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Perception of profile appearance as judged by peers using 3D video imaging

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

by

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Abstract

PERCEPTION OF PROFILE APPEARANCE AS JUDGED BY PEERS USING 3D VIDEO IMAGING

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The purpose of this study was to investigate the social perceptions of subjects with differing lip position and facial convexity in three dimensions. A 3dMD camera (3dMD, Atlanta, GA) was used to capture 3D images of 9 subjects' faces. The images were altered to have ideal lip position and ideal convexity, ideal lip position and Class II convexity, Class II lip position and ideal convexity, and Class II lip position and Class II convexity. 400 laypersons rated their perceptions of the subjects' athletic ability, popularity, leadership, and intelligence on a VAS scale. Subjects with ideal lip position relative to the E-line were rated significantly higher for leadership and intelligence. Males with ideal facial convexity were judged to be better leaders and more intelligent than those with Class II convexity. Subjects with ideal lip position were given the highest mean VAS scores for all four social attributes. The perception of differences related to facial convexity was inconsistent.

Introduction

Patients report their main motivation for seeking orthodontic treatment is dissatisfaction with appearance.[1] This finding has been confirmed by many studies, all concluding that esthetic concerns are a major motivating factor in orthodontic treatment.[2-5] Aside from improvements in physical appearance, patients anticipate psychological and social benefits from orthodontic treatment as well. Patients expect a positive impact on their confidence, self-esteem, social life, and career opportunities.[1] When surveyed, orthodontists and general dentists agreed that the major benefits of orthodontic treatment were psychosocial rather than functional, noting improvements in self-esteem, self-confidence, and physical attractiveness as the most important benefits perceived.[6]

Parents are motivated to seek orthodontic treatment for their children because they want their child to "look nice," they do not want to feel that they have neglected their duty as a parent, and they want to help their children avoid dental problems in the future.[1,3,7] Parents also mention they are concerned about their child being teased. When 336 adolescents referred for orthodontic treatment were questioned, 12.8% reported that they experienced bullying at school.[8] Teasing usually takes place in a school environment, but with the growing use of social media among teens, there is potential for bullying at all hours of the day.

Langlois et al.[9] performed 11 separate meta-analyses evaluating current and historical literature on cultural perceptions of attractiveness, judgment of attractive people, and traits possessed by attractive people. They concluded that raters agree on whom they consider attractive, both within and across cultures and races. Those that were considered attractive were perceived in a more positive manner, and believed to be more competent spouses, have happier marriages, and to have more fulfilling social and professional lives.[10] This positive social stereotyping may become a self-fulfilling prophecy as attractive people are treated more favorably and have more positive interactions than those who are considered as unattractive. Attractive people have been shown to actually have more occupational success, better dating lives, and better physical health.[9]

Many studies have shown a connection between dental esthetics and how a person is perceived.[11-13] Henson et al.[12] asked peers to evaluate photographs of adolescent boys and girls to assess their perceptions of athletic ability, popularity, leadership, and intelligence. Each photograph was digitally altered to have both ideal dental esthetics and non-ideal dental esthetics. When individuals appeared in photographs depicting ideal dental esthetics, they were judged as more athletic, more popular, and better leaders than the same individuals shown in photographs with non-ideal dental esthetics. In a similar study, Pithon et al.[13] surveyed adults responsible for hiring employees for sales jobs. Subjects were digitally altered to have both ideal and non-ideal dental esthetics. Based on their evaluation of the photographs, those responsible for hiring were more likely to employ the subjects with ideal dental esthetics. The subjects whose photos were digitally altered to have ideal dental esthetics were judged as being more intelligent than the same subjects with non-ideal dental esthetics. These studies imply that orthodontic treatment to achieve ideal dental esthetics can have a positive effect on social perceptions.

Many studies have concluded that facial esthetics also influences how a person is perceived. Most studies evaluating facial esthetics depict subjects in 2-dimensional (2D) photographs[14-17] or silhouettes.[18] However, this fails to capture the dynamic nature of the human face. 3D stereophotogrammetry is an accurate tool to capture the soft tissue of the face in all three dimensions.[19] This technology is useful in treatment planning, assessing growth, predicting and evaluating soft tissue changes with orthognathic surgery, and establishing soft tissue averages for different populations.[20-24] Few studies have evaluated the perception of facial convexity in 3D. Babb[25] studied the social perception of young adults with varying facial convexity using rotating 3-dimensional (3D) images. A 3dMD camera (3dMD, Atlanta, GA) captured 3D photographs of subjects, and the subjects' soft tissue profiles were altered to be ideal, prognathic, or retrognathic. Babb found that non-ideal profiles were associated with less positive ratings as judged by peers in the areas of athleticism, leadership, and academic ability. Todd et al.[26] studied the profile of Caucasian males and females in both 2D and 3D. The profiles were altered to represent Class I, mild and moderate Class II, and mild and moderate Class III facial convexities. Professionals and laypeople ranked the subjects in order of attractiveness. The rankings of the 2D and 3D subjects did not correlate, and the Class I facial convexity was not favored consistently by either group, possibly due to a small sample size. They concluded that more research is needed to clarify facial convexity preferences in 3D.

2D studies have established that the mean Caucasian facial convexity angle (G-Sn-Pg) is 12° ± 4°, and the mean African American facial convexity is 11° ± 5° (Figure1).[27-29] Many 2D studies have evaluated which soft tissue profiles are most desirable, and a more convex or retrognathic profile was consistently regarded as less ideal.[14,18,30-32] Czarnecki et al.[32] questioned 545 professionals on their opinions of androgynous silhouettes with varying chin, nose, and lip positions. The professionals judged profiles with the most retrusive chins and most convex faces as least esthetic. They also noted that judgment of the lips was affected by the positions of the chin and the nose. Laypeople agreed that Class II profiles were less esthetic than Class III profiles.[18] Seehra et al.[8] found those that reported bullying at school were significantly more likely to have a Class II division I jaw relationship, overjet greater than 4 mm, and a deep bite.

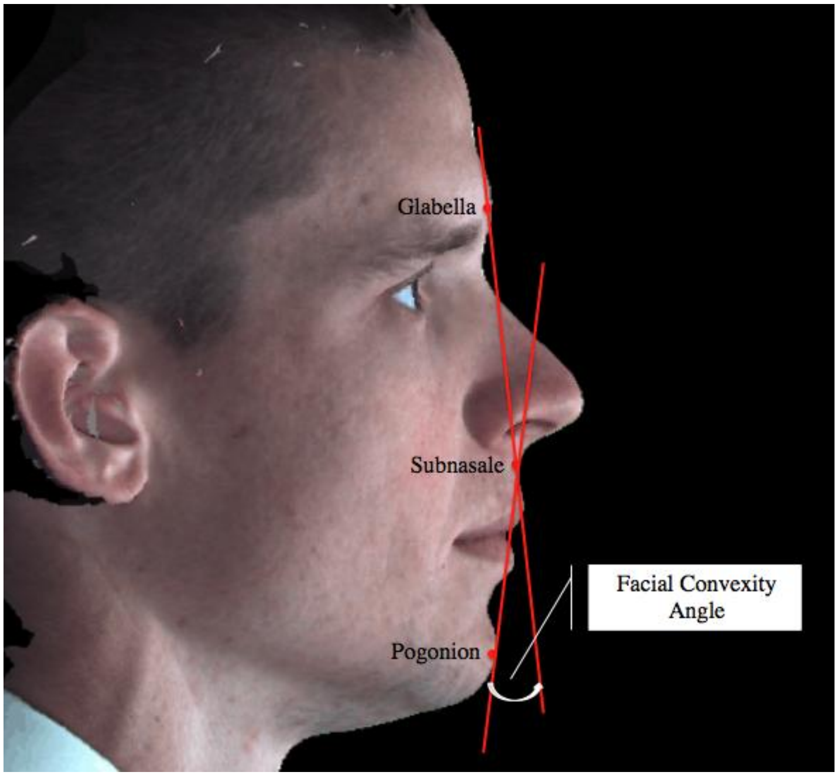

Figure 1. Facial convexity angle (G-Sn-Pg) diagram

Patients can present with a Class II profile due to a protrusive maxilla, maxillary dental protrusion, a retrusive mandible, mandibular dental retrusion, or a combination of these characteristics. The skeletal arrangement and flared maxillary incisors often result in a protrusive upper lip. The upper lip procumbancy of Class II patients has been shown to be significantly different from that of Class I patients.[33] Nanda et al.[27] evaluated Caucasian young adults with Class I occlusion and esthetically pleasing and balanced profiles. They found that for Caucasian females, the esthetically pleasing upper lip was at -4.59 ± 2.49 mm (behind) the E-line, and the lower lip was -2.30 ± 2.27 mm. For Caucasian males, the most esthetically pleasing upper lip was -6.03 ± 1.87 mm, and the lower was -3.95 ± 2.01 mm (behind) the E-line. These values were similar to a study by Coleman et al.[34] where dentists, orthodontists, and lay people digitally adjusted lip position in a profile view to maximize esthetics. Flynn et al.[28] studied ideal African American lips relative to the E-line and found that the preferred lip position was 5.8 mm more protrusive for the upper lip and 5.1 mm more protrusive for the lower lip as compared to Caucasian averages.

It is clear that there are social advantages to having an attractive dental and facial appearance. Both facial convexity and lip position play a role in the overall appraisal of facial attractiveness. If lip balance is influential to the perception of social characteristics, orthodontics alone may be the treatment of choice for patients with lip imbalance that commonly accompanies increased facial convexity. Orthodontic treatment can easily achieve lip balance by changing the dental relationship, whereas skeletal discrepancies in young adult patients often must be corrected surgically. The purpose of this study was to determine if the appearance of a Class II profile with Class II lip overjet influenced perceptions of social attributes more than the appearance of a Class II profile with balanced lips. The null hypothesis was that there was no significant difference in the impact of Class II lips as compared to ideal lips on the perception of athleticism, popularity, leadership, and intelligence.

Materials and Methods

The study was reviewed and approved by the Institutional Review Board of Virginia Commonwealth University. Nine subjects for the study were identified from archives of three-dimensional subjects in the Virginia Commonwealth School of Dentistry Department of Orthodontics. The images were captured using the 3dMDface system (3dMD, Atlanta, GA). The subjects included two males and two females each of Caucasian and African American descent between the ages of 18-30 with no obvious facial asymmetries or history of craniofacial syndromes. An additional Caucasian male subject served as the control. All images were captured with the lips at rest and lightly touching. Subjects gave consent to use and modify their images in the study. The facial convexity and lip position of all subjects were digitally altered using 3dMD Vultus software (Version 2.2.0.10, 3dMD, Atlanta, GA).

Chin and lip positions were defined based on previous averages established in the literature.[27,28,35] All subjects were altered to have an ideal facial convexity based on the appropriate racial average. All subjects except the control subject were also altered to have a retrognathic profile, defined as two standard deviations more convex than average. Retrognathic subjects had a facial convexity of 20° for Caucasian and 21° for African American subjects (Table 1).

Table 1. Profile convexity of digitally altered subjects (G-Sn-Pg)

Race	Ideal	Retrognathic
Caucasian	12°	20°
African American	11°	21°

Using 3dMD Vultus software, the subjects' lips were altered to the preferred positions based on Nanda et al. and Flynn et al.'s values for the appropriate race and sex.[27,28] The same 3dMD subjects were also altered to have Class II lips: the upper lip one standard deviation anterior and the lower lip one standard deviation posterior to the preferred position (Table 2).

Table 2. Values for lip position relative to the E-line (mm)

Race	Sex	Upper Lip		Lower Lip	
		Ideal	Class II	Ideal	Class II
Caucasian	Male	-6.03 ± 1.87	-4.16	-3.95 ± 2.01	-5.96
Caucasian	Female	-4.59 ± 2.49	-2.10	-2.30 ± 2.27	-4.57
African American	Male	-0.23	1.64	1.15	-0.86
African American	Female	1.21	3.7	2.8	0.53

Negative numbers indicate positions posterior to the E-line.

Four digitally altered versions were created for each subject: Ideal chin with ideal lips, ideal chin with Class II lips, Class II chin with ideal lips, and Class II chin with Class II lips. The control subject was altered to ideal facial convexity and ideal lip position relative to the E-line. All digital modifications were performed by a single operator (D.V.B.) and checked for accuracy by a second operator (M.G.S.). Videos that were 20 seconds in length were created for each subject using 3dMD Vultus software. The video began with the subject facing forward, turning to the right and pausing at the profile, rotating forward, and turning to the left to pause at the profile. The videos were incorporated into a survey created in Access 2010 (Microsoft, Redmond, WA). For each video shown, the evaluator was asked to record whether they strongly disagreed (0) or strongly agreed (100) with the following statements using a 100 mm VAS scale: 1) This person is good at sports. 2) This person is popular. 3) This person is a good leader. 4) This person is smart. The video replayed three times to allow evaluators to observe the face from multiple views while answering the four questions. An example of the survey format is depicted in Figure 2. The slider on the VAS scale began at neutral, or 50 mm, for each question, and the evaluator moved the slider according to their perception of the subject. The right of the VAS scale indicated "total agreement" with the statement, while the left indicated "total disagreement" with the statement.

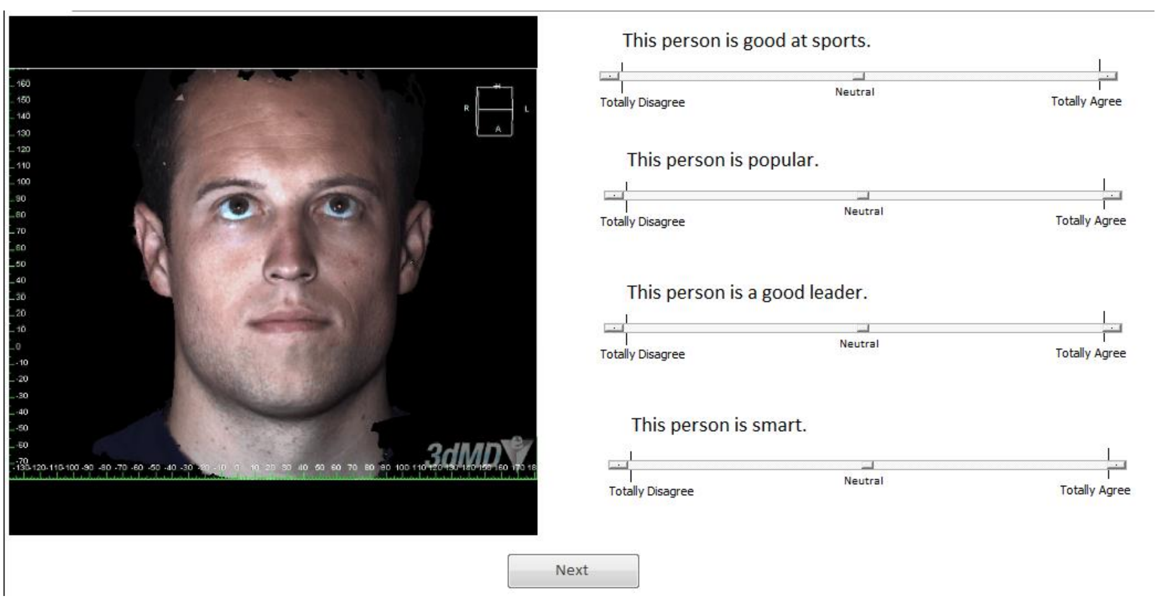

Figure 2. Survey format

Four parallel surveys were created with 9 videos in each survey (8 subjects plus the control). Each subject's face was shown once per survey. The control video was identical in all four versions of the survey. No evaluator was shown more than one version of the same subject for comparison. Table 3 shows the organization of the four parallel surveys.

400 VCU undergraduate students between the ages of 18 and 30 years agreed to complete the survey. Demographics, including age, gender, status in school (Freshman, Sophomore, Junior, Senior, Graduate Student, Other), and race (American Indian or Alaskan Native, Asian, Black or African American, Hispanic/Latino, Native Hawaiian or other Pacific Islander, White or Caucasian, Other) were also collected. A multi-way repeated measures ANOVA was used to assess for differences in the various measures (athletics, popularity, leadership, academics) as a result of both evaluator characteristics (age, gender, race) and the subject characteristics (gender, race, chin position, lips position). Repeated measures analysis accounted for the inherent correlation between responses from the same reviewer. All analyses were performed using SAS EG v.6.1 (SAS Institute, Cary, NC) with a significance level of 0.05.

Table 3. Survey Organization

			Survey A			Survey B			Survey C			Survey D		
Race	Sex	Subject	Order	Convexity	Lips	Order	Convexity	Lips	Order	Convexity	Lips	Order	Convexity	Lips
Caucasian	F	CF1	6	C2	C2	7	I	I	6	I	C2	1	C2	I
Caucasian	F	CF2	7	I	I	2	I	C2	9	C2	I	9	C2	C2
Caucasian	M	CM1	4	I	C2	8	C2	I	8	C2	C2	2	I	I
Caucasian	M	CM2	2	C2	I	4	C2	C2	3	I	I	3	I	C2
Caucasian	M	Control	5	I	I	5	I	I	5	I	I	5	I	I
African American	F	AAF1	1	C2	I	6	C2	C2	4	I	I	6	I	C2
African American	F	AAF2	8	I	C2	9	C2	I	1	C2	C2	4	I	I
African American	M	AAM1	3	I	I	1	I	C2	2	C2	I	8	C2	C2
African American	M	AAM2	9	C2	C2	3	I	I	7	I	C2	7	C2	I

C2 = Class II convexity or lips; I = Ideal convexity or lips

Results

Of the 400 evaluators that completed the survey, 8 were excluded from the study due to invalid answers to demographic questions or age outside of the target range of 18-30 years. A total of 392 evaluators' responses were analyzed. Since each evaluator was randomized to one of four surveys, demographic data were used to determine any biases in the randomization. A summary of the evaluators' characteristics is depicted in Table 4. The distribution of gender, race and year in school, along with average age and the average scores given to the control subject, were used to determine any differences in characteristics among the four surveys. There were no significant differences in the age, gender, or level in school for the evaluators (Table 4). However, there were significant differences noted based on the scores for how popular the control subject was perceived ($P = 0.0479$) and the race distribution ($P = 0.0353$). To account for this potential bias, all models adjusted for the survey taken and respondent race.

Table 4. Demographics of Evaluators (n = 392)

	Survey				P value	
	A	B	C	D		
Sample Size	94	93	102	103		
Age	20.97	20.90	21.01	20.99	0.9932	
Control Subject VAS						
Athletics	42.6	49.7	45.4	43.3	0.1008	
Popularity	43.6	51.1	45.3	44.4	0.0479	*
Leadership	63.1	67.9	64.9	62.2	0.2132	
Academics	69.2	67.4	67.9	70.3	0.7239	
Gender (% Male)	44%	46%	43%	53%	0.4211	
Race					0.0353	*
Asian	29%	15%	26%	21%		
African American	24%	25%	20%	17%		
Other	5%	22%	18%	14%		
White/Caucasian	41%	38%	36%	49%		
Year in School					0.3634	
Freshman	21%	26%	23%	26%		
Sophomore	18%	14%	20%	15%		
Junior	24%	17%	22%	20%		
Senior	22%	31%	22%	22%		
Graduate Student	6%	12%	12%	14%		
Other	7%	0%	3%	3%		

* Indicates P < 0.05

Evaluators were asked to rate the four social characteristics on a 100 mm VAS scale. Scores over 50 were considered to be affirmative answers, while scores under 50 indicated the evaluator disagreed with the statement. A summary of the adjusted mean VAS score and standard error for each social dimension is shown in Table 5. A repeated-measures ANOVA analyzed the relationship between VAS score and subject and evaluator characteristics (Table 6). To simplify the analysis, evaluators who identified themselves as American Indian or Alaskan Native, Hispanic/Latino, or Native Hawaiian or other Pacific Islander were combined into the Other category.

Table 5. Adjusted mean VAS scores by facial convexity and lip position (mm)

Athletics				
Gender	**Chin**	**Lips**	**Mean**	**SE**
Male	Class II	Class II	57.97	0.99
	Class II	Ideal	65.62	1.00
	Ideal	Class II	63.25	0.99
	Ideal	Ideal	60.80	0.82
Female	Class II	Class II	54.27	1.06
	Class II	Ideal	57.69	1.06
	Ideal	Class II	54.99	1.06
	Ideal	Ideal	55.09	1.06
Race	**Chin**	**Lips**	**Mean**	**SE**
AA	Class II	Class II	56.26	1.02
	Class II	Ideal	62.16	1.03
	Ideal	Class II	60.69	1.03
	Ideal	Ideal	60.93	1.02
Caucasian	Class II	Class II	55.98	1.02
	Class II	Ideal	61.16	1.02
	Ideal	Class II	57.55	1.02
	Ideal	Ideal	54.97	0.88

Popular				
Gender	**Chin**	**Lips**	**Mean**	**SE**
Male	Class II	Class II	55.24	0.98
	Class II	Ideal	59.07	0.98
	Ideal	Class II	57.40	0.97
	Ideal	Ideal	54.86	0.80
Female	Class II	Class II	52.59	0.97
	Class II	Ideal	51.98	0.97
	Ideal	Class II	51.44	0.97
	Ideal	Ideal	53.52	0.97
Race	**Chin**	**Lips**	**Mean**	**SE**
AA	Class II	Class II	52.55	0.96
	Class II	Ideal	54.06	0.96
	Ideal	Class II	53.71	0.96
	Ideal	Ideal	55.06	0.96
Caucasian	Class II	Class II	55.27	0.97
	Class II	Ideal	56.99	0.97
	Ideal	Class II	55.13	0.97
	Ideal	Ideal	53.32	0.81

		Leadership		
Gender	**Chin**	**Lips**	**Mean**	**SE**
Male	Class II	Class II	51.28	1.00
	Class II	Ideal	56.14	1.00
	Ideal	Class II	56.40	1.01
	Ideal	Ideal	58.50	0.83
Female	Class II	Class II	53.98	0.98
	Class II	Ideal	56.57	0.98
	Ideal	Class II	52.99	0.98
	Ideal	Ideal	55.95	0.99
Race	**Chin**	**Lips**	**Mean**	**SE**
AA	Class II	Class II	50.94	0.98
	Class II	Ideal	53.37	0.98
	Ideal	Class II	53.81	0.98
	Ideal	Ideal	55.70	0.98
Caucasian	Class II	Class II	54.32	1.02
	Class II	Ideal	59.34	1.02
	Ideal	Class II	55.58	1.02
	Ideal	Ideal	58.74	0.85

		Smart		
Gender	**Chin**	**Lips**	**Mean**	**SE**
Male	Class II	Class II	54.34	1.02
	Class II	Ideal	54.09	1.02
	Ideal	Class II	57.69	1.02
	Ideal	Ideal	59.82	0.84
Female	Class II	Class II	60.71	0.97
	Class II	Ideal	63.41	0.97
	Ideal	Class II	60.90	0.97
	Ideal	Ideal	62.80	0.97
Race	**Chin**	**Lips**	**Mean**	**SE**
AA	Class II	Class II	55.82	0.99
	Class II	Ideal	56.77	0.99
	Ideal	Class II	58.69	1.00
	Ideal	Ideal	59.68	1.00
Caucasian	Class II	Class II	59.23	1.02
	Class II	Ideal	60.73	1.02
	Ideal	Class II	59.90	1.02
	Ideal	Ideal	62.94	0.88

Table 6. Repeated-measures ANOVA results

Subject Components	Sports	Popular	Leadership	Smart
Survey	0.0371	0.2223	0.6094	0.535
Gender	0.0002	0.1413	0.18	0.3704
Race	0.7562	0.0031	0.6068	0.0251
Age	0.0642	0.003	0.0777	0.0578
Subject: Gender	<.0001	<.0001	0.2748	<.0001
Subject: Race	0.0001	0.0413	<.0001	<.0001
Subject Gender*Subject Race	0.5528	0.19	<.0001	<.0001
Chin	0.6152	0.4952	0.019	0.0004
Lips	0.0015	0.2992	<.0001	0.0109
Chin*Lips	<.0001	0.1288	0.3366	0.5131
Subject Gender*Chin	0.3629	0.338	0.0007	0.0003
Subject Gender*Lips	0.5024	0.939	0.571	0.267
Subject Gender*Chin*Lips	0.0091	0.0004	0.2289	0.2203
Subject Race*Chin	0.0045	0.016	0.074	0.2395
Subject Race*Lips	0.1513	0.233	0.1141	0.2713
Subject Race*Lips*Chin	0.4441	0.1705	0.6064	0.5384
Gender * Subject Gender	0.0014	0.4641	0.281	0.8752

The primary variables of interest were lip position, facial convexity, and the interaction between the two. Secondary variables included the interactions between characteristics of the subjects and evaluators such as gender and race. For every social dimension assessed, the most preferred convexity and lip combination always had ideal lip position (Figure 3). Both lip position and facial convexity were found to significantly influence the social perceptions regarding the subjects in the survey. Both the facial convexity of the subject and the lip position relative to the E-line had a significant effect on the perception of leadership and intelligence. Specifically, subjects with ideal facial convexity were perceived to be significantly better leaders ($P = 0.019$) and significantly smarter ($P = 0.0004$) than the same subjects with Class II facial convexity. Subjects with ideal lip position were considered to be better leaders ($P < 0.0001$) and more intelligent ($P = 0.0109$) than the same subjects with Class II lip position.

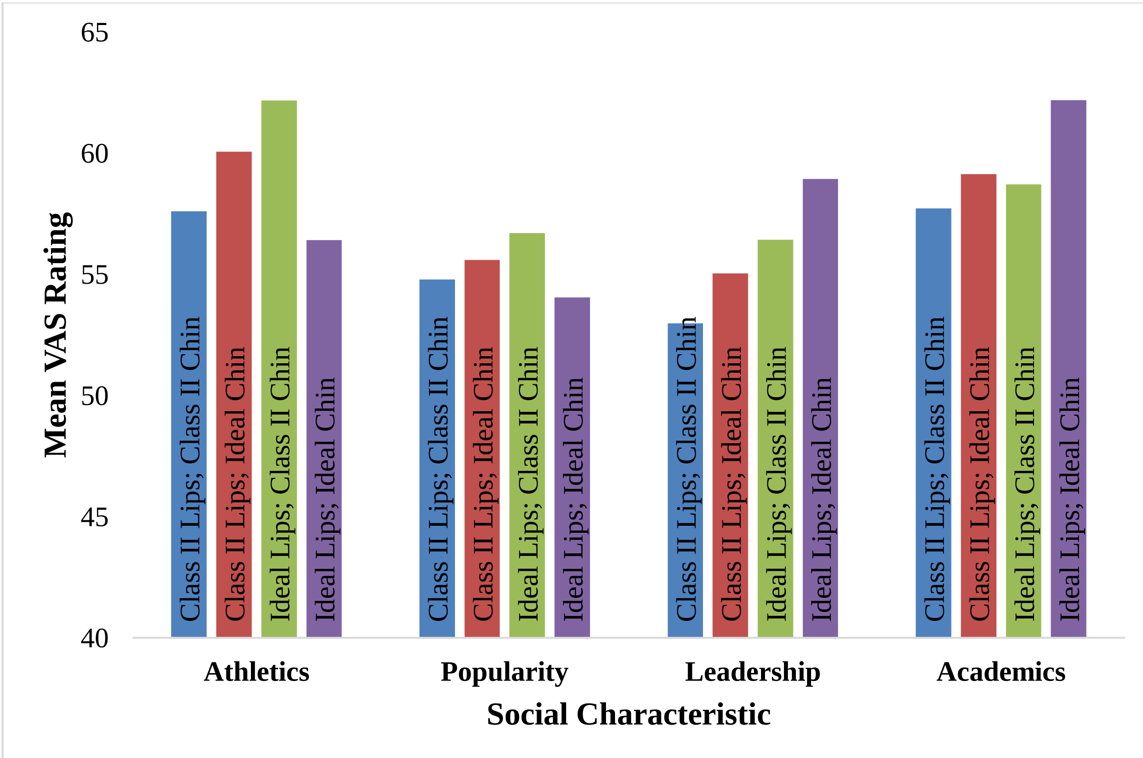

Figure 3. Mean VAS Rating for Social Characteristics

There was a significant three-way interaction between facial convexity, lip position, and gender in regard to the perception of athletic ability (P = 0.0091) and popularity (P = 0.0004). Males with ideal lips and Class II facial convexity were considered to be the most athletic and most popular. For athletic ability, the males with Class II convexity and ideal lip position were rated significantly higher than the ideal convexity and ideal lips combination (4.82 units; 95% CI: 1.05-8.58) and significantly higher than the Class II convexity and Class II lips combination (7.65 units; 95% CI: 3.72-11.58). Perceived popularity was significantly higher (4.2 units; 95% CI: 0.52-7.90) for male subjects with Class II facial convexity and ideal lips than males with both ideal convexity and lip positions (adjusted P = 0.0132).

Social perception of the subjects was influenced by demographic characteristics of both the subjects and evaluators. The perception of facial convexity was influenced by the gender of the subject. For leadership ability, there was no evidence of a difference between facial convexities for females ($P = 0.8054$), but there was a significantly greater increase ($P = 0.0004$) in perceived ability to lead for males with ideal, as compared to Class II, facial convexity (3.74 units; 95% CI: 1.36-6.12). There was no difference in perceived intelligence for females based on facial convexity (adjusted $P = 0.9938$), but a significant difference between ideal and Class II facial convexity for males (adjusted $P < 0.0001$; 4.6 units; adjusted 95% CI: 2.23-6.90). Additionally, females were perceived to have higher intelligence than males for all possible chin and lip combinations (adjusted $P < 0.05$ for all comparisons).

The effects of facial convexity on perceived athletic ability and popularity were dependent on subject race ($P = 0.0045$, $P = 0.0160$, respectively). For athletic ability, Caucasian subjects with ideal facial convexity were rated lower than African American subjects with either ideal (4.55 units; adjusted 95% CI: 2.11-6.99) or Class II facial convexity (2.95 units; 95% CI: 0.48-5.42). In regard to popularity, Caucasian models with Class II facial convexity were rated significantly higher (2.83 units; 95% CI: 0.46-2.50) than African American models with Class II facial convexity (adjusted $P = 0.0119$).

There was a significant two-way interaction between evaluator gender and subject gender for perceived athletic ability ($P = 0.0014$). Overall, male subjects were rated highest and there was no evidence of a difference in the ratings of male subjects between female and male evaluators (adjusted $P = 0.7772$). However, females rated female subjects significantly higher for athletics than males rated female subjects (adjusted $P < 0.0001$). On average, males rated female subjects significantly lower than did females (5.5 units; 95% CI: 2.40-8.66).

Discussion

People make judgments about personality and social attributes based on physical appearance, although it is difficult to elucidate which specific facial features contribute most to the perception of social characteristics. The purpose of this study was to investigate the perception of athletic ability, popularity, leadership, and academic ability of subjects with differing lip position and facial convexity in three dimensions.

The subjects in this study were between 18 and 30 years old and were evaluated by peers of the same age range. All surveys were administered on the university's undergraduate campus, which is physically separate from the medical campus, to minimize the chance that an evaluator would recognize a subject. The demographics of the evaluators closely resembled the demographics of the VCU undergraduate population. Two demographic categories were significantly different among the four surveys, suggesting that the groups that took each survey may have had some inherent differences. Survey A had a significantly lower proportion of evaluators who identified their race as "Other." In survey B, the popularity of the control subject was perceived to be significantly higher than the other three surveys. Though these differences between the randomized groups did reach the threshold of statistical significance, they were small and unlikely to have had a significant impact on the overall results. The analysis was adjusted to account for the possible demographic differences among survey groups.

The majority of previous research on facial attractiveness depicted a frontal or profile view in two dimensions.[14-18] 3D rotating videos were used in this study to allow evaluators to judge the subjects from many different views, more closely mimicking how a face would be seen during a social interaction. Sarver et al.[36] emphasized the oblique view as well as the frontal and sagittal views for performing a complete facial analysis. Evaluators in a study by Stebel et al.[37] concluded that 3D images were more informative than 2D images. 3D evaluation of facial features may be a more realistic way to assess the facial preferences of laypeople.

It was expected that evaluators would prefer the ideal facial convexity and lip positions and rate those subject images as the highest for the social attributes in question. This expectation was based on previous 2D studies of laypersons' perceptions of facial esthetics where orthodontically "ideal" faces were preferred[12,13,25] or subjects with Class II facial convexity were perceived as less attractive than those with a Class I appearance.[14,18,26,30,31] Subjects with ideal facial convexity and lip position were perceived as better leaders and more intelligent in the current study, but for the characteristics of athletic ability and popularity, the results varied.

For athletic ability and popularity, subjects with Class II facial convexities received the highest VAS ratings. Compatible with these findings, many other studies have concluded that laypeople are accepting of Class II facial convexity. Todd et al.[26] asked laypeople to rank 2D and 3D faces with varying facial convexity in order of attractiveness. They found no consistency in the rankings, and both laypeople and dental professionals did not significantly favor the Class I subjects over the Class II or III subjects in 3D. Maple et al.[15] found that orthodontists and oral surgeons preferred Class I profiles more strongly than the general public, and the laypeople questioned had a wider range of facial convexities that they considered to be attractive. They suggested that laypeople rarely focus on profiles and rely on other facial features, such as complexion, nose shape, chin shape, and hairstyle, to influence their perception of attractiveness. Shaw et al.[11] found that children with prominent incisors (suggesting a Class II dental relationship) were perceived to be desirable as a friend and non-aggressive as judged by peers. Published means for facial convexity are based on studies of populations drawn from a convenience sample of subjects that were esthetically pleasing in the authors' opinion.[27-29] Many studies have shown that laypeople do not have the same opinions as dental professionals in regard to ideal facial esthetics.[14,31,38,39] Perhaps when laypeople are given more informative 3D images to evaluate, they find both ideal and Class II facial convexities to be acceptable.

The present study was the first to evaluate varying lip positions in 3D. Subjects with ideal lip position relative to the E-line were given the highest mean VAS scores for all four social attributes studied. This suggests that laypeople perceived ideal lips positively. Coleman et al.[34] altered facial convexity and lip protrusiveness in 2D silhouettes and found that facial convexity did significantly affect preferred lip positions in a profile view. Fuller lips relative to the E-line were preferred for subjects with the greatest retrognathic or prognathic mandibles, theoretically to balance out the skeletal discrepancy. Less protrusive lips were preferred for facial convexities closer to ideal. This may explain evaluators' preference for Class II convexity with ideal lips. The pleasing appearance of the lips may balance the retrognathic chin and, from a layperson's perspective, the face may still appear balanced and socially acceptable.

Perhaps orthodontists place too much emphasis on facial convexity in the profile view when it is of less consequence to laypeople, especially considering social interactions rarely involve the profile view. Conversations are usually held in a frontal or three-quarters view. Factors other than profile, such as hair, eyes, complexion, and makeup of the female subjects, may have a larger role in determining the overall appraisal of facial attractiveness and social attributes. Most people rarely appreciate their own profiles, except occasionally in photographs. Therefore, profiles are rarely evaluated by others. Tüfekçi et al. showed that people are largely unaware of their own profiles and are unable to identify their own profiles in a silhouette view.[40]

The survey administrators intentionally did not watch as evaluators completed the survey to prevent influencing or distracting them. Because of this, survey administrators were unable to confirm that the evaluators were watching the entire twenty-second video of the subjects' rotating face before answering the survey questions. The evaluators may have focused on the questions on the screen instead of closely appraising the subjects' faces, specifically when they were turned to the profile view. Evaluators were unaware of the purpose of the study and may have paid more attention to other facial characteristics. Future studies with a similar design might consider playing the entire video before survey questions could be seen and answered. Future studies could also present fewer subjects or questions to prevent evaluator fatigue.

More research is needed to evaluate the interaction of facial convexity and lip position in 3D. The results of this study suggested that lip position influenced the perception of social characteristics. Those with ideal lip positions were perceived to have more desirable social traits. This suggests that clinicians should prioritize achieving ideal lip position relationships (relative to the E-line) and could possibly be more accepting of variations in facial convexity.

Conclusions

- Lip position influenced the perception of social characteristics.
- Subjects with ideal, balanced lip position relative to the E-line were perceived to be significantly better leaders and significantly more intelligent.
- Both ideal and increased facial convexities were perceived positively by laypeople when evaluating social attributes.
- Laypeople may not readily detect small facial changes in 3D.

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