 0, +10, +15, –15, –10	1	0.18
–5, +5, 0, –10, –15, +10, +15	1	0.18
–5, +5, 0, –10, –15, +15, +10	2	0.35
–5, +5, 0, –15, +10, +15, –10	1	0.18
–5, +5, +10, +15, 0, –15, –10	1	0.18
–5, +5, +10, –15, –10, 0, +15	1	0.18
–5, +5, –10, +15, –15, 0, +10	1	0.18
–5, +10, 0, –10, +5, +15, –15	1	0.18
–5, +10, 0, –10, +15, +5, –15	1	0.18
–5, +10, +5, –15, –10, 0, +15	1	0.18
–5, +10, +15, 0, –10, –15, +5	1	0.18
–5, +10, +15, +5, –10, –15, 0	1	0.18
–5, +10, +15, –10, –15, +5, 0	1	0.18
–5, +10, –15, +15, +5, 0, –10	1	0.18
–5, +15, +10, 0, +5, –10, –15	1	0.18
–5, +15, +10, +5, –15, 0, –10	1	0.18
–5, +15, +10, –10, 0, +5, –15	1	0.18
–5, +15, –10, 0, –15, +10, +5	1	0.18
–5, +15, –10, –15, +10, 0, +5	1	0.18
–5, +15, –15, 0, –10, +10, +5	1	0.18
–5, –10, 0, +5, +10, –15, +15	2	0.35
–5, –10, 0, +5, –15, +10, +15	1	0.18
–5, –10, 0, +5, –15, +15, +10	3	0.53

Preference Order	N	Percent
–5, –10, 0, +10, –15, +5, +15	1	0.18
–5, –10, 0, –15, +5, +10, +15	6	1.06
–5, –10, 0, –15, +5, +15, +10	3	0.53
–5, –10, 0, –15, +10, +5, +15	5	0.88
–5, –10, +5, 0, +15, –15, +10	1	0.18
–5, –10, +5, 0, –15, +10, +15	4	0.71
–5, –10, +5, –15, 0, +10, +15	2	0.35
–5, –10, +5, –15, 0, +15, +10	1	0.18
–5, –10, +5, –15, +10, +15, 0	1	0.18
–5, –10, +10, +5, +15, –15, 0	2	0.35
–5, –10, +10, +15, –15, +5, 0	1	0.18
–5, –10, +15, +5, –15, +10, 0	1	0.18
–5, –10, +15, +10, +5, –15, 0	1	0.18
–5, –10, –15, 0, +5, +10, +15	8	1.41
–5, –10, –15, 0, +5, +15, +10	3	0.53
–5, –10, –15, 0, +10, +5, +15	5	0.88
–5, –10, –15, 0, +15, +5, +10	1	0.18
–5, –10, –15, +5, 0, +10, +15	5	0.88
–5, –10, –15, +5, +10, 0, +15	1	0.18
–5, –10, –15, +15, 0, +5, +10	1	0.18
–5, –15, 0, +5, –10, +10, +15	1	0.18
–5, –15, 0, –10, +5, +10, +15	2	0.35
–5, –15, 0, –10, +10, +5, +15	2	0.35
–5, –15, 0, –10, +15, +10, +5	1	0.18
–5, –15, +10, 0, +15, –10, +5	1	0.18
–5, –15, +10, –10, 0, +5, +15	1	0.18
–5, –15, +10, –10, +5, 0, +15	1	0.18
–5, –15, +10, –10, +15, 0, +5	1	0.18
–5, –15, –10, 0, +5, +10, +15	3	0.53
–5, –15, –10, 0, +5, +15, +10	1	0.18
–5, –15, –10, 0, +10, +5, +15	2	0.35
–5, –15, –10, 0, +10, +15, +5	1	0.18
–5, –15, –10, 0, +15, +5, +10	1	0.18
–5, –15, –10, +10, 0, +15, +5	1	0.18
–5, –15, –10, +10, +5, 0, +15	1	0.18
+10, 0, +5, –5, –10, +15, –15	1	0.18
+10, 0, +5, –10, +15, –5, –15	1	0.18
+10, 0, +15, –10, –15, –5, +5	1	0.18
+10, +5, –5, 0, –10, +15, –15	1	0.18
+10, +5, –5, –10, +15, 0, –15	1	0.18
+10, +5, –5, –10, –15, 0, +15	1	0.18
+10, +5, +15, –10, 0, –15, –5	1	0.18
+10, +5, +15, –15, –5, –10, 0	1	0.18
+10, +5, +15, –15, –10, –5, 0	1	0.18
+10, +5, –10, –5, 0, +15, –15	1	0.18

Preference Order	N	Percent
+10, +5, –15, +15, –10, 0, –5	1	0.18
+10, –5, +5, 0, –10, +15, –15	1	0.18
+10, –5, –15, 0, –10, +5, +15	1	0.18
+10, –5, –15, –10, +5, +15, 0	1	0.18
+10, +15, 0, +5, –5, –15, –10	1	0.18
+10, +15, 0, –15, +5, –10, –5	1	0.18
+10, +15, +5, –5, –15, –10, 0	1	0.18
+10, +15, –5, 0, –15, –10, +5	1	0.18
+10, –10, 0, +5, –5, –15, +15	1	0.18
+10, –10, 0, –5, +15, –15, +5	1	0.18
+10, –10, –5, +5, 0, –15, +15	1	0.18
+10, –10, –5, +5, +15, 0, –15	1	0.18
+10, –10, –5, +15, –15, 0, +5	1	0.18
+10, –10, +15, +5, –5, –15, 0	1	0.18
+10, –15, +15, +5, 0, –5, –10	1	0.18
+10, –15, –10, +15, –5, 0, +5	1	0.18
+15, 0, +5, +10, –5, –15, –10	1	0.18
+15, 0, –5, +10, –15, +5, –10	1	0.18
+15, 0, –10, +5, –5, –15, +10	1	0.18
+15, 0, –10, +10, –5, +5, –15	1	0.18
+15, 0, –10, –15, +5, –5, +10	1	0.18
+15, 0, –10, –15, –5, +5, +10	1	0.18
+15, 0, –10, –15, +10, –5, +5	1	0.18
+15, +5, –5, –15, –10, 0, +10	1	0.18
+15, +5, –5, –15, –10, +10, 0	1	0.18
+15, +5, +10, –10, –5, –15, 0	1	0.18
+15, +5, –10, –5, –15, +10, 0	1	0.18
+15, –5, 0, –10, +5, +10, –15	1	0.18
+15, –5, 0, –15, +10, –10, +5	1	0.18
+15, –5, +5, –10, –15, 0, +10	1	0.18
+15, –5, +10, +5, 0, –10, –15	1	0.18
+15, –5, +10, –10, +5, –15, 0	1	0.18
+15, –5, +10, –15, 0, +5, –10	1	0.18
+15, –5, +10, –15, +5, 0, –10	1	0.18
+15, –5, –10, +10, 0, –15, +5	1	0.18
+15, –5, –10, –15, 0, +10, +5	1	0.18
+15, –5, –15, 0, +5, +10, –10	1	0.18
+15, +10, 0, –15, –10, –5, +5	1	0.18
+15, +10, +5, 0, –5, –10, –15	1	0.18
+15, +10, +5, 0, –10, –15, –5	2	0.35
+15, +10, +5, 0, –15, –5, –10	1	0.18
+15, –10, 0, +10, +5, –5, –15	1	0.18
+15, –10, 0, –15, +10, –5, +5	1	0.18
+15, –10, +5, 0, –15, +10, –5	1	0.18
+15, –10, +5, –5, 0, +10, –15	1	0.18

Preference Order	N	Percent
+15, –10, +5, –15, 0, +10, –5	1	0.18
+15, –10, –5, +5, –15, +10, 0	1	0.18
+15, –10, –5, –15, 0, +10, +5	1	0.18
+15, –10, +10, 0, –15, +5, –5	1	0.18
+15, –10, –15, +10, +5, –5, 0	1	0.18
+15, –10, –15, +10, –5, 0, +5	1	0.18
+15, –15, –5, 0, –10, +5, +10	1	0.18
+15, –15, –5, +10, +5, –10, 0	1	0.18
+15, –15, –5, –10, 0, +5, +10	1	0.18
+15, –15, –5, –10, +5, +10, 0	1	0.18
+15, –15, +10, –10, 0, –5, +5	1	0.18
+15, –15, –10, 0, +10, +5, –5	1	0.18
–10, 0, +5, +15, +10, –5, –15	1	0.18
–10, 0, +5, –15, +15, +10, –5	1	0.18
–10, 0, –5, –15, +5, +10, +15	6	1.06
–10, 0, –5, –15, +10, +5, +15	7	1.24
–10, 0, –5, –15, +15, +10, +5	2	0.35
–10, 0, +15, –5, –15, +10, +5	1	0.18
–10, 0, –15, –5, +5, +10, +15	1	0.18
–10, 0, –15, +10, –5, +5, +15	1	0.18
–10, 0, –15, +10, +15, –5, +5	1	0.18
–10, 0, –15, +15, +5, –5, +10	1	0.18
–10, +5, +10, –5, 0, –15, +15	1	0.18
–10, –5, 0, +5, –15, +10, +15	2	0.35
–10, –5, 0, –15, +5, +10, +15	7	1.24
–10, –5, 0, –15, +5, +15, +10	3	0.53
–10, –5, 0, –15, +10, +5, +15	8	1.41
–10, –5, 0, –15, +10, +15, +5	2	0.35
–10, –5, 0, –15, +15, +5, +10	1	0.18
–10, –5, +5, 0, –15, +10, +15	1	0.18
–10, –5, +5, +15, –15, +10, 0	1	0.18
–10, –5, +5, –15, 0, +10, +15	2	0.35
–10, –5, +10, +5, 0, +15, –15	1	0.18
–10, –5, +10, +5, 0, –15, +15	1	0.18
–10, –5, +10, +5, +15, 0, –15	1	0.18
–10, –5, +10, –15, 0, +5, +15	1	0.18
–10, –5, +15, –15, 0, +10, +5	1	0.18
–10, –5, –15, 0, +5, +10, +15	12	2.12
–10, –5, –15, 0, +5, +15, +10	2	0.35
–10, –5, –15, 0, +10, +5, +15	6	1.06
–10, –5, –15, 0, +10, +15, +5	1	0.18
–10, –5, –15, 0, +15, +5, +10	2	0.35
–10, –5, –15, 0, +15, +10, +5	2	0.35
–10, –5, –15, +5, 0, +10, +15	5	0.88
–10, –5, –15, +5, 0, +15, +10	3	0.53

Preference Order	N	Percent
–10, –5, –15, +5, +10, 0, +15	1	0.18
–10, –5, –15, +5, +10, +15, 0	3	0.53
–10, –5, –15, +10, 0, +5, +15	2	0.35
–10, –5, –15, +10, +5, 0, +15	2	0.35
–10, +10, 0, –15, +15, –5, +5	1	0.18
–10, +10, +5, +15, –5, 0, –15	1	0.18
–10, +10, +15, –15, +5, –5, 0	1	0.18
–10, +15, 0, –5, –15, +5, +10	1	0.18
–10, +15, +5, –5, +10, –15, 0	1	0.18
–10, +15, –5, +5, 0, +10, –15	1	0.18
–10, +15, –5, +10, –15, +5, 0	1	0.18
–10, +15, –5, –15, +10, +5, 0	1	0.18
–10, +15, +10, 0, –5, –15, +5	1	0.18
–10, +15, +10, +5, –5, 0, –15	2	0.35
–10, +15, +10, –5, 0, –15, +5	1	0.18
–10, +15, –15, 0, –5, +10, +5	1	0.18
–10, +15, –15, –5, 0, +5, +10	1	0.18
–10, –15, 0, +5, +15, +10, –5	1	0.18
–10, –15, 0, –5, +5, +10, +15	2	0.35
–10, –15, 0, –5, +10, +15, +5	2	0.35
–10, –15, +5, 0, +10, +15, –5	1	0.18
–10, –15, +5, –5, 0, +10, +15	1	0.18
–10, –15, –5, 0, +5, +10, +15	6	1.06
–10, –15, –5, 0, +5, +15, +10	3	0.53
–10, –15, –5, 0, +10, +5, +15	2	0.35
–10, –15, –5, 0, +15, +5, +10	1	0.18
–10, –15, –5, +5, 0, +10, +15	3	0.53
–10, –15, –5, +5, +10, 0, +15	1	0.18
–10, –15, –5, +15, +5, 0, +10	1	0.18
–10, –15, –5, +15, +10, 0, +5	1	0.18
–10, –15, +15, 0, +10, –5, +5	1	0.18
–10, –15, +15, +5, –5, +10, 0	1	0.18
–10, –15, +15, +5, +10, 0, –5	1	0.18
–15, 0, –5, –10, +10, +5, +15	1	0.18
–15, 0, –10, –5, +5, +10, +15	4	0.71
–15, 0, –10, –5, +15, +5, +10	1	0.18
–15, +5, 0, +10, –10, +15, –5	1	0.18
–15, +5, 0, –10, –5, +15, +10	1	0.18
–15, +5, +10, –5, –10, +15, 0	1	0.18
–15, +5, +10, +15, –10, –5, 0	1	0.18
–15, +5, –10, 0, +10, +15, –5	1	0.18
–15, –5, 0, +5, –10, +10, +15	2	0.35
–15, –5, 0, +5, –10, +15, +10	1	0.18
–15, –5, 0, –10, +5, +10, +15	3	0.53
–15, –5, 0, –10, +10, +5, +15	3	0.53

Preference Order	N	Percent
–15, –5, +10, –10, 0, +15, +5	1	0.18
–15, –5, –10, 0, +5, +10, +15	8	1.41
–15, –5, –10, 0, +5, +15, +10	1	0.18
–15, –5, –10, +5, 0, +10, +15	3	0.53
–15, –5, –10, +5, 0, +15, +10	1	0.18
–15, –5, –10, +5, +10, +15, 0	1	0.18
–15, –5, –10, +10, 0, +15, +5	1	0.18
–15, –5, –10, +15, +10, 0, +5	1	0.18
–15, +10, 0, –10, +15, –5, +5	1	0.18
–15, +10, +15, –5, –10, +5, 0	1	0.18
–15, +15, +5, 0, +10, –5, –10	1	0.18
–15, +15, +5, +10, 0, –5, –10	1	0.18
–15, +15, –5, –10, +5, +10, 0	1	0.18
–15, +15, –10, +5, 0, –5, +10	1	0.18
–15, +15, –10, +5, –5, 0, +10	1	0.18
–15, –10, 0, –5, +5, +10, +15	2	0.35
–15, –10, 0, –5, +10, +5, +15	1	0.18
–15, –10, +5, 0, +10, +15, –5	1	0.18
–15, –10, +5, +10, +15, 0, –5	1	0.18
–15, –10, –5, 0, +5, +10, +15	9	1.59
–15, –10, –5, 0, +5, +15, +10	1	0.18
–15, –10, –5, 0, +10, +5, +15	8	1.41
–15, –10, –5, +5, 0, +10, +15	6	1.06
–15, –10, –5, +5, +10, 0, +15	1	0.18
–15, –10, –5, +10, 0, +5, +15	1	0.18
–15, –10, –5, +10, +5, 0, +15	1	0.18
–15, –10, +15, 0, +5, –5, +10	1	0.18
–15, –10, +15, 0, +5, +10, –5	1	0.18
–15, –10, +15, +5, –5, +10, 0	1	0.18
–15, –10, +15, –5, +5, 0, +10	1	0.18

Vita

Elvi Marie Barcoma was born on November 9, 1986 in Chesapeake, Virginia. She graduated from Bayside High School in Virginia Beach, Virginia in 2004. She then attended the University of Virginia where she received a Bachelor of Science degree in Biology in 2008. Following her undergraduate studies, she went on to attend Virginia Commonwealth University's School of Dentistry and earned her Doctorate of Dental Surgery in 2013. She was accepted into the graduate orthodontic program at Virginia Commonwealth University and will receive a Certificate in Orthodontics in addition to a Master of Science in Dentistry degree in June of 2015. Upon graduation, she will enter private practice in northern Virginia.