2017

Investigating lip protrusion aesthetics by comparing the facial profile view with an oblique view

Barak Jones
Nova Southeastern University

NOVA SOUTHEASTERN UNIVERSITY

Health Professions Division
Department of Orthodontics
College of Dental Medicine

STUDENT NAME: Barak Troy Jones, D.D.S.

STUDENT E-MAIL ADDRESS: bj472@mynsu.nova.edu

STUDENT TELEPHONE NUMBER: 405-780-6140

COURSE DESCRIPTION: Master of Science in Dentistry with Specialization in Orthodontics

TITLE OF SUBMISSION: Investigating lip protrusion aesthetics by comparing the facial profile view with an oblique view

DATE SUBMITTED: 12/15/2017

I certify that I am the sole author of this thesis, and that any assistance I received in its preparation has been fully acknowledged and disclosed in the thesis. I have cited any sources from which I used ideas, data, or words, and labeled as quotations any directly quoted phrases or passages, as well as providing proper documentation and citations. This thesis was prepared by me, specifically for the M.Sc.D. degree and for this assignment.

STUDENT SIGNATURE:_____

Barak Troy Jones, D.D.S. Date

INVESTIGATING LIP PROTRUSION AESTHETICS BY COMPARING THE FACIAL PROFILE VIEW WITH AN OBLIQUE VIEW

A Thesis Presented

By

BARAK TROY JONES, D.D.S.

Submitted to the College of Dental Medicine of Nova Southeastern University in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

December 2017

INVESTIGATING LIP PROTRUSION AESTHETICS BY COMPARING THE FACIAL PROFILE VIEW WITH AN OBLIQUE VIEW

A Thesis Presented

By

BARAK TROY JONES, D.D.S.

Section of Orthodontics

College of Dental Medicine

Nova Southeastern University

December 2017

Approved as to style and content by:

APPROVED BY: _____
SERGIO REAL, D.D.S., M.S. (Committee Chair) Date

APPROVED BY: _____
Patrick Hardigan, B.S., M.S., Ph.D. (Committee Member) Date

APPROVED BY: _____
Marissa Cooper, D.M.D., M.S. (Committee Member) Date

APPROVED BY: _____
Linda C. Niessen, D.M.D., M.P.H. (Dean) Date

Dedication

I dedicate this thesis to my wife. She has been a constant source of support and love throughout this process. Her patience is unmatched and I could have no greater blessing than her constant companionship. Thank you for all you do. You make life wonderful.

Acknowledgements

So many people have made this thesis possible. I would like to make particular mention of a few outstanding individuals. First, my dear friend and mentor, Dr. Sergio Real, served as chair on my thesis committee. He reviewed my work and offered inspirational advice and guidance. His input motivated me to put in much more work and time into accomplishing and refining the project that stood before us. Second, Dr. Patrick Hardigan served on my committee. He served with unwavering patience. Every time I sought his advice and help he most kindly contributed. His contributions were critical to the success of this work. His expertise with the statistical aspects of this project proved invaluable. Third, Dr. Marissa Cooper offered significant support as a committee member. Thanks to her diligent review of the writings and processes needed to accomplish this work it now stands as the finished product that it is today. Her positive feedback aided in pushing this thesis forward, and for that I am so grateful. Last, I wish to thank my dear research assistants, Jaime Gonzales and Kathryn Champion. They did so much to lighten the load. They maintained a spirit of enthusiasm and energy while recruiting survey participants. I consider myself fortunate to have interacted with all the above mentioned individuals. To them and all others who lent support in this undertaking I sincerely offer my gratitude.

Abstract

INVESTIGATING LIP PROTRUSION AESTHETICS BY COMPARING THE FACIAL PROFILE VIEW WITH AN OBLIQUE VIEW

DEGREE DATE: DECEMBER 15, 2017

BARAK TROY JONES, D.D.S.
COLLEGE OF DENTAL MEDICINE NOVA SOUTHEASTERN UNIVERSITY

Thesis Directed By: Sergio Real, D.D.S., M.S., Committee Chair

Patrick Hardigan, B.S., M.S., Ph.D., Committee Member

Marissa Cooper, D.M.D., M.S., Committee Member

Introduction: Orthodontists strive to enhance facial esthetics. Notable orthodontists including Holdaway, Ricketts, Merrifield and more each made contributions to help diagnose facial disharmonies and improve treatment outcomes. Numerous studies have evaluated the face from two perspectives, frontal and profile. Orthodontic treatment can significantly transform a facial profile. Orthodontic literature has time and again compared photos, line drawings and silhouettes in order to define a harmonious profile. Some have concluded that a more protrusive lip profile than what had been outlined traditionally is now preferred. However, while this debate continues, in this dynamic world the profile perspective is not the most commonly encountered. Instead, the oblique view of the face most often dominates billboards, magazines, social media and human interactions.

Objective: This study aimed to evaluate facial esthetics from an oblique perspective and thereby discover the differences that lateral profile esthetics have with oblique view esthetics and to refine the idea of an ideal lip position by involving the oblique perspective.

Methods: This cross-sectional study included two human subjects, one male and one female. For the study, we photographed their faces with lips in repose from two angles: lateral profile and the

oblique three-quarter profile. We then morphed the images in Adobe Photoshop to create five variations of lip protrusion per each original image. The degree of lip protrusion was equivalently manipulated so the oblique profile image sets matched the lateral profile image sets. After randomizing the images within each set, we then included them in a digital survey and administered it to 425 individuals. Judges ranked images in each set from most to least preferred. Following data collection, statistical analysis was run to evaluate findings.

Results: From the oblique images of the female, judges preferred the lower lip 2 mm posterior to the E-plane. From the male oblique images, judges preferred (with no significant difference between the two) the lower lip at 4 mm and 6 mm posterior to the E-plane. From the lateral profile images, judges preferred the lower lip 4 mm posterior to the E-plane for the female and 6 mm posterior to the E-plane for the male.

Conclusion: The preferred degree of lip protrusion judged from the oblique perspective differed from the preferred lip protrusion seen in the profile. From the oblique perspective a more protrusive lip position tended to be preferred. However, protrusion of the lower lip beyond the E-plane was considered undesirable from all perspectives. The gender, race and age of the judges had no impact on the preference of lip protrusion.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

1.1 Background

Societies favor beautiful people.[1-7] Attractive children and adults receive more positive treatment than their unattractive peers, even in spite of close relations.[1] This sense seems to arrive early in life because even infants in their first weeks of life are drawn to more attractive faces.[6] Further investigation shows they who view themselves as attractive consequently enjoy a positive impact on their quality of life.[5,8-11] On the other hand, those with a disfigured appearance may often suffer from feelings of impotence, shame and anger.[5] These observations, among others, imply that there exist powerful reasons and advantages for people to obtain beauty.

Throughout the centuries scientists, artists and philosophers have explored ways to properly define beauty.[12] The early Egyptians and Greeks fortunately supplied artifacts documenting their efforts to idealize the human form.[13] From the Egyptians the carving of Queen Nefertiti stands as a timeless example of female beauty. From the Greeks, among other works, exist the creations of Polyclitus including the *Diadumenus* and the *Doryphoros*. His book, the *Canon,* discussed mathematical proportions for idealizing parts of the human body in relation to one another. Later, the Renaissance scattered across Europe, and then the world, esthetic ideals like those portrayed in Michelangelo's *David* and Leonardo's *Vitruvian Man*. Over the course of art history many canons of ideal proportions have been proposed with variations between each.[14]

1.2 The Perception of Beauty

From a scientific perspective proposals have come forward attempting to explain why and what elements endow an individual with beauty.[3,7,13,15-18] Some have used the golden proportion as a means of evaluating beauty.[19] Some have proposed that attractiveness is determined by the population mean. In other words, averageness equates to attractiveness.[18] This idea plays into a larger one that beauty is determined by biological and evolutionary pressures.[7]

Despite these explanations, the subjective nature of beauty cannot be overlooked. Reber et al.[16] generalized the explanations of beauty into three groups: the objectivists, the subjectivists and the interactionists. Objectivists base their stance on observations that beauty can be objectively manipulated through balance, proportion, symmetry, informational content, complexity, contrast and clarity. Subjectivists, on the other hand, cling more to the idea that anything could be beautiful if it pleases the senses. In other words, beauty is in the eyes of the beholder and taste cannot be debated. However, the interactionists take a more comprehensive perspective involving the other two. Concisely put, "beauty is grounded in the processing experiences of the perceiver that emerge from the interaction of stimulus properties and perceivers' cognitive and affective processes."[16] Beauty is based on processing fluency. As an observer more fluently processes an object, the object then receives a more positive aesthetic response. Many elements can influence this response including familiarity, and number of exposures.[16]

1.3 Facial Esthetics and the Lateral Facial Profile in Orthodontics

In the last two decades the demand for cosmetic procedures has exponentially increased and these trends predict that the demand will continue to rise.[20] Within the realm of the human body, no other feature holds more esthetic value than the face.[5,21] To improve facial attractiveness is the main reason people seek orthodontic treatment.[22] Orthodontists can significantly impact the esthetics of a face. Dr. Merrifield, a prominent orthodontist, said, "Maximum facial harmony, that is always the purpose of orthodontics."[23] Edward Angle, the father of modern orthodontics, observed that the mouth has a potent influence to make or mar the face, and he searched for harmonious relationships between the mouth and other parts of the face.[24] Many since then have gone to great lengths to aid clinicians in effectively establishing facial harmony.

Since the birth of modern orthodontics, special attention has been given to the lateral profile. Edward Angle preached the ideals from the facial profile of the Greek god Apollo as well as the idea of a "line of harmony" extending from the frontal and mental eminences and the

middle of the ala of the nose.[24] After Angle came Charles Tweed who established the "Diagnostic Facial Triangle" intended to equate tooth position with facial esthetics.[25] Later, Downs noted that those with optimum facial esthetics have in common certain profile characteristics.[26] Holdaway greatly contributed to the assessment of soft-tissue facial esthetics. He developed an analysis with eleven measurements including the "H-line".[4] Merrifield then modified the "H-line" and from that created the "Profile Line" which intersects the Frankfort horizontal plane and thereby reveals the now commonly utilized "Z-angle."[23] Along with the rest of these developments, in the 1960s Dr. Robert M. Ricketts published a description about principles of lip esthetics.[27] In that paper he explained the concept of the E-plane. He describes it simply as a tangential line drawn from the nose to the chin to assist in the description of mouth relations to adjacent structures. For adults the lower lip position on average fell about 4 mm posterior to the line with a standard deviation of + or – 3 mm. From Dr. Ricketts' efforts he formulated what he coined the "law of lip relationship". This law states the following: "In the normal white person at maturity, the lips are contained within a line from the nose to the chin, the outlines of the lips are smooth in contour, the upper lip is slightly posterior to the lower lip when related to that line and the mouth can be closed with no strain."

In order to properly serve society, orthodontists strive to improve their understanding and abilities. Some in the literature claim that current society does not agree with the previously mentioned standards of orthodontics regarding lip protrusion.[28] They claim that western civilization's perception of facial esthetics may have evolved over the decades to a more protrusive lip preference.[13,29] However, others declare such claims as "myths of western culture".[12] To meet Ricketts' and others' standards of lip position, oftentimes orthodontic therapy requires the extraction of teeth, usually four premolars. If a more protrusive profile is indeed preferred, then the frequency of treatment requiring extractions could diminish and the level of posterior tooth anchorage would less often be so critical. Consequently, it is imperative to

reassess the esthetic goals of orthodontics because maybe, like with Charles Darwin's finches, evolution has occurred.

1.4 The Oblique Facial Profile

Publications abound with studies that assess lip position and the lateral profile view.[23,28,30-41] But this is only one perspective of the profile and it is not the most familiar to the public. Arnett and Bergman argued that orthodontists often rely too heavily on the anterior to posterior dimensions of the face and stated that complete analysis requires incorporation of vertical and transverse assessment of facial needs.[42] If a prototypical standard of a good profile actually exists, it would be most useful if it held its beauty in the more commonly seen perspectives. However, few have investigated how lateral profile standards impact facial esthetics from an oblique facial profile view.[43,44] The oblique profile aids clinicians by reflecting how a person sees himself and how the lay observer may see the person.[45] The oblique view combines both the profile and frontal information into one visual image and thereby makes it a more familiar and comprehensive perspective by including the transverse, vertical and sagittal dimensions of the face.

Speaking of the oblique view, Sarver referred to it as the view that most accurately reflects the way the patients are seen by others.[45] On social media, in movies and advertisements the oblique view of the face dominates over the profile or facial views. Shortly after Ricketts' publication of the E-plane and the law of the lip, Peck and Peck observed that the public did not seem to agree with the cephalometric norms prescribed by orthodontists. Instead, they observed the general public admired "a fuller, more protrusive dentofacial pattern than customary cephalometric standards would like to permit."[13] Interestingly, in that study the general public had assessed these person's from a dynamic live appearance and not just a static lateral profile photograph. Only after the public gave their stamp of approval did the investigators evaluate the lateral profile. In addition, Riedel[46] noted a similar finding in his study in which he investigated

the profile of female Hollywood stars. When the profiles were evaluated by orthodontists they were found to be "fair" at best and most were considered to be, again, more "protrusive" than what the orthodontists considered ideal.[46] Because the oblique view most often appears before the public eye, it follows that this view may most acutely lend itself to public evaluation. From this view, the discernment of the public may be enhanced due to their familiarity and fluency in evaluating this more common view of the face. It may be that preferences of lip protrusion from this perspective may differ from the standard to which orthodontists have historically been taught. If that is the case, then a new or refined standard should emerge that might not be the most enticing from the profile but, instead, compliments the face from a more holistic point of view. Such measures could then enhance treatment goals which would consequently enhance treatment results and, in some situations, reduce the need for more aggressive treatment modalities.

1.5 Purpose and Specific Aims

The purpose of this study was to evaluate facial esthetics from an oblique perspective and thereby discover the differences that lateral profile esthetics have with oblique view esthetics and to refine the idea of an ideal lip position by involving the oblique perspective.

.

The specific aims of this study consist of the following:

1. To determine the preferred lateral facial profile lip position and preferred oblique facial profile lip position based on rank order.
2. To determine if there is a difference between the rankings of the lateral facial profile lip positions and the rankings of the oblique facial profile lip positions.
3. To determine if there is an association between judges' gender and the rank order esthetic preference for images of lateral view and oblique view.

1.6 Location of Study

The design preparation and completion of the study took place at:

Nova Southeastern University Health Professions Division

3200 South University Drive

Davie, Florida 33328

Chapter 2: Materials and Methods

For this study, prior to recruiting models, a pilot study was performed to ensure an effective method of acquiring and manipulating images. The pilot study helped in developing the methods described below.

2.1 Photographed Subjects

One man and one woman, were selected from the Nova Southeastern College of Dental Medicine as the subjects included in the study. These subjects met specific criteria. They were Caucasian and within the range of twenty to thirty years old. They fell within the normal range of current standards of facial proportions of the nose and the chin with a class I orthognathic profile. The chins were near tangential to the Meridian zero degree.[47] Nose proportions complied with current standards outlined by Dr. Lines et al.[34] Any obvious facial deformities would have excluded volunteers from being subjects in the study. Prior to selecting models, the Institutional Review Board of Nova Southeastern University gave IRB approval to conduct the study.

2.2 Acquisition of Photos

Following informed consent, the subjects posed for four photographs: two lateral profiles with lips at rest and two oblique profiles with the lips at rest. In one photo from each perspective the subjects wore a plastic headband with a ruler attached to it by an acrylic mount. Subjects wore the ruler parallel the Frankfort horizontal plane and positioned directly over the subjects' midsagittal plane. The ruler accounted for the foreshortening that occurs to the lateral profile when viewed from the oblique. It, thereby, calibrated the images so that manipulation of lip protrusion remained equal between the two perspectives. The photographs without the rulers helped allow proper removal of the ruler from the final images by methods of copying, pasting and blending.

The raw photos were transferred to Adobe Photoshop CS6 software and de-identified by superimposing different eyes over the originals. The region masked with new eyes included the globe of the eye and the upper and lower eyelids. A soft eraser tool blended the new eyes with the original photos.

Following de-identification, the photos were then edited in the area of interest. Five variations in lip protrusion of two millimeter increments came from both the lateral and oblique profile views because groups of five can be evaluated without fatiguing the evaluators.[48] The resultant images were included in a digital survey that instructed judges to rank each group of images from 1 to 5. 1 indicated most preferred and 5 indicated least preferred.

The area of image manipulation extended from the inferior border of the nose, soft tissue subnasale, to the most recessed point superior to the chin and inferior to the lower lip, soft tissue B point. Those two points, subnasale and B point, remained unaltered but the region between them was selected and advanced or retracted incrementally according to the millimeter readings of the ruler in the photo. The reference point for the midsaggital plane of all images was the vermillion border of the upper lip right at the middle of the philtrum. The advanced or retracted soft tissue surrounding the lips was sheared back to the original subnasale and B point. A soft brush eraser was used to blend the copied image with the original. Five variations of lip position came from this method and were saved as separate jpegs. This helped maintain consistency across images of both male and female, both perspectives (lateral and oblique), and across images within each series.

The magnitude of incremental labial change in the lateral profile images was made to exactly conform to that of the oblique profile images. This was done by mounting a millimeter ruler horizontally over the subjects' midsagittal plane. For both perspectives the camera captured images while set on a tripod at uniform height, distance, image quality, F stop, ISO, flash, and zoom to maintain equality between images. When the subjects positioned for the oblique image, the profile features become foreshortened. At the same time, the ruler in that image also became

equally foreshortened while maintaining its relation to the photographed person. This mounting to the head method allowed accurate image calibration so that two-millimeter manipulations of the sagittal plane of space were the same in both perspectives.

The Frankfort horizontal plane determined the horizontal position of the head. The lips marked the vertical level at which the center of the camera was set. The entire head remained within the confines of each image to allow a complete evaluation of the lips in relation to the rest of the head. The tragus of the ear indicated the middle of the image for the profile photo and the inferior border of the rim of the orbit of the right eye indicated the center of the oblique image after image cropping.

2.3 Sample

Participants took the survey at the Nova Southeastern University campus. By meeting the following criteria volunteers could participate in this study:

(1) Able to read and speak English.

(2) Capable of completing computer displayed 5-10 minute survey.

(3) Within the age range of eighteen years or older.

The pool of people surveyed were recruited on NSU campus. Specifically, in the Assembly Building and the HPD Library and Laboratory Building. A booth was set up in the first floor atrium from 11 a.m. to 1 p.m. Monday through Friday. As people passed by they were invited to participate in the survey. The theoretical population of this study to which results can be generalized is persons who frequent the NSU Health Professions Division on campus. There were many reasons for selecting this population. It was an accessible population that made the collection of data convenient and feasible. It was assumed that the majority of this population had the intellectual capacity to successfully complete the survey. The population contained an equal balance of both females and males. Many of the students there will likely become leaders in the community as employers or by fulfilling other special roles. This population was at the age of

sexual maturity when physical attractiveness plays an impactful role in decision making for dating, courtship and marriage. The sampling was done by inviting students passing by to participate in a short survey and get a five-dollar gift card. Participants used laptop computers to take the survey and record their answers. Exclusion criteria consisted of anyone that had orthodontic training or, in other words, had already completed their first year of dental school. At Nova Southeastern University School of Dentistry, orthodontic training is introduced during the second year of dental education.

2.4 Survey Administration

Prior to starting the survey, participating volunteers were assessed to see if they met all the criteria demanded for the study. Participants completed the survey via laptop computers in one sitting. The principal investigator or a research assistant stood nearby in case a participant needed to ask clarifying questions. Instructions were provided in English. In most cases, the survey took between three to five minutes to complete. All survey responses were de-identified and stored on a secured cloud-based site provided by REDCap. The survey consisted of questions to gather demographic information. This information was used to establish ethnicity, age and gender of the participants. Following demographic questions, further questioning had the participants rank the sets of oblique images 1 to 5 based on most desirable to least desirable facial appearance. After ranking oblique images, participants then ranked the profile images. They submitted responses on each page and could not return to previous pages to change answers. Those who took the survey received a five-dollar Target gift card as compensation for participating. Four surveys were incomplete and not included in the final results. The survey format and questions were based off a previous study of similar design and subject matter.[39]

2.5 Handling of Gift Cards

Participants who completed the survey were awarded a gift card and then signed a printed-out spreadsheet to confirm that they had received a gift card. Survey administration and data collection terminated when all gift cards had been awarded. The spreadsheet remained in possession of the principal investigator as evidence that gift card distribution had occurred appropriately.

2.6 Statistical Analysis

For each set of images a mixed, general linear model was created to test for differences in rankings for the five images. The fixed factors were subject's age (continuous), gender of judges (male vs female), ethnicity (Asian vs Black vs Latin vs White vs Other) and image (+2 mm vs 0 mm vs -2 mm vs -4 mm vs -6 mm). The random effect was subject. Pairwise comparisons were performed using a Satterthwaite adjustment.

2.7 Sample Size and Power

The sample size calculations were based on Cochran's formula developed for categorical outcomes. First calculate the baseline sample size and then adjust for response rate:

$$N_0 = \frac{(t)^2 (p)(q)}{(d)^2} = \frac{(1.96)^2 (.50)(.50)}{(.05)^2} = 384$$

$$N_1 = \frac{N_0}{R} = \frac{384}{.95} = 405$$

Where:

t	=	Is the alpha (Type I error). In our proposal we used 0.025 in each tail or 1.96.
(p)(q)	=	Is the variance estimate. To maximize this potential we used 0.50 for both p and q.
d	=	Is the acceptable margin of error. We used .05 as our standard.
N_o	=	Is our baseline sample size.
N_1	=	Is our response-rate adjusted sample size.
R	=	Is estimated response rate. We adjust the baseline sample by 95% because this was a method study.

Therefore, the minimum number of participants needed was 405. However, this goal was exceeded with a final sample size of 421.

2.8 Limitations

Digital manipulation may not have sufficiently reflected real life appearance of the soft tissue. Also, the demographics of people polled and their background could have influenced how they prefer features of a Caucasian subject. For that reason, the survey included inquiry of participants' race. Also, the generalizability of the results is limited to the theoretical population which is persons who attend the NSU HPD building including students, staff, faculty and visitors to NSU.

2.9 Instrumentation

Level of measurements – Categorical

Softwares – Adobe Photoshop CS6 and REDCap application

Camera – Nikon D7100 with AF-S Micro KIKKOR 85mm 1:3.5G ED lenses.

Chapter 3: Results

425 judges participated in the survey. Four of the surveys were found incomplete leaving a final sample size of 421. 304 females and 117 males completed the survey.

All four sets of images separately went through a mixed, general linear model created to test for differences in rankings for the five images. The fixed factors or independent variables were subject's age (continuous), gender (male vs female), ethnicity (Asian vs Black vs Latin vs White vs Other) and image (2 mm vs 0 mm vs -2 mm vs -4 mm vs -6 mm). The random effect in each set was subject. Pairwise comparisons were performed using a Satterthwaite adjustment.

The measurements describing morphed images in the following sections are in millimeters relative to the E-plane described by Ricketts. "0" indicates lower lip on the E-plane and "+" indicates anterior to the plane while "-" indicates posterior to the plane.

3.1 Set 1 Results for the Female Oblique Profile Images

Based on the averages of the rank order, the most preferred image determined by the judges was the -2 mm for the female oblique profile morphs. 0mm was second most preferred. +2 mm, -4 mm and -6 mm were all not significantly different from each other and were the least preferred images of the female oblique profile view.

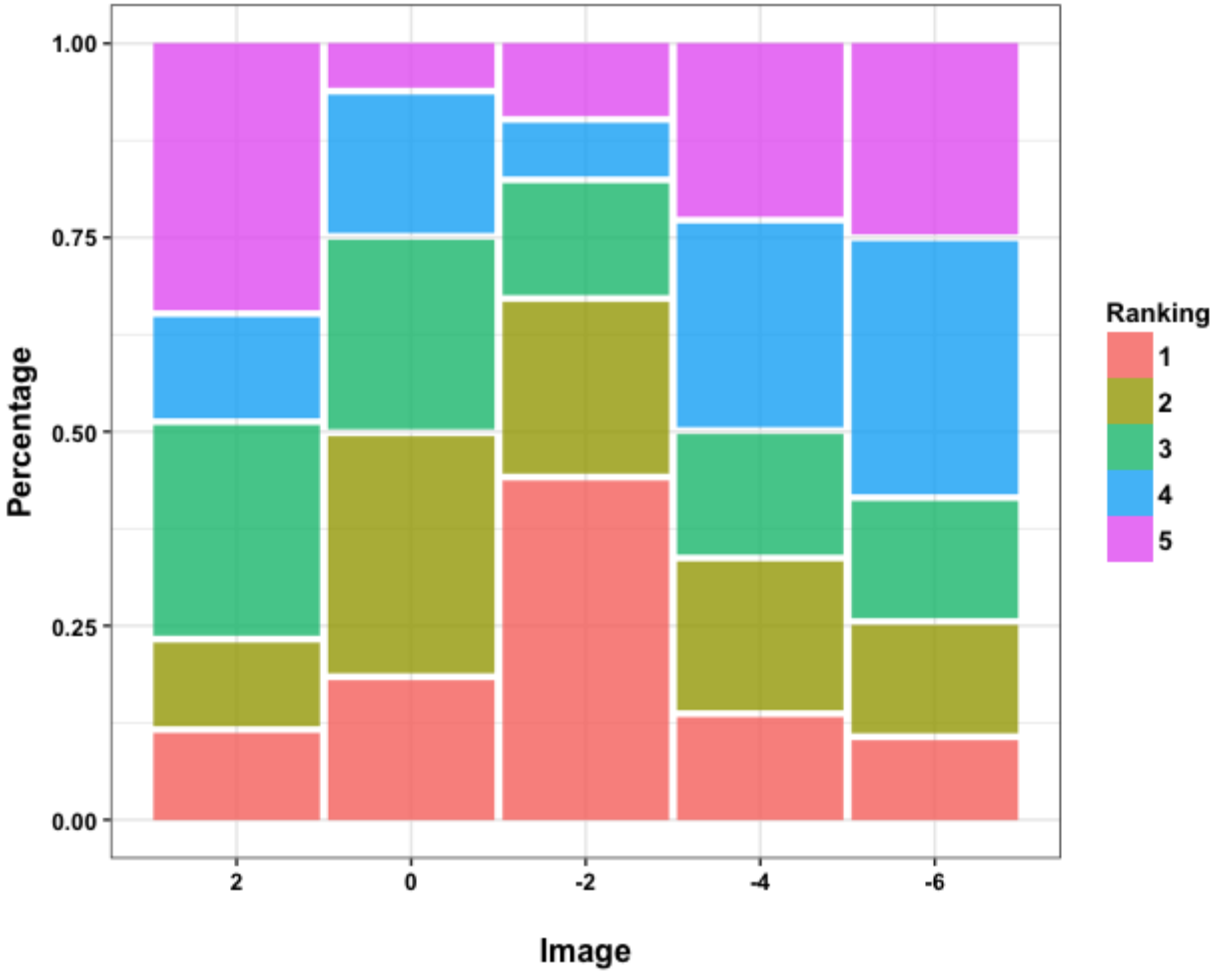
Descriptive statistics are presented in APPENDIX F in Table 1 and Figure 1. There was no statistically significant age effect—C^2 (1, N= 2125) = 0.001, p = 0.999. There was no statistically significant gender effect—C^2 (1, N= 2125) = 0.001, p = 0. 999. There was no statistically significant ethnicity effect—C^2 (1, N= 2125) = 0.001, p = 0. 999. There was a statistically significant image effect—C^2 (1, N= 2125) = 354.960, $p < 0.001$. Fifteen-percent of the variability in image was accounted for by the random effect or subject. Pairwise comparisons are presented in APPENDIX G in Table 1.

Table 3.1: Ranking comparisons for Female Oblique Profile

Image	LS Mean	Lower 95% CI	Upper 95% CI	Group
-2	2.13	2.00	2.27	A
0	2.61	2.48	2.75	B
-4	3.26	3.13	3.40	C
-6	3.48	3.35	3.62	C
2	3.51	3.37	3.64	C

- *Groups not connected by the same letter are significantly different, $p < 0.05$*

Figure 3.1: Mosaic plot of rankings by image for Female Oblique Profile



3.2 Set 2 Results for the Male Oblique Profile Images

Based on the averages of the rank order, the most preferred image determined by the judges was the -4 mm and -6 mm for the male oblique profile morphs. -4 mm and -2 mm were second most preferred. 0 mm and +2 mm were second to least preferred and least preferred, respectively.

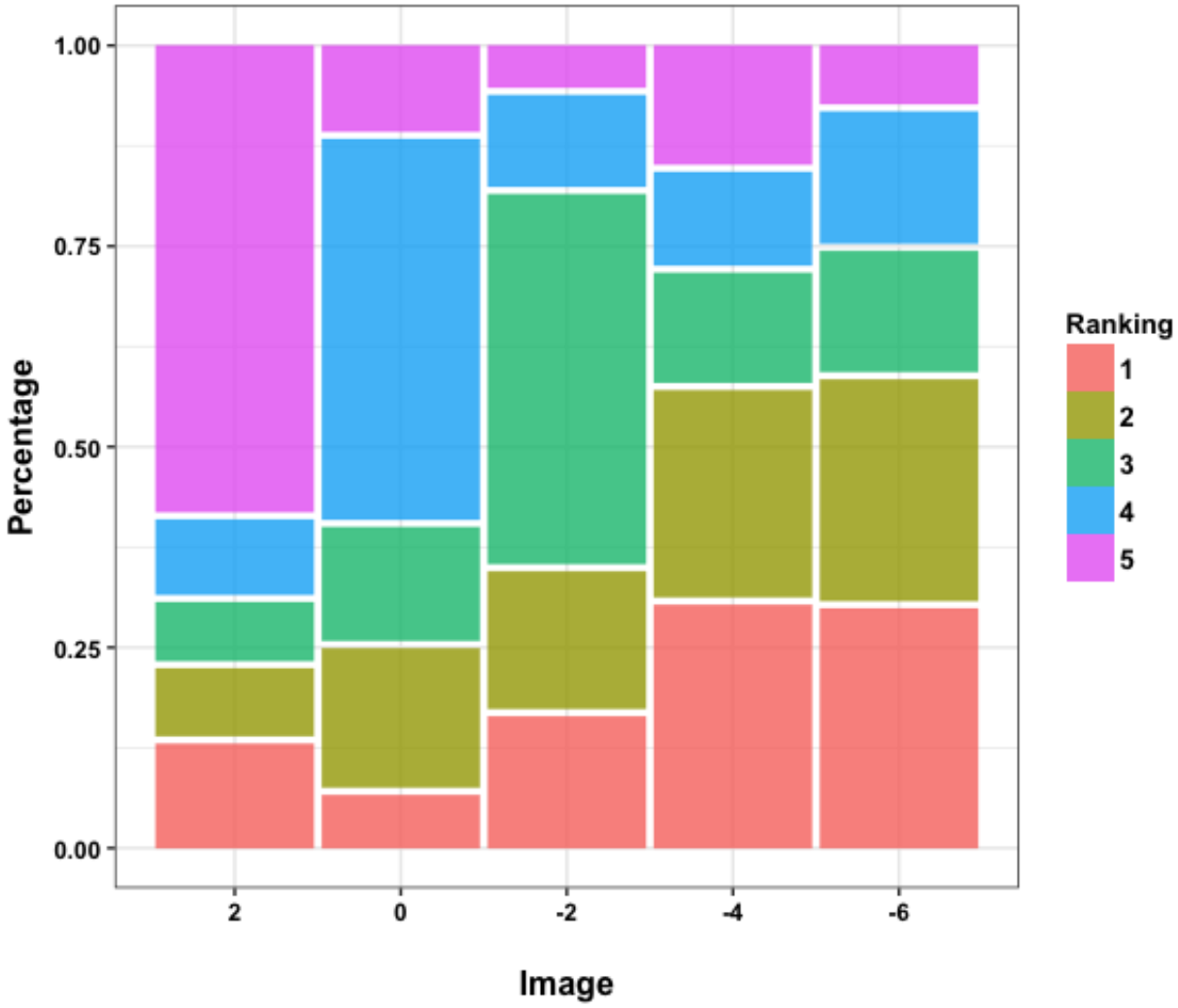
Descriptive statistics are presented in APPENDIX F in Table 2 and Figure 2. There was no statistically significant age effect—C^2 (1, N= 2125) = 0.001, p = 0.999. There was no statistically significant gender effect—C^2 (1, N= 2125) = 0.001, p = 0. 999. There was no statistically significant ethnicity effect—C^2 (1, N= 2125) = 0.001, p = 0. 999. There was a statistically significant image effect—C^2 (1, N= 2125) = 428.240, $p < 0.001$. Seventeen-percent of the variability in image was accounted for by the random effect or subject. Pairwise comparisons are presented in APPENDIX G in Table 2.

Table 3.2: Ranking comparisons for Male Oblique Profile

Image	LS Mean	Lower 95% CI	Upper 95% CI	Group
-6	2.41	2.27	2.54	A
-4	2.53	2.39	2.66	AB
-2	2.72	2.58	2.85	B
0	3.39	3.26	3.53	C
2	3.95	3.82	4.09	D

- *Groups not connected by the same letter are significantly different, $p < 0.05$*

Figure 3.2: Mosaic plot of rankings by image for Male Oblique Profile



3.3 Set 3 Results for the Female Lateral Profile Images

Based on the rank order averages, the female profile was considered best at -4 mm. -6 mm was second although not significantly different from 0 mm. In turn, 0mm was not statistically significantly better than -2 mm. +2 mm was least preferred

Descriptive statistics are presented in APPENDIX F in Table 3 and Figure 3. There was no statistically significant age effect—C^2 (1, N= 2125) = 0.001, p = 0.999. There was no statistically significant gender effect—C^2 (1, N= 2125) = 0.001, p = 0. 999. There was no statistically significant ethnicity effect—C^2 (1, N= 2125) = 0.001, p = 0. 999. There was a statistically significant image effect—C^2 (1, N= 2125) = 323.600, $p < 0.001$. Fourteen-percent of the variability in image was accounted for by the random effect or subject. Pairwise comparisons are presented in APPENDIX G in Table 3.

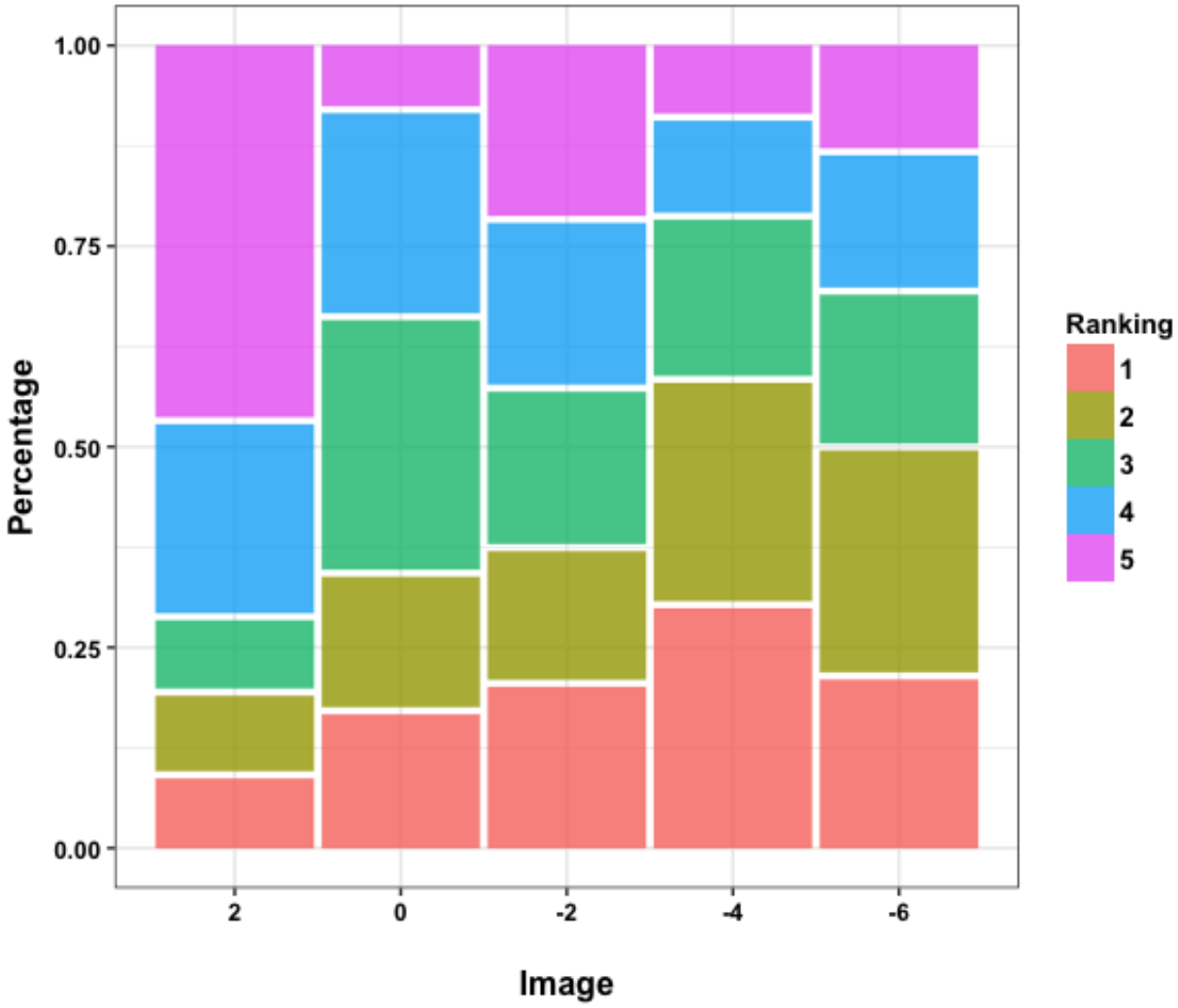
.

Table 3.3: Ranking comparisons for Female Lateral Profile

Image	LS Mean	Lower 95% CI	Upper 95% CI	Group
-4	2.38	2.24	2.52	A
-6	2.71	2.57	2.85	B
0	2.91	2.77	3.04	BC
-2	3.07	2.93	3.20	C
2	3.93	3.80	4.07	D

- *Groups not connected by the same letter are significantly different, $p < 0.05$*

Figure 3.3: Mosaic plot of rankings by image for Female Lateral Profile



3.4 Set 4 Results for the Male Lateral Profile Images

Based on the rank order averages, the male profile was considered best at -6 mm. -4 mm was second most preferred followed by -2 mm. +2 mm, anterior to the E-plane, was least preferred.

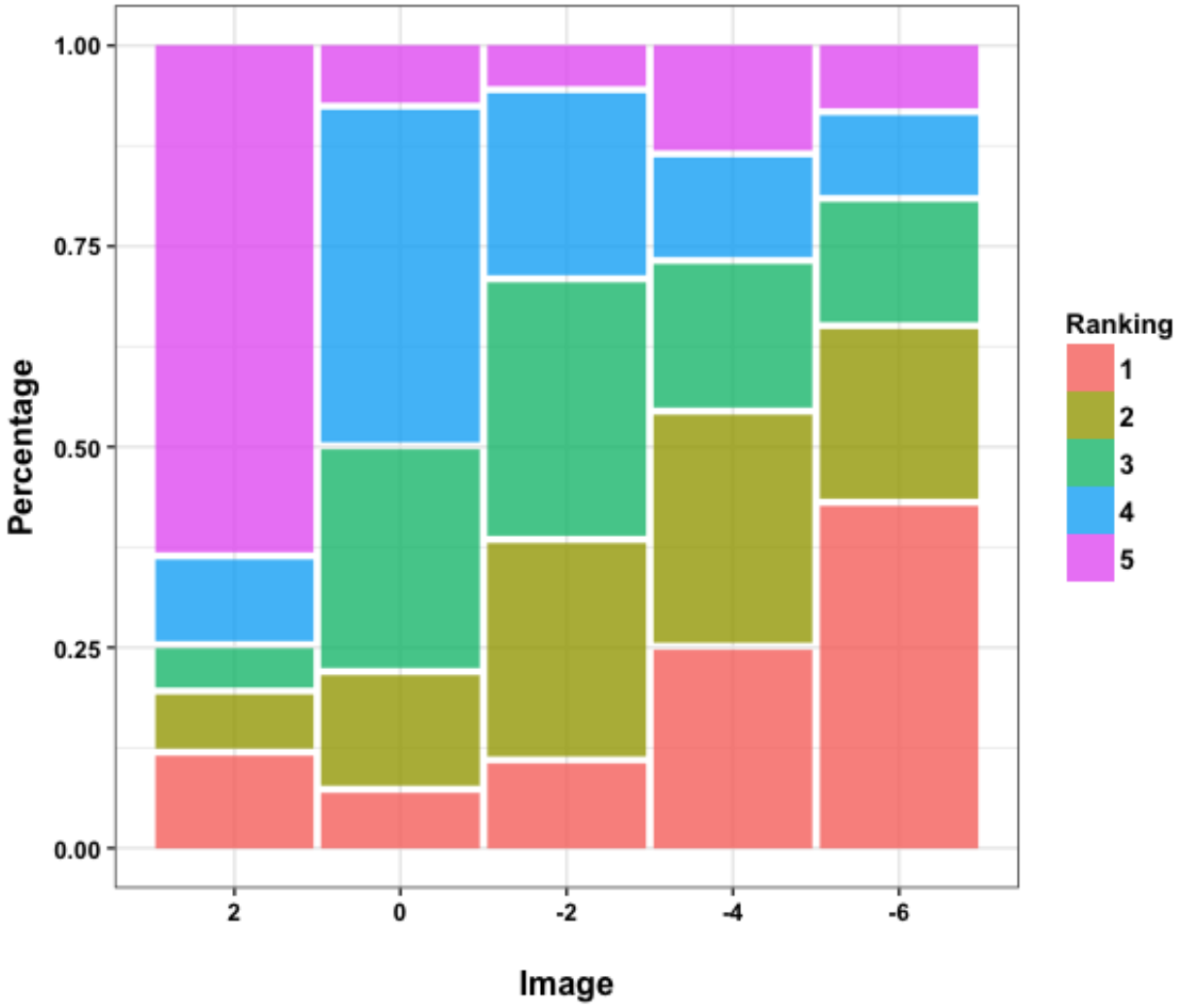
Descriptive statistics are presented APPENDIX F in Table 4 and Figure 4. There was no statistically significant age effect—C^2 (1, N= 2125) = 0.001, p = 0.999. There was no statistically significant gender effect—C^2 (1, N= 2125) = 0.001, p = 0. 999. There was no statistically significant ethnicity effect—C^2 (1, N= 2125) = 0.001, p = 0. 999. There was a statistically significant image effect—C^2 (1, N= 2125) = 577.746, $p < 0.001$. Twenty-two percent of the variability in image was accounted for by the random effect or subject. Pairwise comparisons are presented in APPENDIX G in Table 4.

Table 3.4: Ranking comparisons for Male Lateral Profile

Image	LS Mean	Lower 95% CI	Upper 95% CI	Group
-6	2.16	2.03	2.29	A
-4	2.60	2.46	2.73	B
-2	2.84	2.71	2.97	C
0	3.30	3.17	3.43	D
2	4.10	3.97	4.23	E

- *Groups not connected by the same letter are significantly different, $p < 0.05$*

Figure 3.4: Mosaic plot of rankings by image for Male Lateral Profile



Chapter 4: Discussion

The purpose of this study was to evaluate facial esthetics from an oblique perspective and thereby discover the differences that lateral profile esthetics have with oblique view esthetics and to refine the idea of an ideal lip position by involving the oblique perspective. Subjects who posed for the photographs were evaluated from two distinct perspectives, the lateral profile and the forty-five degree oblique profile. Lip protrusion was manipulated in the anterior posterior dimension, and judges ranked the images based on preference. While moving from the lateral perspective to the oblique, certain reference points are lost. The negative space created by the nasolabial angel, sulcus depths and mentolabial folds cannot be recognized as readily from the oblique. With the loss of these landmarks, among other possible factors, perception of the facial esthetics from the two views may allow variation in interpretation. This may have influenced the esthetic evaluation of the faces allowing greater preference for a more protrusive lip posture from the oblique perspective.

4.1 Specific Aim 1: To determine the preferred lateral facial profile lip position and preferred oblique facial profile lip position based on rank order.

The results of this study show that the preferred lateral facial profile lip position for the Female was 4 mm posterior to the E-plane. The preferred lateral facial profile lip position for the male was 6 mm posterior to the E-plane. These findings agree with those of Ricketts in which he stated that a fuller profile is generally preferred more in females.[27] He also found the mean for adults to be 4 mm posterior to the E-plane with a standard deviation of + or – 3 mm.[27] Both the preferred male and the female lateral profiles fell within this range. Hier et al.[28] and Lines et al.[34] also showed a similar finding in which the sex differences in profile preference favored in males a more prominent chin and nose in relation to lip protrusion. However, the present study has the disadvantage that the interlabial relationship between the male and female models were different. For the female, the lower lip showed more horizontal prominence than the upper lip. For the

male, this interlabial relationship was just the opposite. This relationship may in part explain the differences in ranking that the male model and female model received.

From the oblique profile perspective the preferred degree of lip protrusion was 2 mm posterior to the E-plane for the female. For the male there was no difference in preference between 4 mm and 6 mm posterior to the E-plane.

4.2 Specific Aim 2: To determine if there is a difference between the rankings of the lateral facial profile lip positions and the rankings of the oblique facial profile lip positions.

Although, the shift from lateral to oblique appeared to favor a more protrusive position, the male and female both still fell within the standard advocated by Ricketts. However, this shift of preference may shed light onto why Peck and Peck[13] and Riedel[46] found that many celebrities had fuller profiles than what was considered ideal. Perhaps the oblique perspective holds more esthetic value than the lateral profile.

James showed that with the extraction of premolars in Caucasians the lips can retract on average over 3 mm.[25] The findings from the present study would indicate that caution should be taken not to overly retract the lips to reach a lateral profile standard and thereby risk sacrificing the esthetics from the oblique perspective. However, if lips of Caucasian patients protrude beyond the E-plane, retraction of incisors would be indicated to improve the esthetics of the face.

4.3 Specific Aim 3: To determine if there is an association between judges' gender and the rank order esthetic preference for images of lateral view and oblique view.

Age, gender, and ethnicity had no effect on the rank order of the images. However the lip position manipulations did have a significant influence on the assigned rankings of the images.

These findings agree with Little and Langlois in that there is a high agreement between individuals from different cultures.[1,15] These findings disagree with Hier et al.[28] who showed that

female judges preferred more protrusive lips than did male judges. However, in that study smaller increments of lip manipulation were evaluated.

4.4 Limitations and Future Studies

With computer simulation there is the limitation of not being able to verify that the simulation represents accurate changes in the surrounding soft tissue when lip position is altered. Convenience sampling was used to recruit judges. This method of sampling may have introduced bias. The subjects of the photos were only Caucasian and therefore results are limited in their ability to apply to various ethnic groups. The study's theoretical population is limited to the Nova Southeastern University attendees.

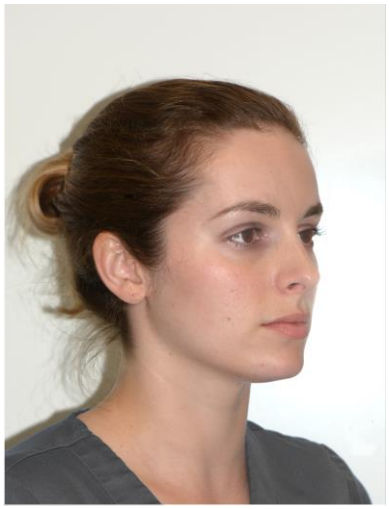
Future studies could include 3D models with lips manipulated to varying degrees to allow a comprehensive three-dimensional assessment of the facial esthetics. This could soon be possible with the rapidly growing development and availability of 3D cameras, software, and printers.

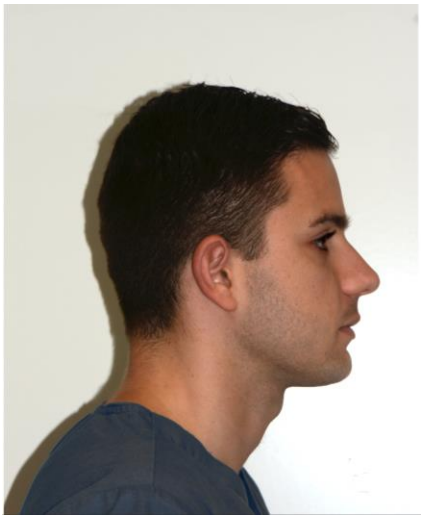
4.5 Conclusions:

The following conclusions can be drawn from this study. The evidence suggests that as the view of faces change from a lateral perspective to a more oblique perspective, observers tended to prefer a more protrusive lip posture than what they preferred in the lateral profile. However, in all cases once the lips crossed the E-plane the results suggest this negatively impacted the esthetic ranking. Gender, ethnicity and age of the evaluators had no impact on the rankings of the various images. Lateral profile rank order of esthetic preference of lip position was different from the oblique profile rank order of esthetic preference.

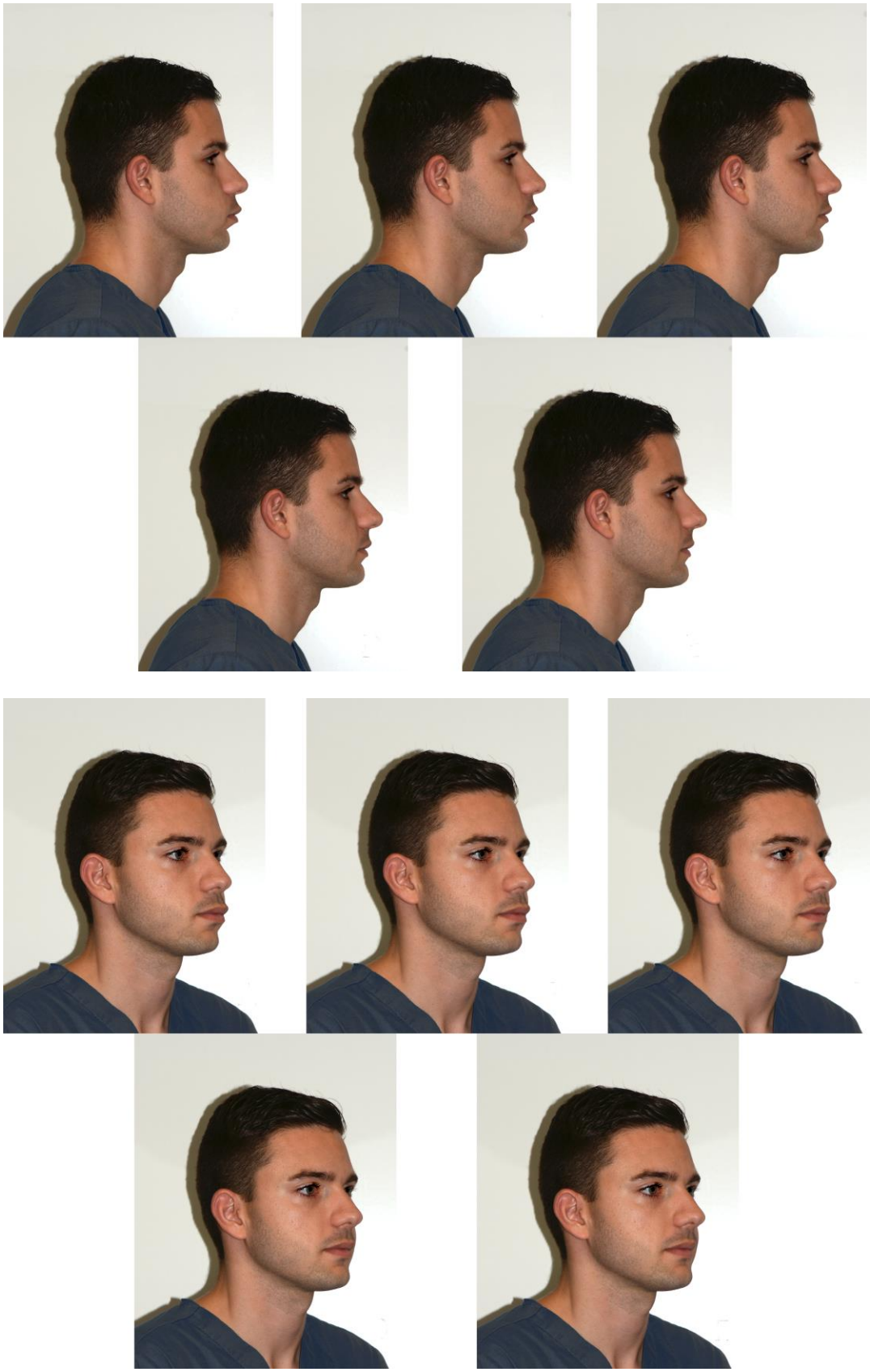
Appendices:

APPENDIX A: Female and Male Lateral and Oblique Profile Images Prior to Lip Manipulation





APPENDIX B: Morphed Female Lateral and Oblique Profile and Male Lateral and Oblique Profile Images



APPENDIX C: Survey

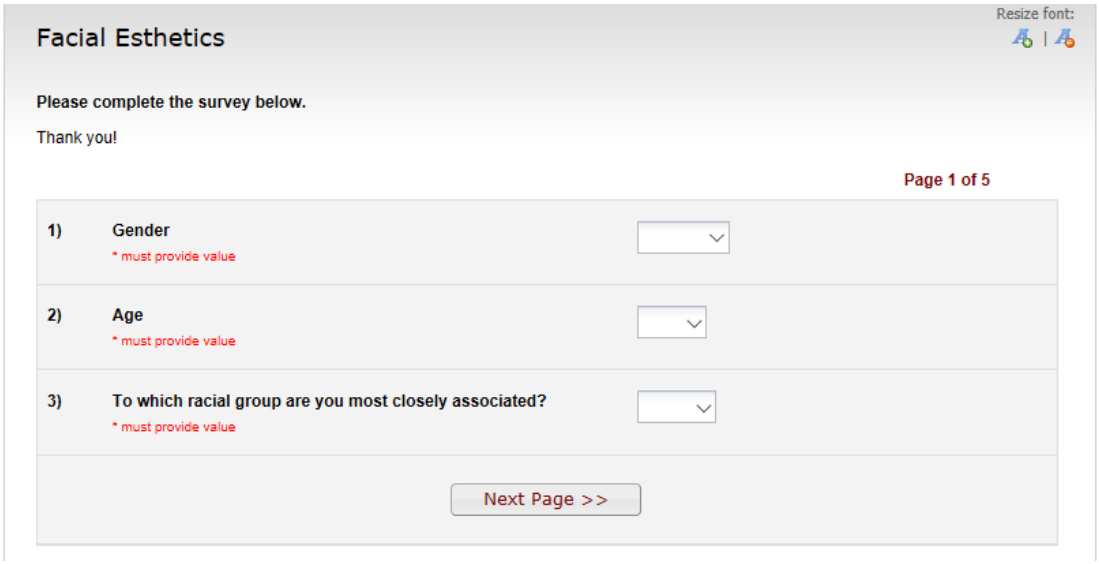


Image set 1

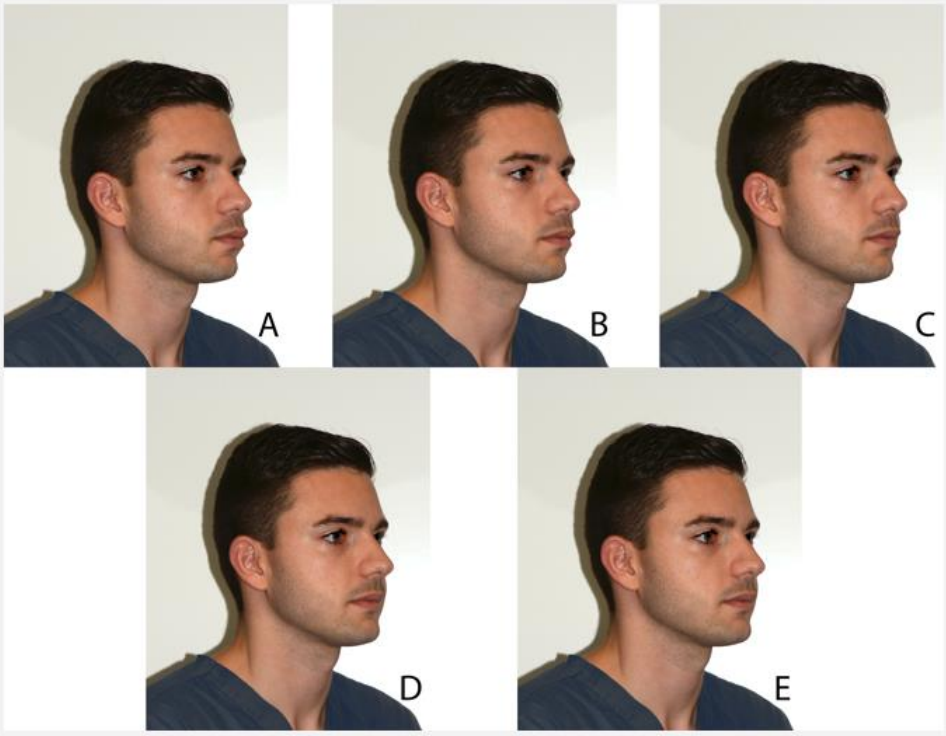
Please rank the following facial images in order of most preferred (1) facial appearance to least preferred (5). After ranking the set of images click "Next Page" to go to the next set. Do this for all sets of images. Please complete this survey in one sitting and complete it only once. Thank you.

	(One selection allowed per column)	1	2	3	4	5	
4)	A * must provide value	○	○	○	○	○	reset
5)	B * must provide value	○	○	○	○	○	reset
6)	C * must provide value	○	○	○	○	○	reset
7)	D * must provide value	○	○	○	○	○	reset
8)	E * must provide value	○	○	○	○	○	reset

Next Page >>

Image set 2

Please rank the following facial images in order of most preferred (1) facial appearance to least preferred (5). After ranking the set of images click "Next Page" to go to the next set. Do this for all sets of images. Please complete this survey in one sitting and complete it only once. Thank you.

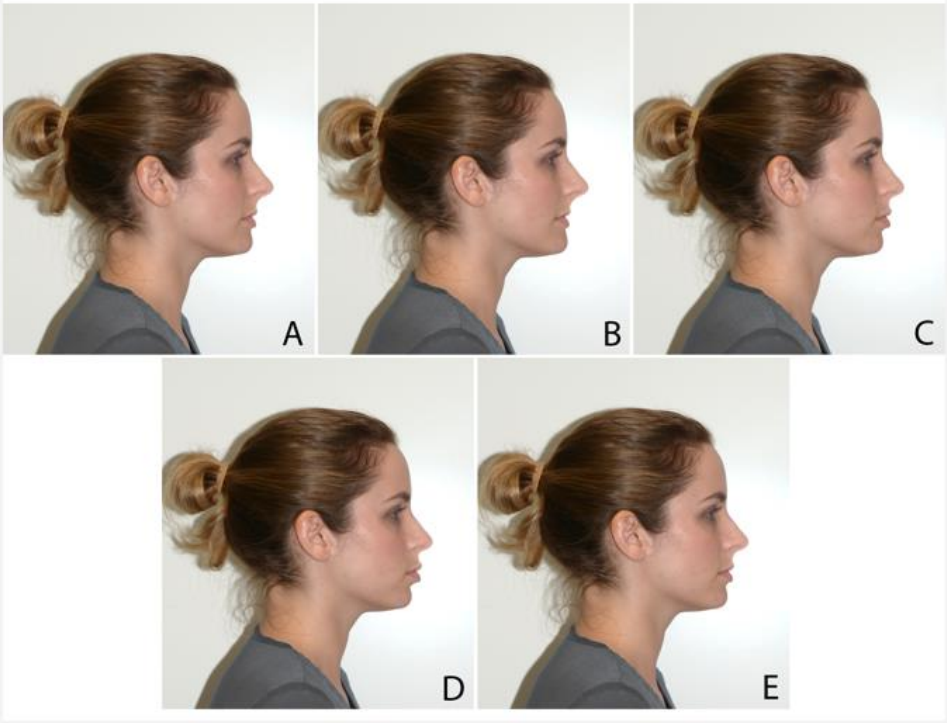


	(One selection allowed per column)	1	2	3	4	5	
4)	A * must provide value	○	○	○	○	○	reset
5)	B * must provide value	○	○	○	○	○	reset
6)	C * must provide value	○	○	○	○	○	reset
7)	D * must provide value	○	○	○	○	○	reset
8)	E * must provide value	○	○	○	○	○	reset

Next Page >>

Image set 3

Please rank the following facial images in order of most preferred (1) facial appearance to least preferred (5). After ranking the set of images click "Next Page" to go to the next set. Do this for all sets of images. Please complete this survey in one sitting and complete it only once. Thank you.

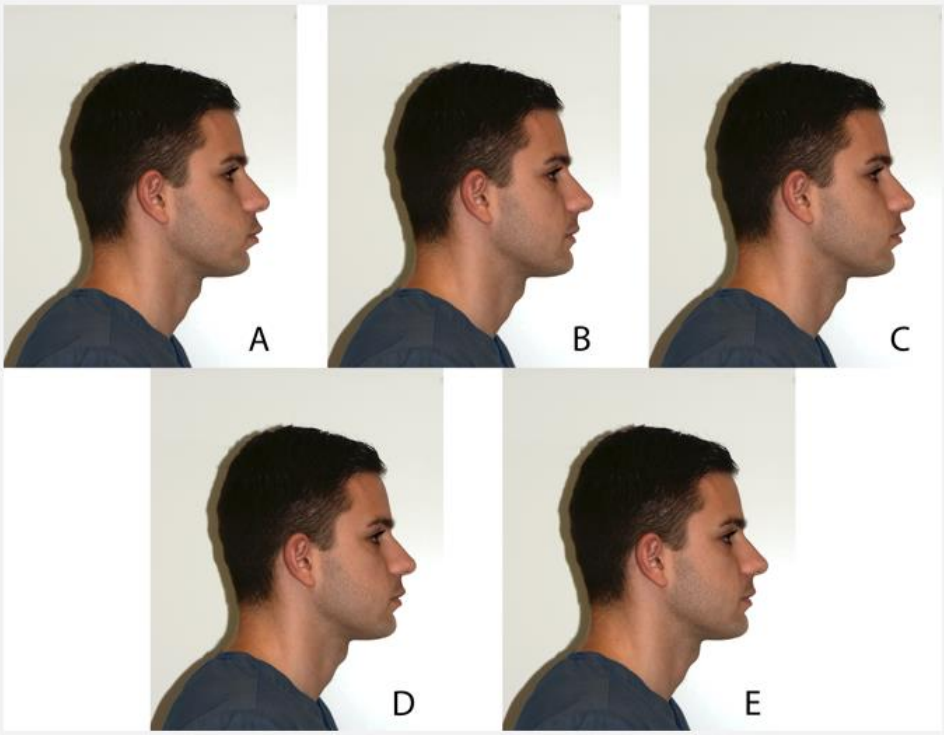


	(One selection allowed per column)	1	2	3	4	5	
4)	A * must provide value	○	○	○	○	○	reset
5)	B * must provide value	○	○	○	○	○	reset
6)	C * must provide value	○	○	○	○	○	reset
7)	D * must provide value	○	○	○	○	○	reset
8)	E * must provide value	○	○	○	○	○	reset

Next Page >>

Image set 4

Please rank the following facial images in order of most preferred (1) facial appearance to least preferred (5). After ranking the set of images click "Next Page" to go to the next set. Do this for all sets of images. Please complete this survey in one sitting and complete it only once. Thank you.



	(One selection allowed per column)	1	2	3	4	5	
4)	A * must provide value	○	○	○	○	○	reset
5)	B * must provide value	○	○	○	○	○	reset
6)	C * must provide value	○	○	○	○	○	reset
7)	D * must provide value	○	○	○	○	○	reset
8)	E * must provide value	○	○	○	○	○	reset

Next Page >>

Close survey

Thank you for taking the survey. Please inform survey administrator you have completed the survey.

Have a nice day!

APPENDIX D: Consent Form for Models

Consent Form for Participation in the Research Study Entitled
Investigating lip protrusion aesthetics by comparing the facial profile view with an oblique view

Funding Source: HPD Research Committee

IRB protocol #:

Principal investigator
Barak Troy Jones, DDS
2600 S University Dr. #106
Davie, Fl 33328
754-900-5844

Co-investigator
Sergio Real, DDS, MS
848 Marina drive
Weston. Fl, 33327
9548543279

For questions/concerns about your research rights, contact:
Human Research Oversight Board (Institutional Review Board or IRB)
Nova Southeastern University
(954) 262-5369/Toll Free: 866-499-0790
IRB@nsu.nova.edu

Site: NSU HPD Library/Laboratory Building and Assembly Building at Nova Southeastern University

What is the study about?
This study is investigating the physical attributes that make a human face attractive. The purpose of this study is to evaluate faces from a ¾ view and then to compare them with a side view of the face. Lip position in both views of the face will be altered in Photoshop. Judges will decide which lip position is best in the photos and the study will see if the different views had any influence on which lip position(s) will be preferred.

Why are you asking me?
You are being asked to participate as a model. Your face meets the requirements of having a near ideal profile according to orthodontic standards. You and one other person will be included in the study for a total of one male and one female subject.

What will I be doing if I agree to be in the study?
Two photos will be taken of your face. One photo will be of the right side of your face. The other will be a ¾ photo of that same side of your face. These photos will then be uploaded into Photoshop and your eyes from the photo will be substituted with the eyes

of another person to de-identify your image. 5 variations of the new photos will be made by altering the lip position. The images will then be included in a survey that will rank them by level of attractiveness.

Is there any audio or video recording?
Photographs will be taken and included in this study. The first photo will include the side of your face or, in other words, your profile. The second photo will be a ¾ view of your face by having you turned 45 degrees from facing directly at the camera.

What are the dangers to me?
There is a minimal risk that the judges will be able to identify you as the subject in the photos. Precautions will be taken to minimize this risk by replacing your eyes in the photos with those of another person. Also, original photos will be kept confidential. The procedures or activities in this study may have unknown or unforeseeable risks. If you have any questions about the research, your research rights, or have a research-related injury, please contact Barak Jones and Sergio Real. You may also contact the IRB at the numbers indicated above with questions as to your research rights.

Are there any benefits for taking part in this research study?
There are no benefits.

Will I get paid for being in the study? Will it cost me anything?
You will receive a 50 dollar Target gift card after the principle investigator obtains both of the needed photos to complete the study. There are no costs to you.

How will you keep my information private?
Data will be stored on a password protected computer to ensure security and confidentiality and will be retained for a minimum of 3 years from the conclusion of the study. Photos will be de-identified in Photoshop by superimposing another person's eyes over your eyes in the photos. All information obtained in this study is strictly confidential unless disclosure is required by law. However, the IRB, regulatory agencies, and the dissertation chair/thesis adviser may review research records because the PI is a student.

What if I do not want to participate or I want to leave the study?
You are free to refuse to participate in, or withdraw from, the study at any time without adverse effects or loss of benefits to which you are otherwise entitled. If you choose to withdraw, any information collected about you **before** the date you leave the study will be kept in the research records for 36 months from the conclusion of the study but you may request that it not be used.

Other Considerations:
If significant new information relating to the study becomes available, which may relate to your willingness to continue to participate, this information will be provided to you by the investigators.

Voluntary Consent by Participant:

By signing below, you indicate that

- this study has been explained to you
- you have read this document or it has been read to you
- your questions about this research study have been answered
- you have been told that you may ask the researchers any study related questions in the future or contact them in the event of a research-related injury
- you have been told that you may ask Institutional Review Board (IRB) personnel questions about your study rights
- you are entitled to a copy of this form after you have read and signed it
- you voluntarily agree to participate in the study entitled “Investigating lip protrusion aesthetics by comparing the facial profile view with an oblique view”

Participant's Signature: _____ Date: _____

Participant’s Name: _____ Date: _____

Signature of Person Obtaining Consent: _____

Date: _____

APPENDIX E: Participation Letter

Participation Letter

Title of Study: Investigating lip protrusion aesthetics by comparing the facial profile view with an oblique view

Principal investigator
Barak Troy Jones, DDS
2600 S University Dr. #106
Davie, FL 33328
754-900-5844

Co-investigator
Sergio Real, DDS, MS
848 Marina drive
Weston, FL 33327
954-854-3279

Institutional Review Board
Nova Southeastern University
Office of Grants and Contracts
(954) 262-5369/Toll Free: 866-499-0790
IRB@nsu.nova.edu

Description of Study: Barak Jones is a post-graduate orthodontics resident seeking a Master's degree at Nova Southeastern University's College of Dental Medicine. The purpose of this study is to enhance understand of facial esthetics. This component of the study will solicit your input on what you view as a more esthetically pleasing face. The intent of this study is to give orthodontists feedback on setting goals of treatment for orthodontic patients.

If you agree to participate, you will be asked to complete a questionnaire. In the questionnaire you will be asked to give information including age, gender and ethnicity. Then you will rank facial images within 4 series of images from most to least preferable. This questionnaire will help the creator of it evaluate whether or not current treatment goals are consistent with the feedback provided by you and others completing the questionnaire. The data from this questionnaire will be used to inform orthodontists of possible changes that should occur in their facial esthetic goals. The questionnaire will take approximately five to ten minutes to complete.

Risks/Benefits to the Participant: There may be minimal risk involved in participating in this study. There are no direct benefits for agreeing to be in this study apart from a small compensation for time to complete the questionnaire. If you have any concerns about the risks/benefits of participating in this study, you can contact the investigators and/or the university's human research oversight board (the Institutional Review Board or IRB) at the numbers listed above.

Cost and Payments to the Participant: There is no cost for participation in this study. Participation is completely voluntary and a five dollar gift card will be awarded following completion of the survey as compensation for time and contribution to the study.

Confidentiality: Information obtained in this study is strictly confidential unless disclosure is required by law. All data will be secured. Your name will not be used in the reporting of information in publications or conference presentations.

Participant's Right to Withdraw from the Study: You have the right to refuse to participate in this study and the right to withdraw from the study at any time without penalty.

I have read this letter and I fully understand the contents of this document and voluntarily consent to participate. All of my questions concerning this research have been answered. If I have any questions in the future about this study they will be answered by the investigator listed above or his/her staff.

I understand that the completion of this questionnaire implies my consent to participate in this study.

APPENDIX F: Descriptive Statistics

Table 1. Descriptive Statistics Female Oblique Profile

Image -2

	Female					Male				
Race	Asian	Black	Latin	Other	White	Asian	Black	Latin	Other	White
N	41	54	58	11	142	22	10	21	8	56
Mean	2.00	2.35	1.97	2.18	2.23	2.45	2.20	2.05	2.75	1.71
SD	1.41	1.42	1.30	1.25	1.38	1.41	1.55	1.24	1.39	0.89
Min	1	1	1	1	1	1	1	1	1	1
Max	5	5	5	5	5	5	5	5	5	5

Image -4

	Female					Male				
Race	Asian	Black	Latin	Other	White	Asian	Black	Latin	Other	White
N	41	54	58	11	142	22	10	21	8	56
Mean	2.63	2.69	2.47	2.82	2.69	3.36	2.20	2.29	2.75	2.32
SD	1.07	1.23	1.10	1.17	1.16	1.22	0.79	1.15	1.28	1.13
Min	1	1	1	1	1	1	1	1	1	1
Max	5	5	5	4	5	5	3	4	5	5

Image -6

	Female					Male				
	Asian	Black	Latin	Other	White	Asian	Black	Latin	Other	White
N	41	54	58	11	142	22	10	21	8	56
Mean	3.59	3.19	3.57	4.00	3.45	3.59	3.00	3.86	2.50	3.80
SD	1.36	1.40	1.42	1.26	1.40	1.44	1.15	1.24	1.51	1.23
Min	1	1	1	2	1	1	2	1	1	1
Max	5	5	5	5	5	5	5	5	5	5

Image 0

	Female					Male				
Race	Asian	Black	Latin	Other	White	Asian	Black	Latin	Other	White
N	41	54	58	11	142	22	10	21	8	56
Mean	3.44	3.33	3.62	3.64	3.45	2.86	3.60	3.43	3.50	3.88
SD	1.32	1.35	1.21	1.29	1.36	1.21	1.51	1.33	1.31	1.11
Min	1	1	1	1	1	1	1	1	2	1
Max	5	5	5	5	5	5	5	5	5	5

Image 2

	Female					Male				
Race	Asian	Black	Latin	Other	White	Asian	Black	Latin	Other	White
N	41	54	58	11	142	22	10	21	8	56
Mean	3.34	3.44	3.38	2.36	3.18	2.73	4.00	3.38	3.50	3.29
SD	1.30	1.42	1.25	1.43	1.38	1.61	1.25	1.32	1.69	1.30
Min	1	1	1	1	1	1	1	1	1	1
Max	5	5	5	5	5	5	5	5	5	5

Table 2. Descriptive Statistics Male Oblique Profile

	Image -2									
	Female					Male				
Race	Asian	Black	Latin	Other	White	Asian	Black	Latin	Other	White
N	40	54	58	11	142	22	10	21	8	56
Mean	3.15	2.74	2.47	3.27	2.65	3.18	2.80	2.62	3.13	2.41
SD	0.86	1.05	0.96	1.01	1.09	0.96	1.48	0.74	1.13	1.09
Min	1	1	1	1	1	1	1	1	1	1
Max	5	5	5	5	5	5	5	4	5	5

	Image -4									
	Female					Male				
Race	Asian	Black	Latin	Other	White	Asian	Black	Latin	Other	White
N	40	54	58	11	142	22	10	21	8	56
Mean	2.30	2.65	2.43	2.18	2.54	2.45	3.40	2.62	2.75	2.54
SD	1.47	1.51	1.50	1.08	1.35	1.50	1.51	1.20	1.49	1.58
Min	1	1	1	1	1	1	1	1	1	1
Max	5	5	5	4	5	5	5	4	5	5

	Image -6									
	Female					Male				
	Asian	Black	Latin	Other	White	Asian	Black	Latin	Other	White
N	40	54	58	11	142	22	10	21	8	56
Mean	2.15	2.63	2.43	2.09	2.32	2.55	2.60	2.05	2.63	2.70
SD	1.08	1.38	1.19	1.38	1.33	1.41	1.51	1.28	1.77	1.14
Min	1	1	1	1	1	1	1	1	1	1
Max	5	5	5	5	5	5	4	5	5	5

	Image 0									
	Female					Male				
Race	Asian	Black	Latin	Other	White	Asian	Black	Latin	Other	White
N	40	54	58	11	142	22	10	21	8	56
Mean	3.35	3.17	3.52	3.55	3.50	3.05	3.00	3.33	3.38	3.48
SD	1.21	1.09	0.92	1.21	1.05	1.29	1.05	1.49	1.30	1.13
Min	1	1	1	1	1	1	2	1	1	1
Max	5	5	5	5	5	5	5	5	5	5

	Image 2									
	Female					Male				
Race	Asian	Black	Latin	Other	White	Asian	Black	Latin	Other	White
N	40	54	58	11	142	22	10	21	8	56
Mean	4.05	3.81	4.16	3.91	3.98	3.77	3.20	4.38	3.13	3.88
SD	1.48	1.64	1.47	1.58	1.48	1.57	1.69	1.12	1.64	1.49
Min	1	1	1	1	1	1	1	1	1	1
Max	5	5	5	5	5	5	5	5	5	5

Table 3. Descriptive Statistics Female Lateral Profile

Image -2

	Female					Male				
Race	Asian	Black	Latin	Other	White	Asian	Black	Latin	Other	White
N	40	54	58	11	142	22	10	21	8	56
Mean	3.03	3.56	2.91	3.55	2.77	3.14	3.90	3.05	3.50	3.21
SD	1.48	1.62	1.44	0.93	1.36	1.42	0.99	1.53	1.20	1.47
Min	1	1	1	2	1	1	2	1	2	1
Max	5	5	5	5	5	5	5	5	5	5

Image -4

	Female					Male				
Race	Asian	Black	Latin	Other	White	Asian	Black	Latin	Other	White
N	40	54	58	11	142	22	10	21	8	56
Mean	2.55	2.39	2.34	2.18	2.46	2.50	2.20	2.33	2.50	2.18
SD	1.41	1.39	1.28	1.17	1.24	1.47	1.14	1.32	1.31	1.15
Min	1	1	1	1	1	1	1	1	1	1
Max	5	5	5	5	5	5	4	5	4	5

Image -6

	Female					Male				
	Asian	Black	Latin	Other	White	Asian	Black	Latin	Other	White
N	40	54	58	11	142	22	10	21	8	56
Mean	2.80	2.41	2.93	2.45	2.62	2.36	2.80	3.19	2.75	2.95
SD	1.26	1.24	1.39	1.29	1.37	1.05	1.55	1.40	1.49	1.33
Min	1	1	1	1	1	1	1	1	1	1
Max	5	5	5	4	5	4	5	5	5	5

Image 0

	Female					Male				
Race	Asian	Black	Latin	Other	White	Asian	Black	Latin	Other	White
N	40	54	58	11	142	22	10	21	8	56
Mean	2.88	2.91	2.97	2.91	2.97	2.77	3.10	2.95	2.63	2.70
SD	1.18	1.05	1.15	1.38	1.20	1.15	0.99	1.32	1.60	1.31
Min	1	1	1	1	1	1	2	1	1	1
Max	5	5	5	5	5	4	5	5	5	5

Image 2

	Female					Male				
Race	Asian	Black	Latin	Other	White	Asian	Black	Latin	Other	White
N	40	54	58	11	142	22	10	21	8	56
Mean	3.75	3.74	3.84	3.91	4.18	4.23	3.00	3.48	3.63	3.96
SD	1.50	1.17	1.42	1.70	1.22	1.23	1.94	1.40	1.51	1.21
Min	1	1	1	1	1	1	1	1	1	1
Max	5	5	5	5	5	5	5	5	5	5

Table 4. Descriptive statistics Male Lateral Profile

	Image -2									
	Female					Male				
Race	Asian	Black	Latin	Other	White	Asian	Black	Latin	Other	White
N	40	54	58	11	142	22	10	21	8	56
Mean	3.03	3.56	2.91	3.55	2.77	3.14	3.90	3.05	3.50	3.21
SD	1.48	1.62	1.44	0.93	1.36	1.42	0.99	1.53	1.20	1.47
Min	1	1	1	2	1	1	2	1	2	1
Max	5	5	5	5	5	5	5	5	5	5
	Image -4									
	Female					Male				
Race	Asian	Black	Latin	Other	White	Asian	Black	Latin	Other	White
N	40	54	58	11	142	22	10	21	8	56
Mean	2.55	2.39	2.34	2.18	2.46	2.50	2.20	2.33	2.50	2.18
SD	1.41	1.39	1.28	1.17	1.24	1.47	1.14	1.32	1.31	1.15
Min	1	1	1	1	1	1	1	1	1	1
Max	5	5	5	5	5	5	4	5	4	5
	Image -6									
	Female					Male				
	Asian	Black	Latin	Other	White	Asian	Black	Latin	Other	White
N	39	54	58	11	142	22	10	21	8	56
Mean	2.03	2.24	2.21	1.27	1.98	2.36	2.70	2.62	2.25	2.40
SD	1.31	1.26	1.35	0.65	1.22	1.50	1.34	1.28	1.75	1.42
Min	1	1	1	1	1	1	1	1	1	1
Max	5	5	5	3	5	5	5	5	5	5
	Image 0									
	Female					Male				
Race	Asian	Black	Latin	Other	White	Asian	Black	Latin	Other	White
N	39	54	58	11	142	22	10	21	8	56
Mean	2.62	2.74	2.52	2.55	2.42	2.95	2.10	2.71	3.00	2.80
SD	1.39	1.42	1.31	1.13	1.25	1.50	1.52	1.62	1.31	1.41
Min	1	1	1	1	1	1	1	1	1	1
Max	5	5	5	5	5	5	5	5	5	5
	Image 2									
	Female					Male				
Race	Asian	Black	Latin	Other	White	Asian	Black	Latin	Other	White
N	39	54	58	11	142	22	10	21	8	56
Mean	2.97	2.85	2.59	3.00	2.91	3.00	3.40	2.48	3.25	2.75
SD	1.11	1.17	0.92	0.63	1.02	1.20	1.26	1.17	1.16	1.08
Min	1	1	1	2	1	1	1	1	2	1
Max	5	5	4	4	5	5	5	5	5	5

Figure 1. Mean barplot for Female Oblique Profile

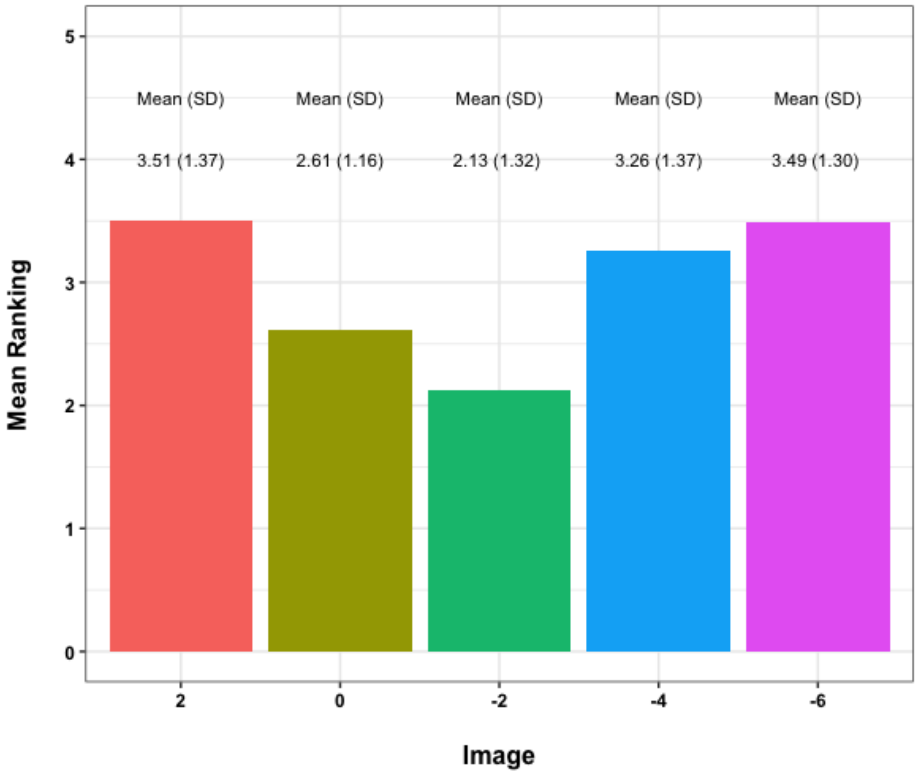


Figure 2. Barplot for Male Oblique Profile

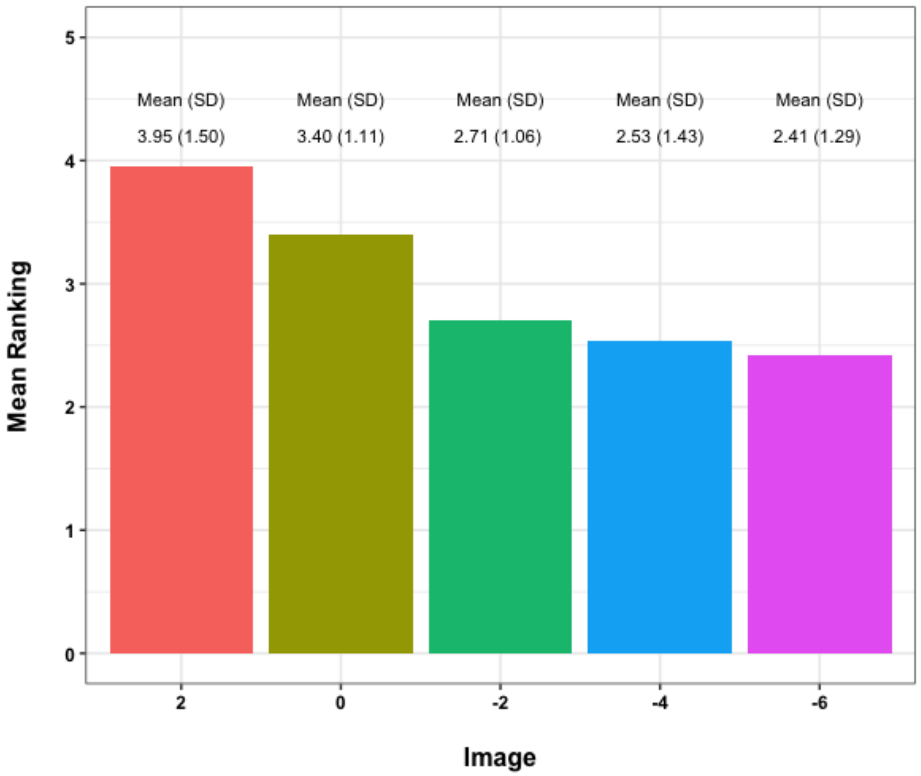


Figure 3. Mean barplot for Female Lateral Profile

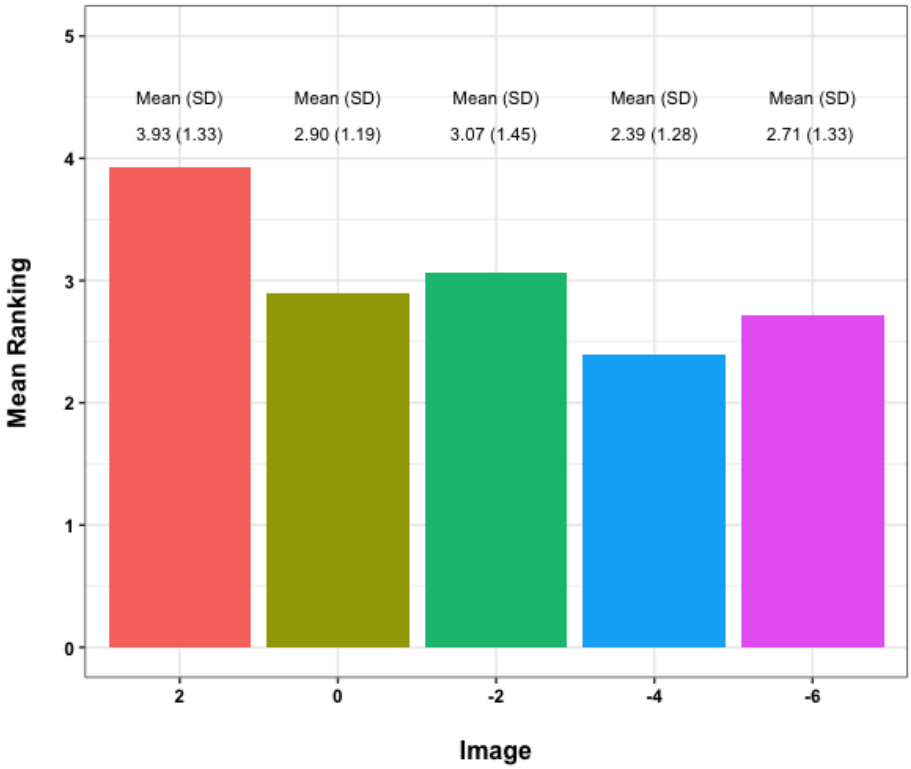
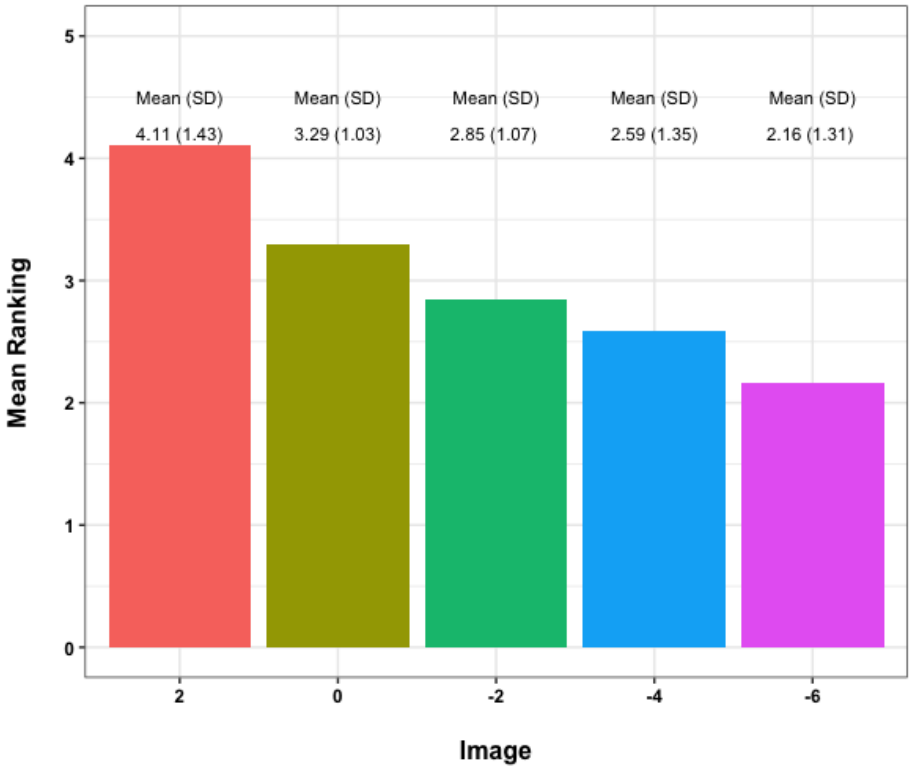


Figure 4. Mean barplot for Male Lateral Profile



APPENDIX G: Pairwise Comparisons Using a Satterthwaite Adjustment

Table 1. Pairwise comparisons of Female Oblique Profile

Contrast	Difference	Lower 95% CI	Upper 95% CI	P – Value
-2 vs -4	-1.13	-1.31	-0.95	<.0001
-2 vs -6	-1.35	-1.53	-1.17	<.0001
-2 vs 0	-0.48	-0.66	-0.30	<.0001
-2 vs 2	-1.37	-1.55	-1.20	<.0001
-4 vs -6	-0.22	-0.40	-0.04	0.1043
-4 vs 0	0.65	0.47	0.83	<.0001
-4 vs 2	-0.24	-0.42	-0.07	0.0569
-6 vs 0	0.87	0.69	1.05	<.0001
-6 vs 2	-0.02	-0.20	0.16	0.9993
0 vs 2	-0.89	-1.07	-0.71	<.0001

Table 2. Pairwise comparisons of Male Oblique Profile

Contrast	Difference	Lower 95% CI	Upper 95% CI	P – Value
-2 vs -4	0.19	0.02	0.37	0.2066
-2 vs -6	0.31	0.14	0.49	0.0042
-2 vs 0	-0.67	-0.85	-0.50	<.0001
-2 vs 2	-1.23	-1.41	-1.06	<.0001
-4 vs -6	0.12	-0.05	0.30	0.6427
-4 vs 0	-0.86	-1.04	-0.69	<.0001
-4 vs 2	-1.42	-1.60	-1.25	<.0001
-6 vs 0	-0.99	-1.16	-0.81	<.0001
-6 vs 2	-1.55	-1.72	-1.37	<.0001
0 vs 2	-0.56	-0.73	-0.38	<.0001

Table 3. Pairwise comparisons of Female Lateral Profile

Contrast	Difference	Lower 95% CI	Upper 95% CI	P – Value
-2 vs -4	0.68	0.50	0.86	<.0001
-2 vs -6	0.35	0.17	0.53	0.0011
-2 vs 0	0.16	-0.02	0.34	0.4071
-2 vs 2	-0.87	-1.05	-0.69	<.0001
-4 vs -6	-0.33	-0.51	-0.15	0.0028
-4 vs 0	-0.52	-0.70	-0.34	<.0001
-4 vs 2	-1.55	-1.73	-1.37	<.0001
-6 vs 0	-0.19	-0.37	-0.01	0.2144
-6 vs 2	-1.22	-1.40	-1.04	<.0001
0 vs 2	-1.03	-1.21	-0.85	<.0001

Table 4. Pairwise comparisons of Male Lateral Profile

Contrast	Difference	Lower 95% CI	Upper 95% CI	P – Value
-2 vs -4	0.24	0.07	0.41	0.0396
-2 vs -6	0.68	0.51	0.85	<.0001
-2 vs 0	-0.46	-0.63	-0.29	<.0001
-2 vs 2	-1.26	-1.43	-1.09	<.0001
-4 vs -6	0.43	0.26	0.60	<.0001
-4 vs 0	-0.70	-0.87	-0.53	<.0001
-4 vs 2	-1.50	-1.67	-1.33	<.0001
-6 vs 0	-1.14	-1.31	-0.97	<.0001
-6 vs 2	-1.94	-2.11	-1.77	<.0001
0 vs 2	-0.80	-0.97	-0.63	<.0001

Referances

1. Langlois JH KL, Rubenstein AJ, Larson A, Hallam M, & Smoot M. Maxims or myths of beauty? A meta-analytic and theoretical review. *Psychological Bulletin.* 2000;126(3):390-423.

2. Riggio RE, Widaman KF, Tucker JS, Salinas C. Beauty is More Than Skin Deep: Components of Attractiveness. *Basic and Applied Social Psychology.* 1991;12(4):423-439.

3. Little AC. Facial attractiveness. *Wiley Interdisciplinary Reviews: Cognitive Science.* 2014;5(6):621-634.

4. Holdaway RA. A soft-tissue cephalometric analysis and its use in orthodontic treatment planning. Part I. *American journal of orthodontics.* 1983;84(1):1-28.

5. Macgregor FC. Facial disfigurement: problems and management of social interaction and implications for mental health. *Aesthetic Plastic Surgery.* 1990;14(4):249-257.

6. Slater A, Von der Schulenburg C, Brown E, et al. Newborn infants prefer attractive faces. *Infant Behavior and Development.* 1998;21(2):345-354.

7. Grammer K, Fink B, MØLler AP, Thornhill R. Darwinian aesthetics: sexual selection and the biology of beauty. *Biological Reviews.* 2003;78(3):385-407.

8. Talbot TL. *COMPARING SELF-PERCEPTION OF ATTRACTIVENESS AND OVERALL LIFE SATISFACTION: THE DIFFERENCES BETWEEN MEN AND WOMEN*: Psychology Department, Western Carolina University 2012.

9. Tolstoy LN. *Childhood, Boyhood and Youth.* London: Penguin Books; 1970.

10. Thornhill R, Gangestad SW. Facial attractiveness. *Trends in Cognitive Sciences.* 1999;3(12):452-460.

11. Shaw WC, Addy M, Ray C. Dental and social effects of malocclusion and effectiveness of orthodontic treatment: a review. *Community Dentistry & Oral Epidemiology.* 1980;8(1):36-45.

12. Olds C. Facial beauty in western art. In: James A. McNamara J, ed. *Esthetics and the treatment of facial form, monograph 28, Craniofacial growth series.* Vol 28. Ann Arbor, MI: The Center for Human Growth and Development The University of Michigan; 1992:7-25.

13. PECK H, PECK S. A Concept of Facial Esthetics. *The Angle Orthodontist.* 1970;40(4):284-317.

14. Richer PMLP. *Artistic anatomy.* Watson-Guptill Publications; 1986.

15. Little AC, Perrett DI. Putting beauty back in the eye of the beholder. *The Psychologist.* 2002;15(1):28-32.

16. Reber R, Schwarz N, Winkielman P. Processing Fluency and Aesthetic Pleasure: Is Beauty in the Perceiver's Processing Experience? *Personality and Social Psychology Review.* 2004;8(4):364-382.

17. Leist A. What Makes Bodies Beautiful. *Journal of Medicine and Philosophy.* 2003;28(2):187-219.

18. Langlois JH, Roggman LA. Attractive faces are only average. *Psychological science.* 1990;1(2):115-121.

19. Rossetti A, Menezes MD, Rosati R, Ferrario VF, Sforza C. The role of the golden proportion in the evaluation of facial esthetics. *The Angle Orthodontist.* 2013;83(5):801-808.

20. Broer PN, Levine SM, Juran S. Plastic Surgery: Quo Vadis? Current Trends and Future Projections of Aesthetic Plastic Surgical Procedures in the United States. *Plastic and reconstructive surgery.* 2014;133(3):293e-302e.

21. Naini FB, Moss JP, Gill DS. The enigma of facial beauty: esthetics, proportions, deformity, and controversy. *American journal of orthodontics and dentofacial orthopedics : official publication of the American Association of Orthodontists, its constituent societies, and the American Board of Orthodontics.* 2006;130(3):277-282.

22. Samsonyanov, #xe1, L, Broukal Z. A Systematic Review of Individual Motivational Factors in Orthodontic Treatment: Facial Attractiveness as the Main Motivational Factor in Orthodontic Treatment. *International Journal of Dentistry.* 2014;2014:7.

23. Merrifield LL. The profile line as an aid in critically evaluating facial esthetics. *American journal of orthodontics.* 1966;52(11):804-822.

24. Angle EH. Classification of malocclusion. 1899.

25. James RD. A comparative study of facial profiles in extraction and nonextraction treatment. *American Journal of Orthodontics and Dentofacial Orthopedics.* 1998;114(3):265-276.

26. Downs WB. Analysis of the Dentofacial Profile. *The Angle Orthodontist.* 1956;26(4):191-212.

27. Ricketts RM. Esthetics, environment, and the law of lip relation. *American journal of orthodontics.* 1968;54(4):272-289.

28. Hier LA, Evans CA, BeGole EA, Giddon DB. Comparison of preferences in lip position using computer animated imaging. *The Angle Orthodontist.* 1999;69(3):231-238.

29. Turley PK. Evolution of esthetic considerations in orthodontics. *American Journal of Orthodontics and Dentofacial Orthopedics.* 2015;148(3):374-379.

30. De Smit A, Dermaut L. Soft-tissue profile preference. *American journal of orthodontics.* 1984;86(1):67-73.

31. Hockley A, Weinstein M, Borislow AJ, Braitman LE. Photos vs silhouettes for evaluation of African American profile esthetics. *American journal of orthodontics and dentofacial orthopedics : official publication of the American Association of Orthodontists, its constituent societies, and the American Board of Orthodontics.* 2012;141(2):161-168.

32. Hockley A, Weinstein M, Borislow AJ, Braitman LE. Photos vs silhouettes for evaluation of African American profile esthetics. *American Journal of Orthodontics and Dentofacial Orthopedics.* 2012;141(2):161-168.

33. Ioi H, Shimomura T, Nakata S, Nakasima A, Counts AL. Comparison of anteroposterior lip positions of the most-favored facial profiles of Korean and Japanese people. *American journal of orthodontics and dentofacial orthopedics : official publication of the American Association of Orthodontists, its constituent societies, and the American Board of Orthodontics.* 2008;134(4):490-495.

34. Lines PA, Lines RR, Lines CA. Profilemetrics and facial esthetics. *American journal of orthodontics.* 1978;73(6):648-657.

35. Mantzikos T. Esthetic soft tissue profile preferences among the Japanese population. *American Journal of Orthodontics and Dentofacial Orthopedics.* 1998;114(1):1-7.

36. Maple JR, Vig KW, Beck FM, Larsen PE, Shanker S. A comparison of providers' and consumers' perceptions of facial-profile attractiveness. *American journal of orthodontics and dentofacial orthopedics : official publication of the American Association of Orthodontists, its constituent societies, and the American Board of Orthodontics.* 2005;128(6):690-696; quiz 801.

37. Nguyen DD, Turley PK. Changes in the Caucasian male facial profile as depicted in fashion magazines during the twentieth century. *American journal of orthodontics and dentofacial orthopedics : official publication of the American Association of Orthodontists, its constituent societies, and the American Board of Orthodontics.* 1998;114(2):208-217.

38. Pithon MM, Silva IS, Almeida IO, et al. Photos vs silhouettes for evaluation of profile esthetics between white and black evaluators. *Angle Orthod.* 2014;84(2):231-238.

39. Richards RD. Evaluation of male and female profile esthetics as a function of anteroposterior lip position. *Nova Southeastern University.* 2011.

40. Bowman SJ, Jr LEJ. The Esthetic Impact of Extraction and Nonextraction Treatments on Caucasian Patients. *The Angle Orthodontist.* 2000;70(1):3-10.

41. Modarai F, Donaldson JC, Naini FB. The influence of lower lip position on the perceived attractiveness of chin prominence. *The Angle Orthodontist.* 2013;83(5):795-800.

42. Arnett GW, Bergman RT. Facial keys to orthodontic diagnosis and treatment planning. Part I. *American Journal of Orthodontics and Dentofacial Orthopedics.* 1993;103(4):299-312.

43. Yang X, Yi Y, Yang S, et al. Role of sagittal and oblique smiling profiles in evaluating facial esthetics. *The Journal of craniofacial surgery.* 2015;26(2):532-536.

44. Todd SA, Hammond P, Hutton T, Cochrane S, Cunningham S. Perceptions of facial aesthetics in two and three dimensions. *European Journal of Orthodontics.* 2005;27(4):363-369.

45. Sarver DM. ORTHODONTICS & ESTHETIC DENTISTRY: MISSION POSSIBLE! A Broader Approach to Interdisciplinary Esthetic Treatment. *Journal of Cosmetic Dentistry.* 2016;31(4):14-26.

46. Riedel RA. An analysis of dentofacial relationships. *American journal of orthodontics.* 1957;43(2):103-119.

47. Gonzalez-Ulloa M, Stevens E. The role of chin correction in profileplasty. *Plastic and reconstructive surgery.* 1968;41(5):477-486.

48. Miller GA. The magical number seven, plus or minus two: some limits on our capacity for processing information. 1956. *Psychological review.* 1994;101(2):343-352.