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Influence of facial profile on social perceptions: a 3D video imaging study.

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Influence of facial profile on social perceptions: a 3D video imaging study.

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

by

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Table of Contents

List of Tables

List of Figures

List of Appendix Tables

Abstract

INFLUENCE OF FACIAL PROFILE ON SOCIAL PERCEPTIONS: A 3D VIDEO IMAGING STUDY

By: Lisa Marie Babb, D.M.D.

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The purpose of this study was to evaluate the influence of facial convexity on the perception of social attributes in a young adult population. Nine models were asked to pose for a 3 dimensional photograph that was then modified to represent ideal, retrognathic, and prognathic facial convexity angles. Survey evaluators were shown digital videos of models with ideal and non-ideal profiles and asked to rate their perception of the following 4 social attributes: intelligence, athleticism, popularity, and leadership ability using a visual analog scale. Results gathered from 271 evaluators showed that the model images with ideal facial convexity angles were rated higher on average than the same model images with retrognathic and prognathic profiles. The differences in ratings between ideal and non-ideal profiles were significant for intelligence ($P = 0.0009$), athleticism ($P = 0.0002$), and leadership ability ($P = 0.0008$). Differences in perceived popularity ($P = 0.2169$) showed no significant differences among facial convexities.

Introduction

For orthodontists, the main treatment objective is to establish an ideal occlusion while improving dentofacial esthetics. Cosmetic improvement, generally to match the ideal image portrayed by media, and social pressures are the top reasons reported by patients choosing to undergo orthodontic treatment.[1-3] Similarly, enhanced facial appearance is the main motivational factor given by individuals for wanting to pursue orthognathic surgery.[4,5] While a majority of patients can be treated to an acceptable occlusion with orthodontics alone, non-growing patients with underlying skeletal discrepancies might not benefit from solely dental movement. In these cases, it is important to understand the patient's motivation for treatment. When a profile change is desired, orthodontic treatment in conjunction with orthognathic surgery might be necessary to attain an ideal result.

In 1993, Czarnecki et al.[6] surveyed a group of dental professionals to find the most preferred facial profile convexity. They asked respondents to evaluate androgynous silhouettes and discovered that profiles with retrusive chins were the least preferred when compared to silhouettes with ideal or straight profile convexity. This was in agreement with an earlier study which evaluated facial harmony and found increased profile convexity was consistently ranked lowest for desired facial balance when judged by orthodontists and laymen.[7] Lines et al.[8] had similar findings when they asked groups of dental professionals and laymen to identify the most preferred amount of chin prominence for men and women. The evaluators chose from five silhouettes with varying degrees of chin prominence. The results showed that silhouettes with the most prominent or retrusive chins were least preferred overall.

The notion that individuals with pleasing physical appearances are more socially accepted is widely acknowledged.[9-12] Psychological research has repeatedly shown that better-looking subjects are assumed to be more intelligent and likely to experience more successful careers.[13-15] This physical attractiveness stereotype suggests that attractive people are judged more favorably in their personal life as well. Attractive people were perceived as more sociable, friendly, and kind.[9] Overall, evaluators assumed that an attractive individual had a higher level of happiness.[9] These findings were reinforced in a study that suggested first impressions could initiate a process that leads to behavioral confirmation.[16] In other words, social perceptions have a self-fulfilling nature. This appeared to be true in young adults among which better-looking individuals were considered more socially competent and actually experienced better social lives.[17] Goldman and Lewis[18] found evidence in support of this idea when they discovered that young adults who were considered more physically attractive also had better social skills. Based on the idea of this ‘self-fulfilling prophecy’ effect, it is reasonable to believe that attractive individuals have an advantage over their less attractive peers.[16]

Several studies have evaluated the effect of malocclusion on overall attractiveness and social perception.[19-21] The findings have been useful in defining factors that determine appealing facial features. Shaw et al.[19] analyzed how dentofacial appearance would affect the social attractiveness of young adults. They asked a group of young adults to evaluate a single photograph and assess the social attributes of the individual depicted in the picture. There were a total of 20 photographs containing an attractive male, unattractive male, attractive female, or unattractive female. The person in the picture had either an ideal occlusion or 1 of 4 different malocclusions. They found that persons having ideal smiles were ranked the highest in personality traits including intelligence, friendliness, and popularity. Henson et al.[20] concluded that subjects with ideal dental esthetics were judged by peers as more athletic, popular and more competent leaders. Most recently, Olsen and Inglehart[21] evaluated the effect of malocclusion on the layperson's social perceptions of attractiveness, intelligence, and personality. They found that evaluators ranked the individuals depicted with an anterior crossbite lowest in attractiveness, intelligence, and extraversion. These studies showed that malocclusion detracts from a person's level of appeal and in turn could lead to negative social interactions.

The majority of psychological and dental studies that assessed the effect of appearance on perceived social skills utilized only a frontal view of the models evaluated. While many studies have examined the average values for profile measurements[22-25] as well as what values are esthetically preferred,[6-8] few have examined the effect of soft-tissue profile variations on social perceptions. Tüfekçi et al.[26] found that individuals who recognized their profiles as being different than average were generally unhappy with their facial appearance but did not relate this finding to how these individuals were perceived socially. When Olsen and Inglehart[21] related malocclusion to social perception, evaluators saw only a frontal and three-quarters profile view.

Most studies that have evaluated soft tissue profile preferences used androgynous silhouettes.[6-8,27,28] Hockley et al.[29] found that when rating profile appearance, a rater's preferences were more similar to accepted norms when viewing detailed photographs of subjects than when evaluating androgynous silhouettes. Phillips et al.[30] also evaluated the validity and reliability of results based on the subject presentation method. They asked 3 panels of judges consisting of orthodontic residents, dental students, and college undergraduate students to evaluate subjects through three different views: 2 full facial (one smiling and one resting) and one profile view. Images of the subjects were presented in a randomized order and they found that no single facial view was consistently ranked as the most attractive option among respondents. Based on their findings, they recommended using multiple views of the subject to achieve the most valid results regarding facial attractiveness and treatment need. Howells and Shaw[31] investigated the correlation of ratings between a 3 dimensional living subject and a 2 dimensional, three-quarters profile view of the same subject. They found that although this method was convenient, only a moderate correlation existed between the ratings of the live individuals and their 2D images.

Use of 3D technology to evaluate the soft-tissue profile is a technique that has been refined over many years. Three-dimensional photogrammetry in orthodontic and surgical treatment planning first appeared in the literature in 1987.[32] More recently, 3D images have been used to assess the perception of symmetry in orthodontic and cleft lip and palate patients.[33,34] Weinberg et al.[35] investigated the accuracy and precision of two different 3D camera systems compared with direct anthropometry and found that all three methods were accurate to a submillimeter level. The results also suggested that users were capable of locating anthropometric landmarks with a very high degree of precision using 3D surface imaging systems.

Profile esthetics is an important component of orthodontic treatment planning. The purpose of this study was to evaluate the influence of facial convexity on the perception of social attributes in a young adult population. Three-dimensional video imaging was used to create the models of various facial profiles that were viewed by evaluators. In each video, the model's head rotated from side to side showing the image from all angles, including full profile and facial front view. All aspects of the model's faces were visible in this study to give the evaluators the physical information necessary to rate the images according to their own preference. The null hypothesis was that there is no difference in the perception of social attributes between young adults with ideal and non-ideal facial profiles.

Materials and Methods

Institutional review board approval was obtained from Virginia Commonwealth University (VCU) to conduct this study. Three-dimensional photogrammetric data of 9 students from the VCU School of Dentistry were obtained using the 3dMDface system (3dMD, Atlanta, GA). The students included were either African American or white, over the age of 18, and presented with no facial deformities. The starting facial convexity of the models did not matter because their images would be modified to suit the needs of the study. All 9 models were volunteers and consented to allow their images to be modified digitally for the purpose of this study.

For each image, the model was asked to have their lips lightly touching so that no interlabial gap was present. In this way, with the lips sealed, dental esthetics could have no effect on how the models would be assessed by evaluators. Using the 3dMDvultus Software Platform (Version 2.2.0.10, Atlanta, GA), each of the 9 images was modified to ideal, retrognathic, and prognathic facial convexity angles. The soft-tissue points and lines used to construct the facial convexity angle can be seen in Figure 1. According to recognized average values, white models were all adjusted to an ideal facial convexity angle of 12° (±4°) and African American models to 11° (±5°).[23-25] To represent a moderate retrognathic or prognathic profile, all images were also adjusted to 2 standard deviations on either side of the ideal value. A list of the adjusted profile convexities can be found in Table I.

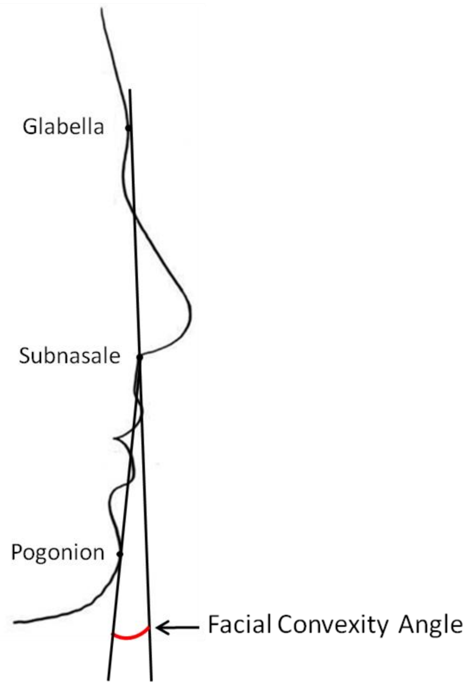

Figure 1. Facial convexity angle diagram

Table I. Profile convexities of digitally modified images

Race	Retrognathic	Ideal	Prognathic
African American	21°	11°	1°
White	20°	12°	4°

The lower lip was adjusted according to a study by Coleman et al.[36] which found that the lip position preferred by evaluators did not vary between Class I and moderate Class III profiles; for moderate Class II profiles, slightly more full lips were preferred. The lip and chin positions were modified in an anterior-posterior direction as needed to reach the appropriate facial convexity with balanced lips. All other attributes including the vertical dimension remained unchanged. Angles were measured using a cephalometric protractor (3M Unitek™, Monrovia, CA) overlaid onto the computer screen projecting the profile of the modified image.

After all necessary modifications were accomplished, a 20 second video of each image was made with the 3dMDvultus Software Platform. In the video, the model's head was positioned so that Camper's line (ala-tragus line) was parallel to the ground. The video clip began with the model's head facing straight forward and proceeded with the head slowly rotating right to left as if the image was slowly shaking its head 'no.' For eight of the nine models, a video was made for each of the three convexities. The ninth model had only one video made at an ideal convexity to serve as a control.

Using the 25 videos, three parallel surveys were constructed using Access 2007 (Microsoft, Redmond, Wash). Each survey contained 1 video of each subject in the ideal, retrognathic, or prognathic presentation. For example, if the video of an ideal model was in survey A, the retrognathic video was in survey B and the prognathic video was in survey C. The video of model 6 was the control and had an ideal profile convexity in all 3 surveys. The characteristics of the videos in each survey are listed in Table II. An example of one of the white male models with ideal and non-ideal profiles can be seen in Figure 2.

Table II. Model and convexity characteristics according to survey

			Survey A		Survey B		Survey C	
Race	Sex	Model[1]	Order	Convexity[2]	Order	Convexity[2]	Order	Convexity[2]
White	Male	Control	6	I	6	I	6	I
White	Female	WF1	2	I	2	P	3	R
White	Female	WF2	7	I	8	P	9	R
White	Male	WM1	8	P	9	R	5	I
White	Male	WM2	1	I	5	R	8	P
African American	Female	AF1	3	P	3	R	1	I
African American	Female	AF2	9	R	7	I	2	P
African American	Male	AM1	4	P	1	R	4	I
African American	Male	AM2	5	R	4	I	7	P

[1] Pictures were identified as control, 1 or 2 within each race, sex group. For example, WF1 is a white female number 1.
[2] Facial convexity: R=retrognathic, I=ideal, P=prognathic.

Figure 2. Digitally altered images of white male model in 3 profile presentations. A. Prognathic B. Ideal C. Retrognathic

Evaluators were asked to participate if they were over the age of 18. There were no other inclusion or exclusion criteria. Evaluators were recruited on the undergraduate Monroe Park campus of Virginia Commonwealth University. A total of 284 evaluators rated the videos in 1 of the 3 surveys by indicating their degree of agreement or disagreement with the following statements: (1) This person is intelligent. (2) This person is a good athlete. (3) This person is popular. (4) This person is a good leader.

Using a computer, each evaluator was given instructions on how to complete the survey. After reading the instructions, evaluators were randomized by the computer program to survey A, B, or C. Before viewing the videos, evaluators were prompted to enter their demographic information including age, sex, year in school and race/ethnicity. After entering demographic information, evaluators could view the videos. Videos appeared on the screen one at a time and next to each video were the 4 statements accompanied by a visual analog scale (VAS). On the VAS was a digital sliding bar starting at 50 (neutral), with 0 (completely disagree) to 100 (completely agree) as the anchors. A sample of the survey screen can be seen in Figure 3. There were 9 videos in each survey, each with 4 statements for a total of 36 ratings by each evaluator. At no time was any evaluator shown more than one video of the same model as each model appeared only once in each survey.

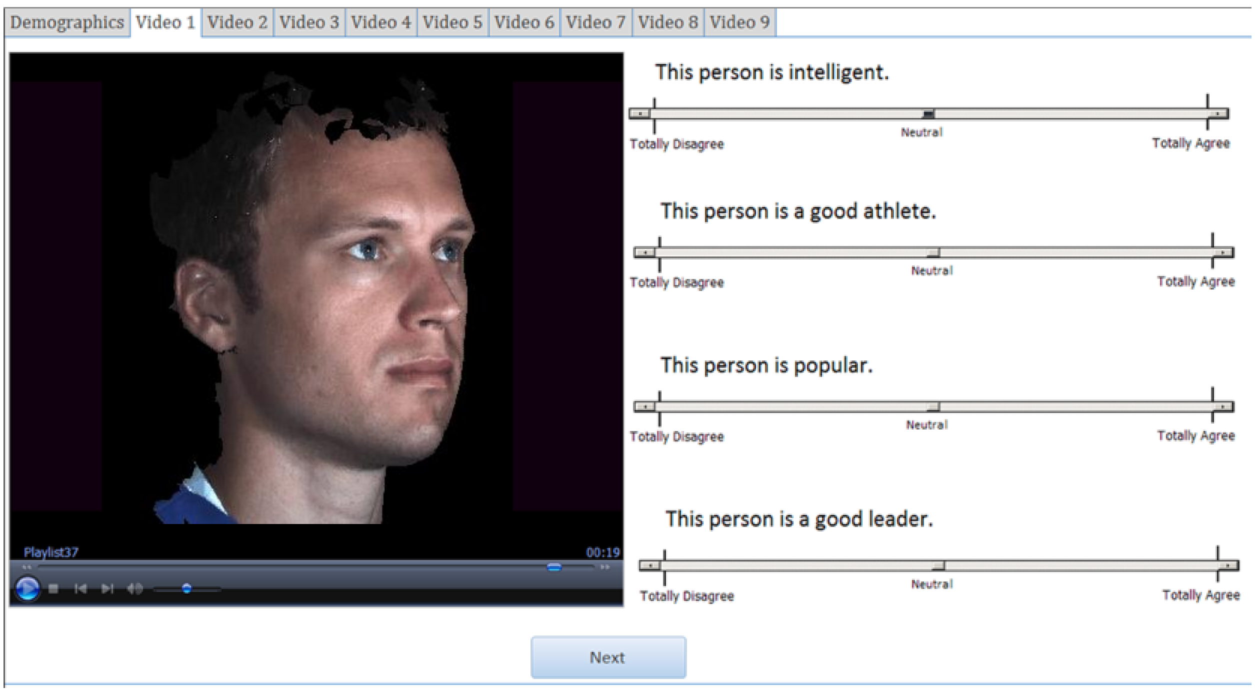

Figure 3. Survey screen as viewed by evaluators

The ratings for the 4 questions accompanying the control video of model 6, which was the same in all surveys, were compared between surveys A, B, and C using analysis of variance (ANOVA). The primary research interest was to determine whether the evaluators rated the models with non-ideal profiles differently than those with an ideal profile for the 4 social attributes: intelligence, athleticism, popularity, and leadership ability. In addition, evaluator characteristics such as sex, race, age, and survey group and model factors including sex and race were considered when testing for ideal versus non-ideal differences. This was accomplished by repeated-measures mixed-model analyses (SAS version 9.3, SAS Institute, Cary, NC).

Results

A total of 284 evaluators completed the survey. There were 13 evaluators who were excluded from further analyses because they had minimal or no variability in their responses on the 100 mm VAS scale, they were under the age of 18, or gave no demographic information at all. The demographic information of the 271 included evaluators is summarized in Table III. Overall, 57% of the evaluators were female; the mean age was 20.7 ± 3.0 yrs; 49% were white, 19% Asian, 17% African American, 8% Hispanic, and other ethnic groups comprised about 7% of evaluators. There were no significant differences in the distribution of evaluator demographics among the 3 surveys (P > 0.13).

Table III. Characteristics of evaluators surveyed

Characteristic	N	%
Sex		
Female	153	56.5
Male	118	43.5
School year		
Freshman	72	26.6
Sophomore	63	23.3
Junior	66	24.4
Senior	54	19.9
Graduate Student	12	4.4
Other	4	1.5
Race/ethnicity		
White	133	49.1
Asian	51	18.8
African American	47	17.3
Hispanic	22	8.1
Other	18	6.6
Survey		

A	81	29.9
B	82	30.3
C	108	39.9

The video of model 6 with an ideal convexity, used as a control, was identical in all 3 surveys. There were no significant differences in the ratings given for the 4 questions accompanying the control photo among the 3 surveys (P > 0.27). (Table IV)

Table IV. Repeated-measures ANOVA results of the control model

	Survey A		Survey B		Survey C		
Attribute	Mean	SE	Mean	SE	Mean	SE	P-value
Intelligent	68.93	2.24	68.34	2.22	72.29	1.94	0.3388
Good athlete	45.48	2.42	47.63	2.41	42.52	2.10	0.2695
Popular	48.17	2.23	50.65	2.21	46.41	1.93	0.3543
Good leader	66.77	2.36	63.60	2.34	63.04	2.04	0.4582

As seen in Figure 4 and detailed in Table V, models with ideal profile esthetics were consistently rated higher on average than the same models with either retrognathic or prognathic profiles. When rating perceived intelligence, responses varied by convexity (P=0.0009) and the ideal model was rated higher than both retrognathic (P = 0.0480) and prognathic (P = 0.0006) models. When rating the models' perceived athleticism, the responses again varied by convexity (P = 0.0002) and the ideal profile was rated higher than the retrognathic (P = 0.0001) but not different from the prognathic (P = 0.3324) profiles. Differences in ratings for perceived popularity were not statistically significant (P = 0.2169) among the models with various convexities. For perceived leadership ability, ratings varied by convexity (P = 0.0008) and both retrognathic (P = 0.0017) and prognathic (P = 0.0066) models were rated lower than ideal models.

Table V. Mean VAS by rated social attribute and convexity

Convexity	VAS	SE	95% CI		P-value*
	This person is intelligent				0.0009
Retrognathic	57.03	0.917	55.22	58.83	0.0480
Ideal	59.34	0.912	57.54	61.14	
Prognathic	55.69	0.893	53.93	57.45	0.0006
	This person is a good athlete				0.0002
Retrognathic	55.82	0.913	54.02	57.61	0.0001
Ideal	60.54	0.905	58.76	62.32	
Prognathic	58.90	0.904	57.12	60.68	0.3324
	This person is popular				0.2169
Retrognathic	52.68	0.897	50.91	54.45	0.2260
Ideal	54.25	0.866	52.54	55.96	
Prognathic	54.01	0.878	52.29	55.74	0.9673
	This person is a good leader				0.0008
Retrognathic	54.03	0.906	52.25	55.81	0.0017
Ideal	57.54	0.878	55.81	59.27	
Prognathic	54.47	0.882	52.73	56.20	0.0066

* Differences from Ideal

The influence of the subject and the evaluator characteristics on ratings are shown in Table VI. Out of all of the evaluator demographics surveyed, only race showed a significant effect on survey responses (P = 0.0022). These differences were evident in the rating of intelligence (P = 0.0140) and leadership abilities (P = 0.0066). Specifically, the African American evaluators assigned higher rating values than all other races for these two attributes (P = 0.0018). The VAS means are shown in Figure 5.

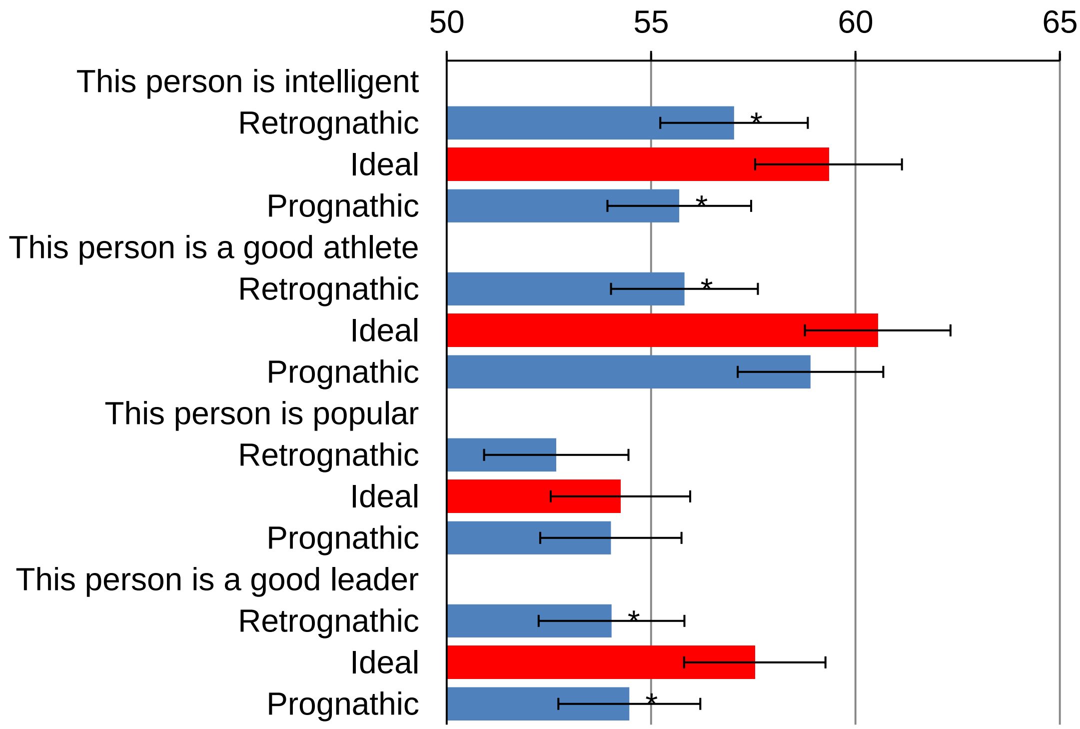

Figure 4. Mean VAS by rated social attribute and convexity. * indicates significant difference from ideal (P < 0.05).

Table VI. Repeated-measures ANOVA significant results

	P-value				
Source	Multivariate	Intelligent	Athlete	Popular	Leader
E-Race[1]	0.0022	0.0140	0.2005	0.1594	0.0066
M-Sex[2]	<.0001	<.0001	<.0001	<.0001	0.0057
M-Race	<.0001	<.0001	0.0002	0.0060	0.0150
M-Sex*M-Race	<.0001	0.0018	<.0001	<.0001	<.0001
Convexity	<.0001	0.0007	0.0005	0.1277	0.0002

1. E = Evaluator
2. M = Model

Evaluators perceived subjects with ideal profiles to be more intelligent than those with non-ideal profiles (P=0.0009). The ratings of the evaluators varied depending on the model's sex. Overall, female models were perceived as more intelligent than male models (P < 0.0001). Intelligence ratings also varied by the model's race. The African American male models were rated significantly lower in intelligence than white males (P = 0.0018).

Evaluators were significantly more likely to perceive models with an ideal or prognathic profile as good athletes than those with retrognathic profiles ($P=0.0002$). Again, the ratings of the evaluators depended on the model's sex. Male models were rated significantly higher for perceived athleticism than female models ($P < 0.0001$). Ratings for athleticism also varied by race. African American models were perceived to be significantly better athletes than the white models ($P = 0.0002$).

When rating popularity, evaluators did not perceive a significant difference among the 3 convexities ($P = 0.2169$). However, there was a significant difference in popularity ratings depending on the model's sex and race. Males were perceived as significantly more popular than females ($P < 0.0001$) and white males were rated higher than the African American male models ($P = 0.0060$).

Models with ideal convexity were perceived to be better leaders than the prognathic and retrognathic models ($P = 0.0008$). Ratings varied based on the sex ($P = 0.0057$) and race ($P = 0.0150$) of the models. The African American male models were rated lowest for perceived leadership ability.

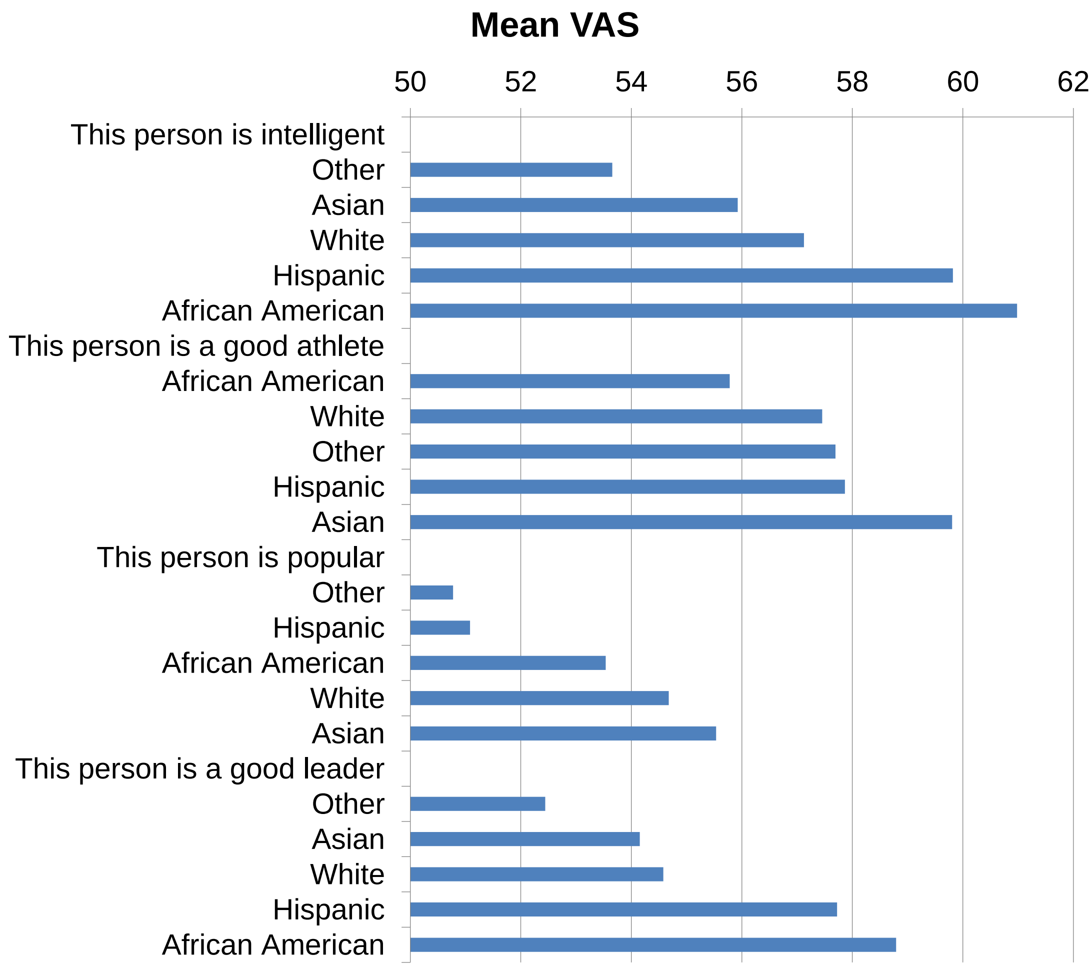

Figure 5. Effect of evaluator race on ratings for the four social attributes.

Discussion

The purpose of this study was to determine whether differences in facial convexity depicted in 3D video images would affect the perception of social attributes in young adults. This was achieved by evaluating whether the same individual would be perceived differently depending on the facial convexity with which they were depicted. The ideal models were perceived to be of higher intelligence and have superior leadership skills compared to prognathic and retrognathic models. For perceived athleticism, ideal models were rated significantly better than retrognathic models and not different than prognathic models. Popularity was the only social attribute that was not significantly different among facial convexities, although the trend toward higher ratings for ideal models was observed in this category as well. These findings suggest that patients with non-ideal profile esthetics could derive social benefits from orthodontic treatment performed along with procedures intended to improve facial convexity such as growth modification or orthognathic surgery.

Kerr and O'Donnell[37] found that respondents rated subjects with Class I occlusions as more attractive than those who had Class II or Class III appearances when evaluating profile photographs of patients. Phillips et al.[38] had a similar result when they had panels of orthodontists, oral surgeons, and laymen judge images to evaluate perception of facial attractiveness. Subjects with Class I profiles were perceived as more attractive than those with Class II profiles. In 2011, Olsen and Inglehart[21] also found that the models that were depicted with an anterior crossbite and an increased chin prominence were considered less intelligent and socially less acceptable. The findings in this study were consistent with previous studies as the models with ideal profiles, on average, were given higher scores than the non-ideal models.[6-8,21,37,38] The higher scores indicated that evaluators perceived superior social attributes. However, it can be concluded that the better ratings also reflected higher acceptance of the ideal profiles compared to the non-ideal profiles. In this study, because each model acted as their own control and profile convexity was the only characteristic modified among the three surveys, the differences in ratings for each model's perceived social attributes can be attributed solely to the differences in profile convexity.

In growing patients, orthodontic treatment along with growth modification procedures might be able to attain an ideal, socially acceptable soft-tissue profile result. However, in non-growing patients, a combination of orthodontics and orthognathic surgery might be required to obtain the same ideal result. In patients whose skeletal discrepancy and resulting soft tissue appearance are beyond acceptable limits, the benefits of proceeding with a surgical option to eliminate the discrepancy are more obvious. However, in those with moderate profile discrepancies, like the non-ideal models depicted in this study, treatment decisions become more difficult. Johnston et al.[27] attempted to find a relationship between the severity of the skeletal discrepancy and the desire for surgical correction in a lay population. They found that when evaluators saw profile silhouettes within 5 degrees of the accepted skeletal average, two-thirds of the evaluators indicated that they would not undergo orthognathic surgery when deciding on their own hypothetical treatment. When the discrepancy reached 10 degrees on either side of the average accepted value, however, nearly 80 percent of the respondents said they would elect to have surgical treatment. More recently, Naini et al.[28] attempted to find a set point at which a skeletal discrepancy was no longer within the range of acceptable and became a facial deformity. The reference profile in their study started with a straight line connecting soft-tissue glabella, subnasale, and soft-tissue pogonion. Orthodontists, pre-surgical orthognathic patients, and lay people evaluated profiles ranging from a mandibular position at -16 mm behind the reference line to 12 mm ahead of this line. The values at which the decision to pursue orthognathic surgery was unanimous were at -9 mm for mandibular retrusion and 3-5 mm for mandibular protrusion.

The non-ideal images of white models in the present study varied by only 8° from the average accepted cephalometric value. According to the values described by Johnston et al.,[27] a 10° deviation from ideal was the limit at which most people chose to proceed with a surgical treatment plan. At only 8° away from ideal, neither the retrognathic nor prognathic white subjects depicted in this study would necessarily choose to be treated with orthognathic surgery. However, the African American models had non-ideal profiles that were at exactly a 10° deviation from the average cephalometric value. According to the findings of Johnston et al.,[27] these individuals might have had severe enough discrepancies to warrant a surgical correction. This might be a potential explanation as to why white models were generally rated more highly than African American models in all categories except athleticism when evaluating non-ideal profiles.

One drawback of the above studies was the use of androgynous silhouettes to evaluate facial convexity rather than detailed images of subjects.[27,28] The absolute values beyond which surgery was recommended may have differed if multiple views of the subjects along with facial characteristics were present in the evaluated images. Still, studies such as these are helpful in determining when to proceed with a surgical option but it is important to consider the psychological effects of surgery as well. Rustemeyer[39] found that individuals who were initially self-conscious about their dentofacial appearance had the greatest increase in their quality of life following orthodontics and orthognathic surgery. Recently, however, Trovik et al.[40] surveyed patients who were at least ten years post-surgery and found that most patients were only marginally satisfied with their results. Those who reported the most positive changes were patients whose peers noticed a change in their appearance post-treatment. The results from these surgical studies suggest that orthognathic surgery to help improve profile appearance would be most successful in patients who are significantly concerned about their appearance and whose family and friends would recognize the post-treatment improvement.

Henson et al.[20] evaluated perception of social attributes based solely on dental esthetics and found that, in general, patients with ideal dentitions were rated higher in their perceived athletic ability, popularity, and leadership ability. The present study evaluated the same social attributes but removed any effect of the dentition by asking models to pose with lightly sealed lips. From the results of the present study, it appears that facial convexity has a significant effect on perceived social attributes. In general, however, the responses that were statistically different varied by only a few points on the VAS scale. In the categories of intelligence, athleticism, and leadership ability ideal models were rated 4-8% higher than non-ideal models. Given the findings of Shaw et al.[19] who found that background facial attractiveness was the most influential factor in determining social perceptions, a similar conclusion can be drawn that facial convexity contributes a small but significant portion to the perceived social attributes of young adults. When rating perceived popularity, there was no difference between ideal and non-ideal profile convexities. This suggests that young adults recognize that knowledge of an individual's personal characteristics is relevant for making a determination about an individual's popularity.

While the findings for perceived intelligence, athleticism, and leadership abilities were statistically significant, this relatively small improvement may not be clinically significant. The findings of this study are useful when faced with the difficult clinical decision of choosing between a surgical or non-surgical treatment plan for a non-growing individual with a moderate profile convexity discrepancy. Because the evaluated perceived social attributes only improved by 4-8% between ideal and non-ideal profiles, surgical treatment to improve profile convexity solely to influence social perception might not result in a noticeable effect. However, the combination of orthodontics to enhance the dental esthetics, which Henson found to improve social perception by an average of 10%, and orthognathic surgery to improve profile esthetics might result in a large enough enhancement in social perception to justify the treatment.[20] If the main purpose of surgery is to treat the patient to the most stable functional occlusion only, the potential improvement in social perception becomes an added benefit.

The results of the current study were derived by depicting moderate changes in soft-tissue profile convexity. Future research should include evaluation of the same attributes based on more severe differences in convexity to discover when the most drastic change in perception of social attributes occurs. Furthermore, the only factor changed between the images in this study was mandibular prominence. Using 3 dimensional photogrammetry to compare the effect of nose and lip prominence as well as vertical facial height changes on perception of social attributes would be useful for orthodontic diagnosis and treatment planning purposes. Finally, it would be useful to conduct a study that compares the ratings of live individuals with ratings of their 3D video images. The level of correlation between the scores would indicate whether or not 3D video imaging is a reliable method for presenting subjects for research purposes.

Conclusion

The purpose of this study was to determine the influence of soft tissue profile convexity on the perceived social attributes of young adult males and females as judged by their peers. Specifically, the objective was to determine if facial convexity affected evaluators' ratings of the intelligence, athleticism, popularity, and leadership ability. Evaluators were shown digital videos of models with ideal and non-ideal profiles and asked to rate those 4 attributes using a VAS. The subject images with ideal facial convexity angles were consistently rated higher on average than the same subject images with retrognathic and prognathic profiles. The differences in ratings between ideal and nonideal profiles were significant for intelligence, athleticism and leadership ability. Differences in perceived popularity showed no significant differences among facial convexities. As a result of these findings, it would be expected that orthodontic treatment, potentially in conjunction with mechanisms designed to influence facial profile esthetics, can provide a small, but significant improvement in the perception of important social attributes for young adults.

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Appendix

Table A1. Description of ratings of "This person is intelligent"

	Convexity								
	Retrognathic			Ideal			Prognathic		
Model	N	Mean	SD	N	Mean	SD	N	Mean	SD
Control				271	70.09	20.15			
AF1	82	59.88	18.55	108	60.95	16.53	81	63.07	17.45
AF2	81	59.48	19.49	82	61.70	15.73	108	54.82	17.04
AM1	82	58.43	16.82	108	54.13	17.94	81	50.41	19.37
AM2	81	45.28	18.54	82	50.63	21.79	108	46.46	19.21
CF1	108	50.85	20.19	81	62.56	15.83	82	57.39	20.49
CF2	108	65.79	18.49	81	65.56	17.13	82	66.84	21.45
CM1	82	58.38	19.34	108	61.28	17.74	81	53.90	17.93
CM2	82	58.77	20.15	81	58.40	15.01	108	53.08	20.77
All	706	57.21	19.83	1002	62.23	19.08	731	55.29	20.12

Table A2. Description of ratings of "This person is a good athlete"

	Convexity								
	Retrognathic			Ideal			Prognathic		
Model	N	Mean	SD	N	Mean	SD	N	Mean	SD
Control				271	44.95	21.82			
AF1	82	53.87	22.55	108	55.48	19.71	81	55.88	22.57
AF2	81	58.99	21.79	82	63.65	19.27	108	61.27	17.98
AM1	82	65.09	19.61	108	66.46	20.58	81	59.35	22.81
AM2	81	55.57	21.95	82	63.43	24.76	108	65.08	18.37
CF1	108	39.79	19.29	81	52.19	18.60	82	49.45	21.56
CF2	108	44.30	21.50	81	49.58	22.73	82	48.43	22.06
CM1	82	72.55	17.53	108	64.95	15.44	81	69.83	18.38
CM2	82	55.40	19.91	81	67.56	20.79	108	60.86	19.99
All	706	54.68	22.83	1002	56.39	22.40	731	59.14	21.32

Table A3. Description of ratings of "This person is popular"

	Convexity								
	Retrognathic			Ideal			Prognathic		
Model	N	Mean	SD	N	Mean	SD	N	Mean	SD
Control				271	48.22	20.06			
AF1	82	52.39	19.38	108	48.48	16.94	81	51.88	18.07
AF2	81	49.36	19.87	82	52.78	19.75	108	50.38	17.68
AM1	82	57.71	18.68	108	58.97	18.91	81	52.67	19.41
AM2	81	55.36	18.86	82	56.57	21.29	108	56.38	19.92
CF1	108	49.98	21.22	81	55.09	18.35	82	57.98	17.84
CF2	108	43.03	20.47	81	45.84	16.96	82	45.06	20.69
CM1	82	69.76	19.52	108	65.16	17.20	81	67.79	19.85
CM2	82	52.39	21.64	81	59.40	17.94	108	58.28	18.08
All	706	53.22	21.26	1002	53.55	19.74	731	55.04	19.80

Table A4. Description of ratings of "This person is a good leader"

	Convexity								
	Retrognathic			Ideal			Prognathic		
Model	N	Mean	SD	N	Mean	SD	N	Mean	SD
Control				271	64.32	21.21			
AF1	82	59.50	20.61	108	57.43	17.07	81	56.52	20.19
AF2	81	55.51	21.22	82	58.21	17.96	108	55.49	18.08
AM1	82	54.37	17.33	108	51.72	18.64	81	45.80	18.84
AM2	81	47.12	20.06	82	57.52	18.23	108	50.39	20.45
CF1	108	44.21	18.36	81	59.42	16.06	82	57.29	22.07
CF2	108	56.56	20.94	81	57.96	19.12	82	59.63	18.79
CM1	82	59.07	19.97	108	60.58	17.94	81	57.06	20.19
CM2	82	54.72	20.94	81	56.25	19.45	108	52.35	21.17
All	706	53.63	20.54	1002	59.20	19.28	731	54.15	20.32

Table A5. Repeated-measures ANOVA Results of the Control Model

Evaluator effects	df	F	P-value
Characteristic	3	0.84	0.4705
Survey(Characteristic)	8	0.79	0.6078
Sex(Characteristic)	4	1.77	0.1361
Race(Characteristic)	16	0.97	0.4887
School(Characteristic)	20	0.53	0.9539
Age(Characteristic)	4	0.75	0.5582
Sex*Race(Characteristic)	16	1.04	0.4161
Sex*School(Characteristic)	20	0.85	0.6460
Sex*Age(Characteristic)	4	1.71	0.1485
Race*School(Characteristic)	60	0.84	0.7924
Race*Age(Characteristic)	16	0.93	0.5326
School*Age(Characteristic)	20	0.47	0.9750
Error	270		

Table A6. Screening model results

Source	Num. df	Den. Df	F	P-value
Between Evaluator effects				
Survey(Characteristic)	8	666	1.06	0.3883
E-Sex(Characteristic)	4	666	0.43	0.7874
E-Race(Characteristic)	16	666	1.72	0.0383
E-School(Characteristic)	20	666	1.56	0.0575
E-Age(Characteristic)	4	9198	3.34	0.0098
E-Sex*E-Race(Characteristic)	16	666	1.19	0.2712
E-Sex*E_School(Characteristic)	20	666	0.71	0.8175
E-Age*E-Sex(Characteristic)	4	9198	1.55	0.1836
E-Race*E-School(Characteristic)	60	666	1.21	0.1364
E-Age*E-Race(Characteristic)	16	9198	3.17	<.0001
E-Age*E-School(Characteristic)	20	9198	0.41	0.9907
Between images effects (within evaluator effects)				
Characteristic	3	666	1.54	0.2021
Convexity(Characteristic)	8	2160	5.11	<.0001
Model(Characteristic)	32	8584	26.08	<.0001
Convexity*Model(Characteristic)	56	8584	1.98	<.0001

Table A7. Reduced model results

Source	Num. df	Den. df	F	P-value
Between Evaluator effects				
E-Race(Characteristic)	16	794	2.08	0.0075
E-Age(Characteristic)	4	9350	0.87	0.4784
E-Age*E-Race(Characteristic)	16	9350	1.39	0.1344
Between images effects (within evaluator effects)				
Characteristic	3	794	15.46	<.0001
Convexity(Characteristic)	8	2160	5.25	<.0001
Model(Characteristic)	32	8584	26.17	<.0001
Convexity*Model(Characteristic)	56	8584	2.16	<.0001

Vita

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