

EFFECTS OF COMPUTER-AIDED ANTERO-POSTERIOR FOREHEAD
MOVEMENT ON RATINGS OF FACIAL ATTRACTIVNESS BASED ON THE
ETHNICITY OF THE MODEL AND EVALUATOR

by

Jimmy Hyon Ku
Lieutenant Commander, Dental Corps
United States Navy

A thesis submitted to the Faculty of the
Comprehensive Dentistry Graduate Program
Naval Postgraduate Dental School
Uniformed Services University of the Health Sciences
in partial fulfillment of the requirements for the degree of
Master of Science
in Oral Biology

June 2017

Naval Postgraduate Dental School
Uniformed Services University of the Health Sciences
Bethesda, Maryland

CERTIFICATE OF APPROVAL


MASTER'S THESIS

This is to certify that the Master's thesis of

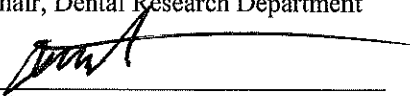
Jimmy Hyon Ku

has been approved by the Examining Committee for the thesis requirement
for the Master of Science degree in Oral Biology at the June 2017 graduation.


Research Committee:



Ling Ye, DDS, PhD
LCDR, DC, USN
Committee Chair, Dental Research Department



David Hartzell, DDS, MS
CAPT, DC, USN
Chairman, Comprehensive Dentistry



Andrew Avillo, DMD, MS
CDR, DC, USN
Program Director, Comprehensive Dentistry

The author hereby certifies that the use of any copyrighted material in the thesis manuscript titled:

“EFFECTS OF COMPUTER-AIDED ANTERO-POSTERIOR FOREHEAD
MOVEMENT ON RATINGS OF FACIAL ATTRACTIVENESS BASED ON THE
ETHNICITY OF THE MODEL AND EVALUATOR”

is appropriately acknowledged and, beyond brief excerpts, is with the permission of the copyright owner.

RESIDENT SIGNATURE



Jimmy Hyon Ku
Comprehensive Dentistry Graduate Program
Naval Postgraduate Dental School
June 2017

NAVAL POSTGRADUATE DENTAL SCHOOL
JIMMY HYON KU

2017

This thesis may not be re-printed without the expressed written permission of the author.

Distribution Statement

Distribution A: Public Release.

The views presented here are those of the author and are not to be construed as official or reflecting the views of the Uniformed Services University of the Health Sciences, the Department of Defense or the U.S. Government.

ABSTRACT

EFFECTS OF COMPUTER-AIDED ANTERO-POSTERIOR FOREHEAD MOVEMENT ON RATINGS OF FACIAL ATTRACTIVENESS BASED ON THE ETHNICITY OF THE MODEL AND EVALUATOR

JIMMY HYON KU

M.S., COMPREHENSIVE DENTISTRY, 2017

Directed by: LING YE, COMMITTEE CHAIR, DENTAL RESEARCH DEPT.
Naval Postgraduate Dental School

Introduction: There is no universally-accepted method for determining the most esthetically pleasing antero-posterior positioning of the jaws. L.F. Andrews proposed using the relationship between the forehead and the maxillary central incisors as a reference. To date, there are no studies investigating Andrews' philosophy with changes in forehead position and taking into consideration the ethnicity of the model and evaluator.

Purpose: To investigate differences in how judges of different ethnicities subjectively evaluate the profile attractiveness of models of different ethnicities when the model profiles are changed at the level of the forehead.

Methods: Three female models of different races - Caucasian, African American, and Asian - were photographed smiling in profile. The photographs were digitally manipulated to move the forehead anteriorly by 2, 4, and 6mm, and posteriorly by 2mm. 31 Caucasian, 28 African American, and 17 Asian layperson evaluators rated the attractiveness of the photographs using a 0-100mm visual analog scale.

Results: For the Caucasian model, Caucasian evaluators preferred the unaltered photograph over those with forehead positions placed 4 and 6mm anteriorly. For the

Asian model, African American evaluators preferred the unaltered photograph over those with forehead positions placed 2 and 6mm anteriorly; and Caucasian evaluators preferred the unaltered photograph over that with forehead positioned 2mm anteriorly. For the African American model, Caucasian evaluators preferred the unaltered photograph over those with forehead positions placed 2 and 4mm anteriorly and 2mm posteriorly.

Conclusions: The results indicate that there is racial variation when assessing facial profile. More data is required to identify potential trends relating AP forehead position and attractiveness.

TABLE OF CONTENTS

	Page
LIST OF TABLES	7
LIST OF FIGURES	8
CHAPTER	
I. REVIEW OF THE LITERATURE	9
Introduction.....	9
Proposed Philosophies of Profile Esthetic Analysis	9
L.F. Andrews' Element II	10
Ethnicity and Profile Assessment	13
Purpose of Research.....	13
II. MATERIALS AND METHODS.....	14
III. RESULTS	20
IV. DISCUSSION	23
V. CONCLUSIONS.....	26
APPENDIX A MODEL PHOTOGRAPH RELEASE FORMS	28
APPENDIX B RESEARCH APPROVAL LETTERS	31
REFERENCES	34

LIST OF TABLES

Table		Page
1.	Microsoft Excel spreadsheet of raw data.....	19
2.	Pairwise comparisons of the original photographs to altered photographs	23

LIST OF FIGURES

Figure		Page
1.	Andrews Element II.....	11
2.	Standardized setup for capturing model photographs.....	14
3.	Standardization setup for alteration of images	15
4.	Photograph sets of each model	16
5.	Evaluator ethnicity self-identification and written instructions.....	17
6.	Visual analog scale	18
7.	Z-score results, Caucasian Model.....	21
8.	Z-score results, African American Model	21
9.	Z-score results, Asian Model	22

CHAPTER I: LITERATURE REVIEW & PURPOSE OF RESEARCH

Introduction

Dental-facial esthetics is one of the most important contributing factors in an individual's decision to obtain orthodontic treatment (Albino et. al., 1981). Because of this, it is imperative that esthetics is given a high priority during the orthodontic treatment planning phase (Proffit et al., 2007).

Patients presenting with severe malocclusions may require orthodontic and orthognathic movements of the maxilla, mandible, or both. However, there is no universally-accepted method for determining the most esthetically acceptable antero-posterior positioning of the jaws (Ellis et al., 2017).

Proposed Philosophies of Profile Esthetic Analysis

There have been numerous proposals. In 1900, Edward Angle wrote that artistic depictions of the Greek god Apollo had the ideal facial profile form: his glabella, subnasale, and pogonion connected to form a straight line, what Angle called "The Line of Harmony" (Angle, 1900). However, Angle later showed reservations of this arbitrary standard in his writings, conceding that it may only be applicable to some facial types (Turley, 2015).

In 1926, Simon introduced the photostatics method, the use of profile photographs for profile esthetic analysis. He related structures in these photographs with the Frankfort horizontal and orbital planes and compared them against standards established by

Kollman and Zeising, which were based on arbitrary ratios and the Golden Proportion (Turley, 2015).

Lateral cephalometric radiography was developed in 1931, allowing for direct analysis of dentoskeletal patterns (Turley, 2015). In 1946, Tweed proposed using the Frankfort-mandibular incisor angle, relating hard tissue landmarks elucidated from cephalometric radiography to relate mandibular teeth to hard tissue landmarks on the cranial base (Tweed, 1946).

However, Peck and Peck concluded that attractive faces demonstrated a more protrusive profile than what was considered “normal” per the existing orthodontic guidelines (Peck & Peck, 1970). Additionally, Moss and colleagues demonstrated that faces judged to be attractive did not necessarily adhere to orthodontically-accepted hard tissue profiles or to the Golden Proportion (Moss et. al., 1995).

Arnett theorized that relying on hard tissue references when correcting occlusion could lead to poor outcomes due to variability in skeletal patterns. He proposed including information obtained via soft tissue cephalometrics along with hard tissue information for proper diagnosis and treatment planning, and recommended using the subnasale as one such soft tissue reference (Arnett & Gunson, 2004).

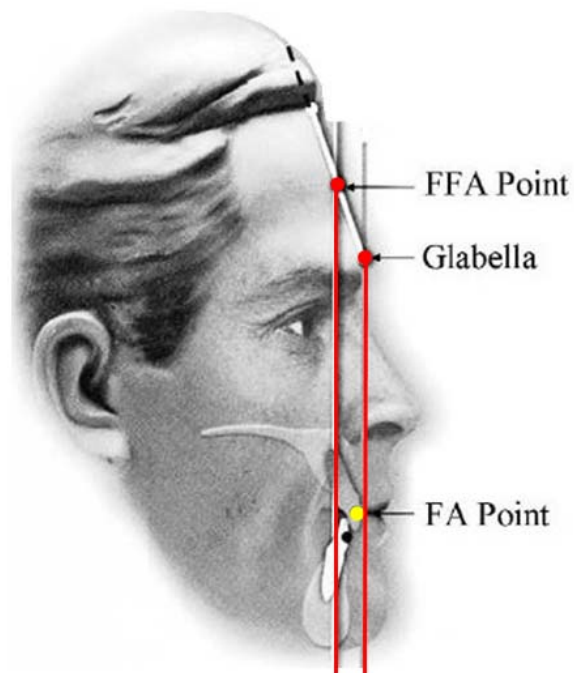
L.F. Andrews' Element II

In 1991, L.F. Andrews introduced his Six Elements of Orthodontic Philosophy. He stated that skeletal landmarks are unpredictable because they were internal structures that did not represent the overlaying external soft tissues; that soft tissue structures such as the nose and chin were unreliable because of morphology variations between individuals and

that they continue to grow with age; and that other potential soft tissue landmarks such as the lips were unreliable because they could change unpredictably with orthodontic and orthognathic treatment (L.F. Andrews, 1991).

In Element II of his philosophy, L.F. Andrews proposed positioning the maxillary central incisors relative to the position of the forehead to achieve the most esthetic results (Figure 1). More specifically, he proposed that the anterior prominence of the maxillary central incisors (the “Facial Axis Point”) lie between imaginary vertical lines emanating from the glabella and the midpoint of the clinical forehead (the “Forehead Facial Axial Point”) (L.F. Andrews, 1991).

Figure 1.



L.F. Andrews reasoned that unlike hard tissues, the forehead is an external structure that is visible; and unlike structures such as the nose, lips, and chin, it remains

positionally and morphologically stable with increasing age and with orthodontic and orthognathic treatment (L.F. Andrews, 1999).

There is some scientific evidence to support this aspect of L.F. Andrews' philosophy. W.A. Andrews used 188 profile photographs of Caucasian females and found that 93% of faces deemed attractive by a panel of evaluators agreed with L.F. Andrews' proposed profile (W.A. Andrews, 2008). Adams did a similar study with 197 profile photographs of Caucasian males and found that 91% of those faces deemed attractive by a panel of evaluators had maxillary central incisors that lay within the boundaries proposed by L.F. Andrews (Adams et al., 2013). Schlosser and colleagues used a model who exhibited L.F. Andrews' proposed ideal profile and digitally manipulated her maxillary teeth forwards and backwards, and found that evaluators preferred the original over the altered photograph with 4mm of maxillary tooth retrusion and with the maxillary central incisors posterior to L.F. Andrews' boundary (Schlosser et. al., 2005).

Ellis and colleagues suggested that Schlosser's digital manipulation of the maxillary teeth, and not other surrounding structures such as the upper lip and mandible, may have created a visual distraction for the evaluators by creating esthetically unacceptable teeth-to-teeth and teeth-to-lip relationships. In order to address this, Ellis conducted a study where the foreheads of three models were digitally manipulated to various positions while keeping the position of the jaws intact. For the Caucasian female model, evaluators rated the photograph with the original forehead position as the most attractive, and the image with the most forehead protrusion – by 6mm – as the least attractive. However, no statistically significant information could be obtained from evaluations of the African American and Asian female models (Ellis et. al., 2017).

Ethnicity and Profile Assessment

Numerous studies demonstrate that racial variation exists when assessing facial profile esthetics. Hall and colleagues found that evaluators in their study preferred African American models to have greater profile convexity than for Caucasian American models (Hall et. al., 2000). Nomura and colleagues found that evaluator groups separated by ethnicity preferred different lip profiles: in their study, African evaluators preferred more protrusive lip profiles than Hispanic American evaluators (Nomura et. al. 2009). Chong and colleagues had Caucasian and Chinese evaluators rate profile photographs of Chinese faces and concluded that ethnicity of the evaluators was a significant factor influencing esthetic lip position preferences (Chong et. al., 2014), and Mejia-Maidl and colleagues found that Mexican American evaluators preferred less protrusive upper and lower lips than Caucasian evaluators (Mejia-Maidl et. al., 2005).

Purpose of Research

Scientific evidence supporting L.F. Andrews' philosophy of relating the maxillary central incisors to the forehead is sparse. Additionally, none have obtained significant information regarding ethnic variations in profile assessment with respect to L.F. Andrews' reference point, the forehead.

Therefore, the purpose of this research is to investigate differences in how judges of different ethnicities subjectively evaluate the profile attractiveness of models of different ethnicities when the models' profile is changed at the level of the forehead.

CHAPTER II: MATERIALS AND METHODS

Models

The acquisition of models and model photographs for this research project was conducted by Ellis and colleagues (Ellis et al., 2017) and re-printed below verbatim:

Three volunteer female models, 18 years or older, were selected from orthodontic patient evaluations at Naval Postgraduate Dental School (NPDS), Bethesda MD. The models represented different races - Caucasian, Asian, and African American. Exclusion criteria included no major skeletal deformities and not in active orthodontic treatment. Each model signed the NPDS release form giving their permission to use their photos (Appendix A).

Right lateral profile photographs were taken by the same photographer with a Canon Rebel XTI digital camera (Canon, Newport News, VA) under standard conditions (Schlosser et al., 2005) (Figure 2). The first image was taken in repose and was used to ensure that the patient fell within the inclusion criteria for the study. The second image, a smiling profile photograph, was captured with a 100-mm ruler fixed in front of the subject's nose to calibrate for magnification and a hanging plumb to assist in paralleling the subject's head position (Figure 3).

Figure 2.

STANDARD CONDITIONS FOR CAPTURING PHOTOS

- The camera lens will be pointing directly at the subject.
- Lighting will be provided by the room light fixtures from the ceiling so that the shadows will be projected downwards.
- The camera will be at a fixed distance of 60 inches from the tip of the nose. The camera will be mounted on a tripod and the height will be adjusted to be in line with the subject's face.
- Camera will be set on Manual Mode with the following settings:
 - F-stop: 11
 - ISO speed: 400
 - Exposure time: 1/125s

Figure 3.

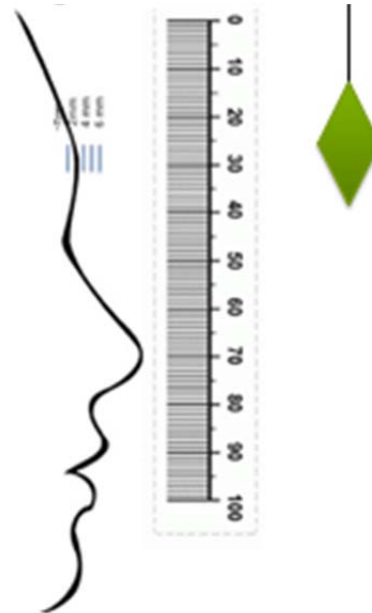


Image Alteration & Presentation

Image alterations and presentation of photographs for this research project was conducted by Ellis and colleagues (Ellis, et al., 2017) and re-printed below verbatim:

The model's smiling profile photograph was altered with a computer graphics program (Adobe Photoshop Version 7.0.1, Adobe systems). Four altered images were created by moving the soft tissue glabella forward in a horizontal plane by 2 mm, 4 mm, and 6 mm, and backward in a horizontal plane by 2 mm. The alterations were conducted by an information technology (IT) specialist at NPDS with experience using the Photoshop computer program. The ruler and the plumb were removed from the altered photos to eliminate distractions.

The original and four altered images of each model were printed on 8.5" x 11" photo paper (Figure 4), labelled 1 through 15, and placed in a binder for evaluation. The website (<http://www.stattrek.com/statistics/random-number-generator.aspx>) was utilized to place the photos in a randomized viewing order for each of the models.

Figure 4.



-2 mm

Original

2 mm

4 mm

6 mm



-2 mm

Original

2 mm

4 mm

6 mm



-2 mm

Original

2 mm

4 mm

6 mm

Subjects/Evaluators

31 Caucasian, 28 African American, and 17 Asian volunteer evaluators without any professional background in any aspect of dentistry were recruited from the Walter Reed National Military Medical Center (WRNMMC).

Rating of Photographs and Data Collection

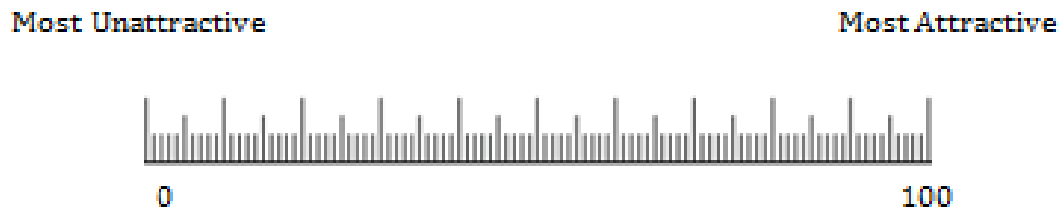
Each evaluator was provided with the binder of 15 photographs and score sheets. Each score sheet contained the written instructions and an area for the evaluator participant to select their self-identified ethnicity (Figure 5) and one 100mm visual analog scale (VAS) per photograph (Figure 6). The principal investigator gave the instructions and answered any questions. After the subject acknowledged that he or she understood the instructions, no further guidance was offered.

Figure 5.

Please circle one. I consider myself to be:			
Caucasian	African American	Asian	None of these

- Please mark the assessment of the subject's facial attractiveness on the 100 mm visual analog scale. Please mark the closest millimeter marking.
- The attractiveness of the photograph is based purely on the criteria which you deem important.
- You may not return to any previous photographs as you proceed through the binder.

Figure 6.



Each evaluator rated the attractiveness of the 15 photographs by placing a vertical mark along the VAS line, with the 100mm mark representing the highest level of attractiveness and 0mm representing the lowest level. All of the subjects viewed the images in the sequence provided and were not allowed to return to the previously viewed photos conditions per the protocol developed by Schlosser and colleagues (Schlosser et. al., 2005).

Each VAS rating was measured from the 0 line using a 100-mm ruler to the closest millimeter increment. Measurements were entered into a Microsoft Excel spreadsheet (Table 1) for data analysis.

Table 1.

Attractiveness VAS Score 0-100																
Viewing order		Model 1 - Caucasian					Model 2 - Asian					Model 3 - African American				
Rater Type	Rater No	14	15	13	11	12	3	5	2	1	4	9	7	8	6	10
		Original	-2 mm	2 mm	4 mm	6 mm	Original	-2 mm	2 mm	4 mm	6 mm	Original	-2 mm	2 mm	4 mm	6 mm
Caucasian	A1	74	80	74	39	60	50	65	45	41	45	64	46	55	55	45
	A2	32	34	28	27	26	34	39	31	30	35	45	35	38	30	40
	A3	90	90	90	89	89	50	50	50	50	49	89	76	86	70	88
	A4	84	85	80	71	80	85	85	74	75	86	81	65	76	66	81
	A5	80	90	71	90	70	60	90	60	81	90	90	81	80	71	70
	A6	50	49	48	50	50	40	41	40	40	39	40	40	40	40	40
	A7	45	30	30	25	35	41	55	30	50	30	50	50	60	39	55
	A8	80	81	80	75	80	71	71	71	70	72	50	50	50	50	50
	A9	65	75	54	40	43	69	54	76	75	55	41	70	40	55	45
	A10	64	70	70	48	62	64	77	68	59	67	58	48	61	54	52
	A11	70	70	70	70	70	50	50	50	50	50	60	60	60	60	60
	A12	32	32	33	32	32	75	65	65	65	75	40	23	35	35	50
	A13	40	50	50	60	40	50	30	50	60	45	40	25	15	30	30
	A14	46	40	45	40	45	35	30	25	30	25	30	41	50	51	30
	A15	80	85	80	76	70	75	70	65	70	70	60	70	70	71	65
	A16	54	56	52	50	50	51	50	51	50	51	52	53	51	52	51
	A17	71	76	64	56	64	43	66	45	38	49	51	58	42	54	70
	A18	55	75	45	35	40	35	35	35	35	35	70	60	70	45	76
	A19	66	67	65	64	65	74	84	69	69	82	89	76	79	74	88
	A20	70	76	74	74	72	77	67	78	80	65	43	43	43	43	42
	A21	65	66	67	78	66	79	78	68	77	77	74	64	72	71	66
	A22	86	83	82	83	83	71	72	69	72	71	72	73	68	72	72
	A23	49	49	52	45	53	37	37	38	41	27	53	48	48	56	52
	A24	50	49	49	50	50	50	50	50	50	50	50	50	50	50	50
	A25	46	46	47	45	46	52	69	51	52	51	93	70	89	71	90
	A26	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	A27	59	59	59	58	58	50	51	50	45	47	60	62	58	62	64
	A28	89	99	85	80	81	71	80	65	98	71	86	81	81	81	90
	A29	52	54	54	52	53	45	53	47	45	39	62	58	58	58	58
	A30	70	68	70	70	70	80	80	80	80	80	80	75	80	75	80
	A31	50	50	50	50	50	60	60	60	60	60	60	60	60	60	60

Attractiveness VAS Score 0-100																
Viewing order		Model 1 - Caucasian					Model 2 - Asian					Model 3 - African American				
Rater Type	Rater No	14	15	13	11	12	3	5	2	1	4	9	7	8	6	10
		Original	-2 mm	2 mm	4 mm	6 mm	Original	-2 mm	2 mm	4 mm	6 mm	Original	-2 mm	2 mm	4 mm	6 mm
Afr. American	B1	20	40	9	20	10	50	28	39	40	39	49	50	37	39	10
	B2	51	51	52	53	52	51	51	51	51	52	52	52	52	52	51
	B3	20	20	21	20	20	31	31	30	31	31	30	31	31	31	30
	B4	50	50	51	49	50	69	50	43	52	50	50	80	80	50	50
	B5	55	45	55	60	45	55	41	50	50	50	60	40	52	50	46
	B6	36	40	37	36	38	39	42	38	40	39	60	54	56	54	59
	B7	29	27	29	20	20	30	40	50	50	30	29	29	28	30	28
	B8	65	70	65	70	70	51	46	51	50	41	39	30	31	30	41
	B9	64	82	64	56	65	86	76	72	73	75	74	76	76	76	74
	B10	30	29	29	30	30	25	24	15	25	23	40	30	31	30	39
	B11	50	40	40	40	40	45	50	45	50	40	40	50	35	50	40
	B12	25	25	30	30	26	20	15	15	9	10	9	24	20	16	30
	B13	70	68	64	61	62	62	77	57	60	66	81	70	65	64	76
	B14	71	77	74	80	75	64	65	60	70	64	64	65	70	70	65
	B15	80	80	80	75	80	61	61	60	61	60	55	55	55	55	55
	B16	52	47	52	48	48	40	50	40	40	40	40	35	40	35	40
	B17	45	46	50	50	40	45	38	45	42	30	37	35	35	35	35
	B18	65	64	63	62	57	47	48	42	41	47	62	53	58	56	54
	B19	55	55	55	55	55	50	50	50	0	50	45	45	45	45	45
	B20	37	42	36	38	36	53	36	47	54	35	26	25	31	32	26
	B21	78	80	81	80	79	83	84	77	80	85	82	80	81	85	81
	B22	40	60	50	50	40	30	40	41	41	30	40	40	40	40	40
	B23	65	73	76	52	46	66	66	53	51	56	62	47	52	48	53
	B24	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
	B25	53	59	53	52	52	47	58	48	63	47	53	34	34	38	53
	B26	30	29	29	30	30	25	30	23	19	20	30	25	25	30	30
	B27	89	90	83	90	81	80	80	80	85	80	56	55	55	50	45
	B28	81	83	81	81	81	70	70	70	70	70	68	67	68	68	69

Attractiveness VAS Score 0-100																
Viewing order		Model 1 - Caucasian					Model 2 - Asian					Model 3 - African American				
Rater Type	Rater No	14	15	13	11	12	3	5	2	1	4	9	7	8	6	10
		Original	-2 mm	2 mm	4 mm	6 mm	Original	-2 mm	2 mm	4 mm	6 mm	Original	-2 mm	2 mm	4 mm	6 mm
Asian	C1	50	40	60	60	50	45	50	45	50	50	10	40	40	30	40
	C2	15	10	5	5	5	10	10	10	10	10	10	10	10	10	10
	C3	70	75	60	59	40	80	74	75	70	80	81	46	65	55	65
	C4	51	51	51	51	50	35	34	37	20	35	40	40	39	30	41
	C5	30	30	30	30	40	35	30	35	40	40	20	16	26	15	30
	C6	78	72	71	77	78	38	46	38	46	45	64	59	65	59	68
	C7	72	71	67	70	71	84	84	85	84	84	64	66	67	64	66
	C8	46	54	49	49	44	46	41	43	49	56	60	47	54	46	62
	C9	26	26	22	30	21	40	40	35	35	25	30	30	30	25	30
	C10	22	21	24	27	20	40	39	38	43	39	35	36	37	39	36
	C11	81	83	81	81	81	69	70	70	70	71	68	67	68	68	69
	C12	50	50	50	55	49	20	30	35	40	21	50	46	50	51	50
	C13	51	50	51	51	55	34	40	35	45	25	25	25	16	25	25
	C14	60	60	60	60	60	65	67	66	67	65	51	56	55	56	53
	C15	76	55	72	71	62	72	55	83	83	72	66	65	64	67	65
	C16	43	36	43	34	19	34	34	53	53	34	46	33	47	45	32
	C17	49	50	50	50	50	50	50	49	50	50	50	50	50	50	31

Statistical Analysis

The raw scores were standardized to Z scores per the following calculation:

$$Z \text{ score} = \frac{[\text{Subjects Attractiveness rating} - \text{Population mean rating score}]}{\text{Population's standard deviation}}$$

Friedman's post hoc test and Wilcoxon signed ranks test were used for analysis of the data. Pairwise comparisons of the original view to each of the altered views -- -2mm, +2mm, +4mm, +6mm -- were analyzed using the Wilcoxon signed ranks test. The factors involved were evaluator ethnicity (Caucasian, African American, and Asian), model ethnicity (Caucasian, African American, and Asian), and forehead position (five variations per subject).

CHAPTER III: RESULTS

The mean Z-scores for each model are represented by the bar graphs in Figures 7-9. The x-axis represents the evaluator ethnicity category and the y-axis represents the mean Z-score. A positive number on the y axis represents an attractive (high) rating on the VAS scale and a negative number represents an unattractive (low) rating on the VAS scale.

Figure 7.

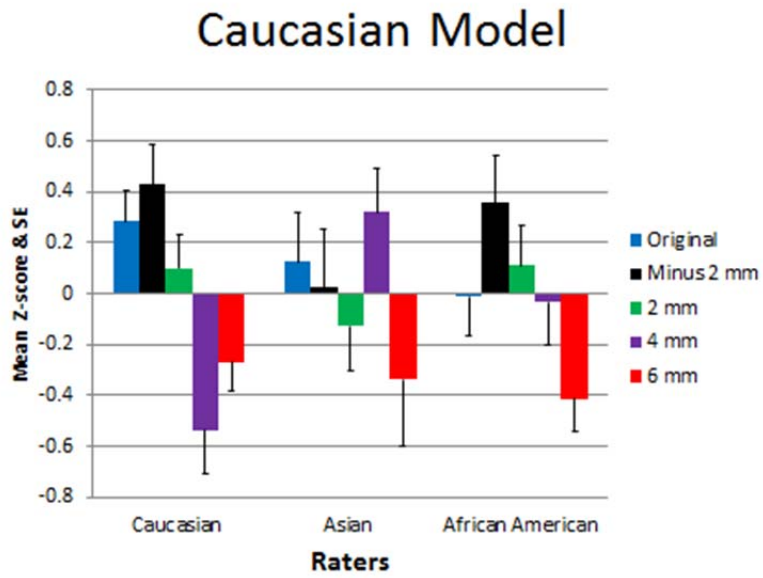


Figure 8.

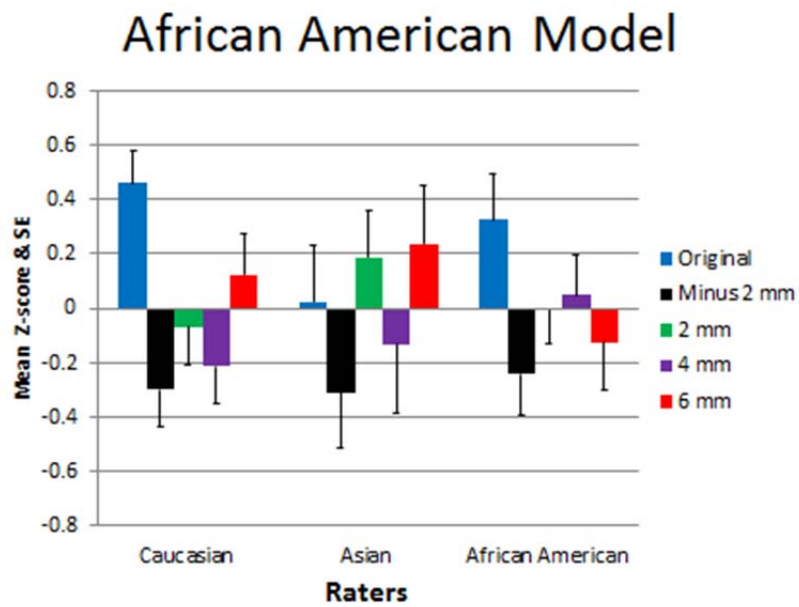


Figure 9.

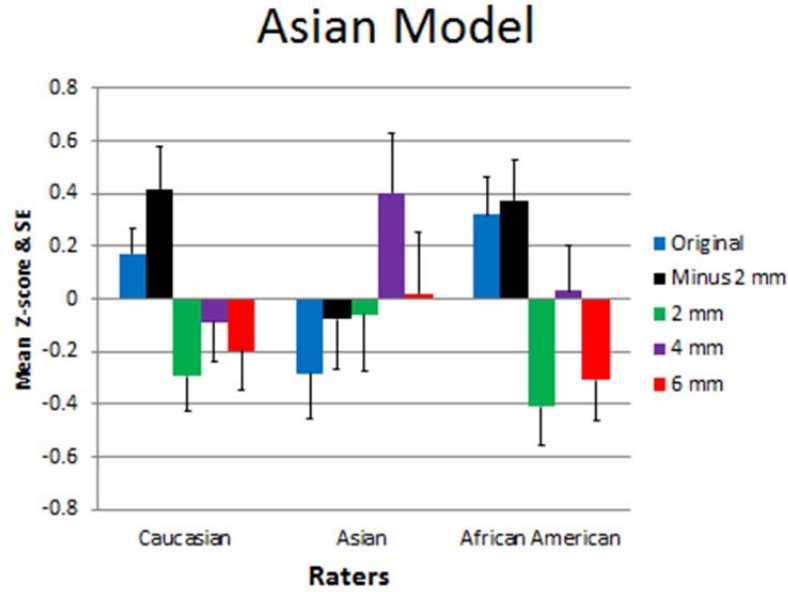


Table 2 represents the pairwise comparisons of Z-scores between the original photographs to the altered photographs for each model and each ethnic group of evaluators. Significance is depicted in red. Using a p-value of 0.0125, the following results were deemed statistically significant:

- For the Caucasian model, Caucasian evaluators showed a preference for the original photograph over those with the forehead positioned 4 and 6mm anteriorly;
- For the African American model, Caucasian evaluators showed a preference for the original photograph over those with the forehead positioned 2mm posteriorly and 2 and 4mm anteriorly;
- For the Asian model, Caucasian evaluators showed a preference for the original photograph over those with the forehead positioned 2mm anteriorly;

and African American evaluators showed a preference for the original photograph over those with the forehead positioned 2 and 6mm anteriorly.

Table 2.

	Caucasian Model, Caucasian Evaluator				African American Model, Caucasian Evaluator				Asian Model, Caucasian Evaluator						
	Z_Cm2 - Z_CO	Z_C2 - Z_CO	Z_C4 - Z_CO	Z_C6 - Z_CO	Z_AA2 - Z_AAO	Z_AA2 - Z_AAO	Z_AA4 - Z_AAO	Z_AA6 - Z_AAO	Z_Am2 - Z_AO	Z_A2 - Z_AO	Z_A4 - Z_AO	Z_A6 - Z_AO			
Caucasian Evaluator	Asymp. Sig. (2-tailed)	0.394	0.455	0.012	0.003	0.008	0.006	0.099	0.281	0.018	0.14	0.063			
African American Evaluator	Caucasian Model, African American Evaluator				African American Model, African American Evaluator				Asian Model, African American Evaluator						
	Z	Z_Cm2 - Z_CO	Z_C2 - Z_CO	Z_C4 - Z_CO	Z_C6 - Z_CO	Z	Z_AA2 - Z_AAO	Z_AA2 - Z_AAO	Z_AA4 - Z_AAO	Z_AA6 - Z_AAO	Z	Z_Am2 - Z_AO	Z_A2 - Z_AO	Z_A4 - Z_AO	Z_A6 - Z_AO
		-1.287 ^f	-.475 ^e	-.075 ^d	-1.892 ^f		-1.999 ^e	-1.078 ^e	-1.208 ^e	-1.966 ^e		-.402 ^e	-2.616 ^d	-1.071 ^d	-2.585 ^d
	Asymp. Sig. (2-tailed)	0.198	0.632	0.94	0.059	0.046	0.281	0.227	0.049	0.687	0.009	0.284	0.01		
Asian Evaluator	Caucasian Model, Asian Evaluator				African American Model, Asian Evaluator				Asian Model, Asian Evaluator						
	Z	Z_Cm2 - Z_CO	Z_C2 - Z_CO	Z_C4 - Z_CO	Z_C6 - Z_CO	Z	Z_AA2 - Z_AAO	Z_AA2 - Z_AAO	Z_AA4 - Z_AAO	Z_AA6 - Z_AAO	Z	Z_Am2 - Z_AO	Z_A2 - Z_AO	Z_A4 - Z_AO	Z_A6 - Z_AO
		-.549 ^e	-.714 ^e	-.746 ^d	-1.227 ^f		-.784 ^e	-.667 ^d	-.314 ^e	-.804 ^d		-.784 ^e	-.769 ^e	-1.538 ^e	-1.007 ^f
	Asymp. Sig. (2-tailed)	0.583	0.475	0.456	0.22	0.433	0.505	0.754	0.422	0.433	0.442	0.124	0.314		
		Caucasian Model				African American Model				Asian Model					
		C	Caucasian	m2	Forehead -2mm										
		AA	African American	O	Forehead original										
		A	Asian	2	Forehead +2mm										
				4	Forehead +4mm										
				6	Forehead +6mm										

CHAPTER IV: DISCUSSION

Data Analysis:

The Caucasian evaluator group (n=31) was able to produce significant results for all three models: They demonstrated a preference of the original photographs to several of the altered Caucasian, African American, and Asian photographs. This is in disagreement with Ellis’ study (Ellis et al., 2017), in which the mostly Caucasian

evaluators were able to produce significant results only with several of the Caucasian photographs. This is of interest because in the current study, all of the evaluators were laypersons without any training or experience in the dental field; while in the Ellis study, 20 of the 40 evaluators were American-trained dentists who demonstrated a keener eye to minute changes in profile compared with the laypersons (Ellis et al. 2017).

The African American evaluator group in this study (n=28), of similar size with the Caucasian evaluator group, was only able to produce significant results with some of the Asian model photographs but not the Caucasian and African American model photographs. This may be attributed to either a small sample size for this group, or may represent the phenomena described by Nomura and colleagues, where different evaluator groups separated by ethnicity displayed disparate lip profile preferences (Nomura et al., 2009).

There were no statistically significant results for Asian evaluators. This may be attributed to the small sample size, 17, of this group compared with the other evaluator groups (31 Caucasian, 28 African American). This may have been the result of the smaller percentage of potential Asian evaluator volunteers available at WRNMMC, a United States military facility. Ideally, a larger number of Asian evaluators should have been obtained and would have occurred with a longer data collection time period or if evaluator recruitment was performed outside of this facility.

Trends:

No trends relating antero-posterior forehead positioning and subjective ratings of attractiveness could be ascertained by the data. For example, there was no clear evidence

that attractiveness increased or decreased with each incremental change in forehead position.

Project Design Considerations:

18 of 76 evaluators, or 24%, rated all five photographs of each model exactly the same, with six coming from the Caucasian evaluator group, nine from the African American evaluator group, and four from the Asian evaluator group. There are two possible reasons for this, both gleaned from evaluator comments made during and after rating the photographs: First, several evaluators commented that they were unable to discern differences between the photographs; secondly, several evaluators commented that they were uncomfortable making judgments on a person's appearance. The first point is not problematic as one of the reasons for this research was to assess whether evaluators were able to detect these minute changes. The second point, however, potentially created unreliable data points, particularly if the evaluator made the tacit decision to rate all photographs the same regardless of their true opinions. A potential solution to combat this problem for future research would be to have the photographs presented electronically - with the evaluator out of sight of the investigator - in order to preserve evaluator anonymity and elicit more truthful responses.

Another common evaluator comment was that they were able to detect what changes were being made between photographs after already viewing several photographs. The photographs were sequenced in the same order for all surveys, with the five Asian photographs being presented first, followed by the five African American photographs, and the five Caucasian photographs being presented last. If learning

occurred in the evaluators during the course of taking the survey, loss of blinding to the purpose of the research would be more apparent in the data for Caucasian model photographs versus the other model photographs. Potential solutions would be to randomize the sequence of photographs for each survey taken and/or eliminate the grouping of photographs so that all of one model's photographs are not viewed consecutively.

Lastly, all three of the models exhibited maxillary incisors anterior to L.F. Andrews' boundaries, and to varying degrees. Their foreheads were digitally manipulated from this starting point, and this starting point was used as a reference against which the manipulated photographs were compared. However, if the main purpose of this research was to investigate L.F. Andrews' Element II philosophy, using models whose profiles coincided with L.F. Andrews' ideal would have provided more useful results. Alternatively, if models with this "ideal" profile could not be identified and recruited to participate in this research, the profiles of models with non-ideal profiles should have been digitally manipulated until they did fit Andrews' ideal and this should have been designated as the starting reference profile.

CHAPTER V: CONCLUSIONS

There have been many proposals but no consensus regarding the most esthetic dentoskeletal profile form. L.F. Andrews proposed aligning the antero-posterior position of the forehead and maxillary incisors, but strong scientific evidence supporting this does not exist. Additionally, previous studies have shown that ethnic variation exists with respect to facial profile esthetic preferences.

This study demonstrated a possible variation between Caucasian and African American evaluators' evaluations of Caucasian, African American, and Asian female models when the forehead was digitally manipulated. Comparisons with Asian evaluators could not be made due to the small sample size of this group.

No trends relating relative forehead position with attractiveness was elucidated, which could be remedied by repeating this study with a larger number of evaluators for all ethnic groups. Evaluator truthfulness may have been an issue, which could be rectified by conducting the survey without the direct presence of the investigator. Learning may have occurred with evaluators the further they progressed through the survey; this could be addressed by randomizing the photographs for each survey and by not grouping all photographs of one model together. Lastly, no data was collected directly testing L.F. Andrews' philosophy due to poor model selection; the reference models should either exhibit profiles in line with Andrews' philosophy or be digitally manipulated so that they do.

APPENDIX A: MODEL PHOTOGRAPH RELEASE FORMS

HIPAA PRIVACY		OFFICE OF PUBLIC AFFAIRS AUTHORIZATION FOR RELEASE OF INFORMATION (MEDIA)	
YOUR INFORMATION			
LAST NAME: Holmes	FIRST NAME AND MIDDLE INITIAL: Carla L.	PHONE NUMBER: (760) 231-5569	
ADDRESS 1103 Ivy Club Ln. Apt 243	CITY/STATE: Landover, MD	ZIP CODE: 20785	
Person/Organization Providing the Information <i>[DoD 6025.18-R C5.3.1.2]</i>		Person/Organization to Receive the Information <i>[DoD 6025.18-R C5.3.1.3]</i>	
Naval Postgraduate Dental School, WRNMMC Bethesda, MD		Naval Postgraduate Dental School staff and residents	

Description of the Information to be Released (Provide a detailed description of the specific information to be released) <i>[DoD 6025.18-R, C5.3.1.1]</i> <i>Photographs, video, audio, and digital images, including full-face representations, to be recorded of me or parts of my body in the course of evaluation and treatment at the Naval Postgraduate Dental School.</i>

Description of Each Purpose for the Use or Release of the Information (Provide a detailed description of the activity for which the information will be used) <i>[DoD 6025.18-R, C5.3.1.4]</i> <i>For use in medical, dental, scientific, and educational presentations, in resident and continuing education course materials (including those published online), in articles being written for scientific publications, as well as on specialty boards. When used for non-patient treatment purposes all personal identifying data (name, date of birth, SSN, etc) will be removed.</i>

This authorization for release of the above information to the above named persons/organizations will expire on: **N/A** (date)

I understand:

- I authorize the use or disclosure of my individually identifiable health information as described above for the purpose listed. I understand that this authorization is voluntary. *CLH*
- I have the right to revoke this authorization. *[DoD 6025.18-R C5.3.2.1] CLH*
- I understand the Notice of Privacy Practices provides instructions should I choose to revoke my authorization. *CLH*
- **I understand that I cannot revoke information once it has been given to the media, because the covered entity has taken action in reliance on the authorization.** *[DoD 6025.18-R C5.2.5] CLH*
- I understand that I am signing this authorization voluntarily and that treatment, payment or eligibility for my benefits will not be affected if I do not sign this authorization. *[DoD 6025.18-R C5.3.2.2.1] CLH*
- I understand if the organization I have authorized to receive the information is not a health plan or health care provider, the released information may no longer be protected by federal privacy regulations. *[DoD 6025.18-R C5.3.2.3] CLH*
- I understand I have the right to receive a copy of this authorization. *[DoD 6025.18-R C5.3.4] CLH*
- I understand DoD covered entities may use and disclose Protected Health Information (PHI) of individuals who are Armed Forces personnel for activities deemed necessary by appropriate military command authorities to assure the proper execution of the military mission. *[DoD 6025.18-R C7.11.1.1] CLH*

Signature: <i>[Handwritten Signature]</i> <i>[DoD 6025.18-R, C5.3.1.6]</i>	Signature of Parent (if patient is under legal age of consent):	Date: 2 April 15
--	---	---------------------

When using or disclosing Protected Health Information (PHI) in any form or when requesting PHI from another covered entity, a covered entity shall make reasonable efforts to limit the use, disclosure, or request of PHI to the minimum necessary to accomplish the intended purpose of the use, disclosure, or request. [DoD 6025.18-R C8.2.1]

HIPAA PRIVACY

OFFICE OF PUBLIC AFFAIRS AUTHORIZATION FOR RELEASE OF INFORMATION (MEDIA)

YOUR INFORMATION		
LAST NAME: <i>Photkhamyath</i>	FIRST NAME AND MIDDLE INITIAL: <i>Khamrah Nmi</i>	PHONE NUMBER: <i>703 944 0317</i>
ADDRESS <i>Raymond Ct. 2826 Falls Church Rd</i>	CITY/STATE: <i>Falls Church VA</i>	ZIP CODE: <i>22072</i>

Person/Organization Providing the Information <i>[DoD 6025.18R C5.3.1.2]</i>	Person/Organization to Receive the Information <i>[DoD 6025.18R C5.3.1.3]</i>
Naval Postgraduate Dental School, WRNMMC Bethesda, MD	Naval Postgraduate Dental School staff and residents

Description of the Information to be Released
(Provide a detailed description of the specific information to be released)
[DoD 6025.18-R, C5.3.1.1]

Photographs, video, audio, and digital images, including full-face representations, to be recorded of me or parts of my body in the course of evaluation and treatment at the Naval Postgraduate Dental School.

Description of Each Purpose for the Use or Release of the Information
(Provide a detailed description of the activity for which the information will be used)
[DoD 6025.18-R, C5.3.1.4]

For use in medical, dental, scientific, and educational presentations; in resident and continuing education course materials (including those published online), in articles being written for scientific publications, as well as on specialty boards. When used for non-patient treatment purposes all personal identifying data (name, date of birth, SSN, etc) will be removed.

This authorization for release of the above information to the above named persons/organizations will expire on: **N/A** (date)

I understand:

- I authorize the use or disclosure of my individually identifiable health information as described above for the purpose listed. I understand that this authorization is voluntary.
- I have the right to revoke this authorization. *[DoD 6025.18-R C5.3.2.1]*
- I understand the Notice of Privacy Practices provides instructions should I choose to revoke my authorization.
- **I understand that I cannot revoke information once it has been given to the media, because the covered entity has taken action in reliance on the authorization.** *[DoD 6025.18-R C5.2.5]*
- I understand that I am signing this authorization voluntarily and that treatment, payment or eligibility for my benefits will not be affected if I do not sign this authorization. *[DoD 6025.18-R C5.3.2.2.1]*
- I understand if the organization I have authorized to receive the information is not a health plan or health care provider, the released information may no longer be protected by federal privacy regulations. *[DoD 6025.18-R C5.3.2.3]*
- I understand I have the right to receive a copy of this authorization. *[DoD 6025.18-R C5.3.4]*
- I understand DoD covered entities may use and disclose Protected Health Information (PHI) of individuals who are Armed Forces personnel for activities deemed necessary by appropriate military command authorities to assure the proper execution of the military mission. *[DoD 6025.18-R C7.11.1.1]*

Signature: <i>R. Photkhamyath</i> <i>[DoD 6025.18-R, C5.3.1.6].</i>	Signature of Parent (if patient is under legal age of consent):	Date: <i>11 MAR 2015</i>
---	---	-----------------------------

When using or disclosing Protected Health Information (PHI) in any form or when requesting PHI from another covered entity, a covered entity shall make reasonable efforts to limit the use, disclosure, or request of PHI to the minimum necessary to accomplish the intended purpose of the use, disclosure, or request. [DoD 6025.18-R C8.2.1]

HIPAA PRIVACY

OFFICE OF PUBLIC AFFAIRS AUTHORIZATION FOR RELEASE OF INFORMATION (MEDIA)

YOUR INFORMATION		
LAST NAME: <i>Ward</i>	FIRST NAME AND MIDDLE INITIAL: <i>Chloe E.</i>	PHONE NUMBER: <i>404 345 0216</i>
ADDRESS <i>3516 Anderson Road</i>	CITY/STATE: <i>Kensington, MD</i>	ZIP CODE: <i>20895</i>

Person/Organization Providing the Information <i>[DoD 6025.18R C5.3.1.2]</i>	Person/Organization to Receive the Information <i>[DoD 6025.18R C5.3.1.3]</i>
Naval Postgraduate Dental School, WRNMMC Bethesda, MD	Naval Postgraduate Dental School staff and residents

Description of the Information to be Released
(Provide a detailed description of the specific information to be released)
[DoD 6025.18-R, C5.3.1.1]

Photographs, video, audio, and digital images, including full-face representations, to be recorded of me or parts of my body in the course of evaluation and treatment at the Naval Postgraduate Dental School.

Description of Each Purpose for the Use or Release of the Information
(Provide a detailed description of the activity for which the information will be used)
[DoD 6025.18-R, C5.3.1.4]

For use in medical, dental, scientific, and educational presentations, in resident and continuing education course materials (including those published online), in articles being written for scientific publications, as well as on specialty boards. When used for non-patient treatment purposes all personal identifying data (name, date of birth, SSN, etc) will be removed.

This authorization for release of the above information to the above named persons/organizations will expire on: **N/A** (date)

I understand:

- I authorize the use or disclosure of my individually identifiable health information as described above for the purpose listed. I understand that this authorization is voluntary.
- I have the right to revoke this authorization. *[DoD 6025.18-R C5.3.2.1]*
- I understand the Notice of Privacy Practices provides instructions should I choose to revoke my authorization.
- **I understand that I cannot revoke information once it has been given to the media, because the covered entity has taken action in reliance on the authorization.** *[DoD 6025.18-R C5.2.5]*
- I understand that I am signing this authorization voluntarily and that treatment, payment or eligibility for my benefits will not be affected if I do not sign this authorization. *[DoD 6025.18-R C5.3.2.2.1]*
- I understand if the organization I have authorized to receive the information is not a health plan or health care provider, the released information may no longer be protected by federal privacy regulations. *[DoD 6025.18-R C5.3.2.3]*
- I understand I have the right to receive a copy of this authorization. *[DoD 6025.18-R C5.3.4]*
- I understand DoD covered entities may use and disclose Protected Health Information (PHI) of individuals who are Armed Forces personnel for activities deemed necessary by appropriate military command authorities to assure the proper execution of the military mission. *[DoD 6025.18-R C7.11.1.1]*

Signature: <i>Chloe E Ward</i> <i>[DoD 6025.18-R, C5.3.1.6]</i>	Signature of Parent (if patient is under legal age of consent):	Date: 11 MARCH 2015
---	---	-------------------------------

When using or disclosing Protected Health Information (PHI) in any form or when requesting PHI from another covered entity, a covered entity shall make reasonable efforts to limit the use, disclosure, or request of PHI to the minimum necessary to accomplish the intended purpose of the use, disclosure, or request. [DoD 6025.18-R C8.2.1]

APPENDIX B: RESEARCH APPROVAL LETTERS

Walter Reed National Military Medical Center
Department of Research Programs
8901 Wisconsin Avenue
Bethesda, MD 20889-5600

Date: January 10, 2017

MEMORANDUM FOR Ku, Jimmy
SUBJECT: No Change in Determination Status

PROJECT #: 395642
REFERENCE #: 878470
PROJECT TITLE: The effects of Computer-aided Antero-posterior Forehead Movement on Ratings of Facial Attractiveness
DETERMINATION: Change of Principal Investigator

DECISION DATE: 01/10/2017

1. The Department of Research Programs has received your modification documents for above referenced project. The WRNMMC DRP Determinations Official has determined that your project has not changed in determination status.
2. Should your involvement with this project change, please contact the Determinations Official to ensure that the changes do not impact this determination.
3. Submit all proposed changes to the project for review and approval before initiating the changes.
4. If you have any questions, the POC is Sanjur Brooks, DPS at 240-295-8273 or Sanjur.Brooks.civ@mail.mil. Please include your project title and reference number in all correspondence

Respectfully,

BROOKS.SA

R.1516532374

Sanjur Brooks, DPS, M.A.
Human Protections Administrator
Department of Research Programs

FORMERLY: 8901 WISCONSIN AVENUE
BETHESDA, MD 20889-5600
TEL: 301-295-8273
WWW.WALTERREED.MIL

WALTER REED NATIONAL MILITARY MEDICAL CENTER
Department of Research Programs
8901 WISCONSIN AVENUE
BETHESDA MARYLAND 20889-5600

Date: December 16, 2016

From: Director, Walter Reed National Military Medical Center, Bethesda, Maryland 20889
To: Hartzell, David Haichi

Subject: START LETTER - APPROVAL OF RESEARCH PROJECT 395642, The effects of Computer-aided Antero-posterior Forehead Movement on Ratings of Facial Attractiveness

Reference #: 876586

1. Congratulations! You have been granted approval to conduct your research project at Walter Reed National Military Medical Center, Bethesda (WRNMMC).
2. Your research protocol was approved after administrative, scientific, and ethical review by the Department of Research Programs (DRP) and the Determinations Officer. Other requirements such as agreements and committee requirements have been met, waived by the DRP chief, or determined unnecessary.
3. The Determinations Official has determined that this project is EXEMPT FROM IRB REVIEW according to IAW 32 CFR 219.101 (b)(2).
4. It is your responsibility as the Principal Investigator to have complete and accurate knowledge of what your protocol states you are allowed to do, and of any research agreements you have associated with your research.
5. You are reminded to provide all amendments, deviations, internal adverse events, or any other pertinent information to DRP as a new package. Submit all proposed changes to the study for review and approval before initiating the changes. When you complete your research you must file a closure report.
6. All written publications, clinical or research related, including abstracts, manuscripts, case reports and book chapters (e.g. reports of WRNMMC approved clinical investigation or research conducted by WRNMMC-assigned personnel; reports involving WRNMMC patients; reports citing WRNMMC in the title or byline) reflecting the WRNMMC affiliation must be submitted to WRNMMC publication clearance committee.

Page 1 of 2

-
7. Please do not hesitate to contact the Determinations Official for assistance or the undersigned at (301) 295-8219 or ann.m.naybackbeebe.mil@mail.mil with questions or concerns.

NAYBACKBEEBE. Digitally signed by
NAYBACKBEEBE.ANN.MARIE.11335671
23
DN: c=US, o=U.S. Government, ou=DoD, ou=PKI,
.MARIE.113356712 ou=USA,
3 cn=NAYBACKBEEBE.ANN.MARIE.1133567123
Date: 2016.12.19 08:13:03 -05'00'

ANN M. NAYBACK-BEEBE
COLONEL, U.S. ARMY
ACTING CHIEF, DEPT. OF RESEARCH PROGRAMS

REFERENCES:

1. Adams, M., Andrews, W., Tremont, T., Martin, C., Razmus, T., Gunel, E., & Ngan, P. (2013). Anteroposterior relationship of the maxillary central incisors to the forehead in adult white males. *Orthodontics The Art and Practice of Dentofacial Enhancement, 14*(1).
2. Albino, J., Cunat, J., Fox, R., Lewis, E., Slakter, M., & Tedesco, L. (1981). Variables Discriminating Individuals who Seek Orthodontic Treatment. *Journal of Dental Research, 60*(9), 1661-1667.
3. Andrews LF. Syllabus of the Andrews Orthodontic Philosophy, 9th ed. San Diego, CA. The Lawrence F. Andrews Foundation. 2001.
4. Andrews, W. A. (2008). AP Relationship of the Maxillary Central Incisors to the Forehead in Adult White Females. *The Angle Orthodontist, 78*(4), 662-669.
5. Angle, E. H. (1900). *Treatment of Malocclusion of the Teeth and Fractures of the Maxillae*. Philadelphia, PA: The S.S. White Dental Manufacturing Company.
6. Arnett, G., & Gunson, M. J. (2004). Facial planning for orthodontists and oral surgeons. *American Journal of Orthodontics and Dentofacial Orthopedics, 126*(3), 290-295.
7. Chong, H. T., Thea, K. W., Descallar, J., Chen, Y., Dalci, O., Wong, R., & Darendeliler, M. A. (2014). Comparison of White and Chinese perception of esthetic Chinese lip position. *The Angle Orthodontist, 84*(2), 246-253.
8. Ellis, H. S., Hamidzadeh, F., Stefanos, S. M., Rouhanian, M., Huber, J. H., & Ye, L. (2017). The Effects of Computer-Aided Anteroposterior Forehead Movement on Ratings of Facial Attractiveness. *Journal of Dental and Oral Health, 3*(5), 1-7.

9. Hall, D., Taylor, R. W., Jacobson, A., Sadowsky, P., & Bartolucci, A. (2000). The perception of optimal profile in African Americans versus white Americans as assessed by orthodontists and the lay public. *American Journal of Orthodontics and Dentofacial Orthopedics*, 118(5), 514-525
10. Mejia-Maidl, M. (2005). Preferences for Facial Profiles Between Mexican Americans and Caucasians. *The Angle Orthodontist*, 75(6), 953-958.
11. Moss, J., Linney, A., & Lowey, M. (1995). The use of three-dimensional techniques in facial esthetics. *Seminars in Orthodontics*, 1(2), 94-104.
12. Nomura, M., Motegi, E., Hatch, J. P., Gakunga, P. T., Nganga, P. M., Rugh, J. D., & Yamaguchi, H. (2009). Esthetic preferences of European American, Hispanic American, Japanese, and African judges for soft-tissue profiles. *American Journal of Orthodontics and Dentofacial Orthopedics*, 135(4).
13. Peck, H., & Peck, S. (1970). A Concept of Facial Esthetics. *Proceedings of the E.H. Angle Society*, 40(4), 284-318.
14. Proffit, W. R., Fields, H. W., & Sarver, D. M. (2007). *Contemporary orthodontics* (4th ed.). St. Louis, MO: Elsevier/Mosby.
15. Schlosser, J. B., Preston, C. B., & Lampasso, J. (2005). The effects of computer-aided anteroposterior maxillary incisor movement on ratings of facial attractiveness. *American Journal of Orthodontics and Dentofacial Orthopedics*, 127(1), 17-24.
16. Turley, P. K. (2015). Evolution of esthetic considerations in orthodontics. *American Journal of Orthodontics and Dentofacial Orthopedics*, 148(3), 374-379.
17. Tweed, C. H. (1946). The Frankfort-mandibular plane angle in orthodontic diagnosis,

classification, treatment planning, and prognosis. *American Journal of Orthodontics and Oral Surgery*, 32(4), 175-230.