The effect of dental and background facial attractiveness on facial attractiveness and perceived integrity and social and intellectual qualities

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Introduction: The purposes of this study were to assess the role of dental attractiveness in background facial attractiveness and to evaluate how facial and dental attractiveness influenced raters' opinions of the integrity, social attractiveness, and intellectual attractiveness of the models. **Methods:** Photographs of male and female individuals rated by peers as unattractive, average, and attractive were combined with oral images of 4 different levels of dental attractiveness (Index of Orthodontic Treatment Need [IOTN] 1, 5, 7, and 10). Sixty-seven participants meeting the inclusion criteria were recruited as raters. Raters viewed closed-lip smile and open-lip, posed smile of 24 models and rated them for facial attractiveness and integrity and multiple social/intellectual attractiveness dimensions using a Visual Analog Scale. **Results:** Intrarater reliability was fair to excellent. Analysis of variance showed significant 3-way interactions ($P < 0.0001$=aim 1; $P < 0.005$=aim 2) for model sex, facial attractiveness, and dental attractiveness. The contribution of dental attractiveness to facial attractiveness was not fixed or linear, but dependent on dental attractiveness level, background facial attractiveness, and model sex. For both sexes, dental impact on facial attractiveness was neutral or negative when teeth were less than ideal, beginning at IOTN 5 for all background facial attractiveness levels. The impact of dental attractiveness on integrity and social and intellectual attractiveness was also dependent on dental attractiveness level, background facial attractiveness, and model sex. Dental attractiveness can make dramatic differences in Average and Attractive male individuals. **Conclusions:** The impact of dental attractiveness on facial attractiveness and integrity and social and intellectual attractiveness was dependent on dental attractiveness level, background facial attractiveness, and model sex. The effect of dental esthetics on facial attractiveness was neutral or negative for both male and female individuals when there was a need for treatment (IOTN 5 or higher) for all levels of facial attractiveness. For both male and female models, lower dental esthetics had a greater effect on more attractive faces. Judgments about integrity and social and intellectual attractiveness were strongly affected by dental esthetics, and these effects were more dramatic and consistent for male faces. (Am J Orthod Dentofacial Orthop 2019;156:464-74)

The strong demand in society for improvement of facial attractiveness is rooted in the influence a person's beauty has on how they are perceived. Possessing a higher level of attractiveness allows for more positive judgment, treatment, and behavior evaluation by society.[1,2] Those who are physically attractive are assumed to have more socially desirable personalities, be more likely to secure more prestigious jobs, be less

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likely to be unmarried, and be more likely to enjoy overall happier, more successful lives than those who are less attractive.[2]

Through past research, the significant role of the face in attractiveness is clear,[3,4] but the influence of the appearance of the teeth on facial attractiveness remains to be understood. Previous research suggests that one isolated feature does not determine facial attractiveness; rather, it is the interaction of all the facial features that determines facial attractiveness.[5,6] Other research identifies the mouth as the most important facial feature in determining facial attractiveness, followed in order by the eyes, hair, and nose.[7,8] However, other research points to the eyes as the most salient feature.[9,10]

The significance of dental attractiveness on facial attractiveness remains uncertain, but there is a significant role that dental appearance plays in determining a first impression.[11] Shaw et al[12] compared children with normal dental attractiveness with those with a malocclusion or facial deformity. Children with normal dental esthetics were perceived as more physically attractive and possessing positive personality characteristics including friendliness, less aggressiveness, and intelligence. Similarly, Olsen et al[13] found that young adults with normal teeth were perceived as more attractive, intelligent, extroverted, agreeable, and conscientious.

Methods are available to tie dental attractiveness to facial attractiveness and its impact on social attractiveness. A recent approach to evaluating the importance of the teeth in the overall perception of the face was the use of eye tracking to measure visual attention to facial features. Hickman et al[14], Richards et al[9], and Baker et al[10] have all contributed to our understanding that visual attention to the mouth is dependent upon background facial attractiveness (facial attractiveness without the teeth visible), dental attractiveness, and the sex of the model and raters.

The studies of Richards et al[9] and Baker et al[10] both used the IOTN Aesthetic Component (AC) to quantify dental attractiveness.[15] The AC consists of a 10-point scale based on dental esthetic impairment and uses color, intraoral, frontal photographs. The levels are divided into 3 categories: 1-4, representing "no or little treatment needed"; level 5-7, representing "borderline need"; and 8-10, representing "clear need for treatment". Several studies have confirmed the reliability and validity of the IOTN scale.[15-18]

There are several techniques to assess psychosocial attractiveness. Shaw et al[6] used 9 personality questions. They examined how modifying images of attractive and unattractive male and female young adults with prominent incisors, missing lateral incisor, severely crowded incisor, or a unilateral lip cleft influenced social attractiveness (encompassing integrity, social, and intellectual dimensions). The 9 questions used in that study were "Is this person friendly?", "Is this person an extrovert?", "Is this person of high social class?", "Is this person compliant?", "Is this person popular?", "Is this person fun?", "Is this person honest?", "Is this person kind?", and "Is this person intelligent?"

The aims of this investigation were to assess the role of quantified dental attractiveness on facial attractiveness and to evaluate how different levels of quantified facial and dental attractiveness of models influenced raters' opinions of their social attractiveness.

MATERIAL AND METHODS

Composite images constructed for previous eye-tracking studies were used in this study.[9,10,19] The images used included composites of female and male models with 3 different levels of background facial attractiveness (Unattractive, Average, and Attractive) and 1 of 4 different levels of dental attractiveness (AC-IOTN 1,5,7,10). The faces and teeth were combined to give all combinations of background facial and dental attractiveness.

To produce the background facial attractiveness images, frontal facial images of 18-30-year-old Caucasian male and female individuals were obtained from volunteers from the Ohio State University, Columbus, OH. In an attempt to eliminate the variable of ethnicity between models and raters, recruitment was restricted to Caucasian viewers.[20,21] Two photographs were taken of each individual, one with a closed-lip smile showing no teeth and another posed with an open-lip smile and teeth exposed. Posed smiles are defined as voluntary smiles that are not triggered by emotion and are reliably reproducible.[22] Participants were excluded if they presented with distracting features such as a facial tattoo, unique hairstyle, extreme facial hair, asymmetry, abnormal piercing, or other notable characteristics. Models previously were categorized as Unattractive, Average, or Attractive in earlier studies.[9,10]

To control for the level of dental attractiveness in the images, nonidentifiable frontal, intraoral photos were obtained from the database at the Ohio State University, College of Dentistry, Division of Orthodontics. Multiple intraoral images previously evaluated to represent dental esthetics of AC-IOTN 1, 3, 4, 5, 6, 7, and 10 were collected.[9] These images were then evaluated by orthodontists (15 full- and part-time university faculty with a minimum of 10 years practice experience) and AC-IOTN levels were assigned. In this study, AC-IOTN levels of 1, 5, 7, and 10 were used, therefore identifying the levels of orthodontic need as "no need" (1), "borderline need" (5-7), or "clear need" (10).

The rated intraoral images at the 4 levels of dental attractiveness (IOTN 1, 5, 7, 10) were then layered on the 24 unique open-lip smiling images of the male and female models rated at different levels of facial attractiveness (Unattractive, Average, Attractive), replacing their own smiles. Imaging software (Adobe Photoshop Elements 11, Adobe Systems; San Jose, CA) was used to form the composite images. A total of 24 unique open-lip composites and the corresponding 24 closed-lip original images were used in this study. Examples of composites are shown in Supplementary Figure.

Following approval by the Institutional Review Board, 68 participants were recruited on the main campus, away from the Medical Center, to serve as raters. The survey participants were included if they were between 18 and 30 years old, were Caucasian, were able to understand English, had no prior neurological condition, had normal or corrected-to-normal vision, were willing to complete the survey that took approximately 40 minutes, were not currently using any medication that might affect cognitive abilities, had no previous participation in a facial eye-tracking study, and were not a dental professional or a dental student.

In order to reduce potential bias, participants were told that the purpose of the study was to "help us understand how individuals view other people." Once the session was completed, participants were debriefed to explain the true purpose of the study.

Aim 1 of the study was to evaluate how different levels of quantified background facial and dental attractiveness of models influenced raters' opinions; this would allow us to assess the role of dental attractiveness in overall facial attractiveness. We used a total of 72 images (24 open-lip composites, 24 closed-lip images, and 50% repeats for reliability). The order of the images was randomized, with the closed-lip image for each model always displayed before the open-lip image, but not immediately preceding it. The faces of the models were never repeated for the different IOTN levels; however, the IOTN-rated intraoral images were repeated in the composites for the different background attractiveness levels.

The 72 images were shown on individual computer screens with image size that was comparable to a normal social interactive distance at approximately 2 feet for 8 seconds each. Willis et al[23] determined that the minimum time required to make social decisions was 100 ms; therefore, 8 seconds was ample time. Allotted time was tested and proven to be sufficient in pilot data collection. For each image, the participant answered the question "Is this person attractive?" They recorded their responses on a 100-mm Visual Analog Scale (VAS) anchored with 0 being Unattractive and 100 being Attractive. The influence of teeth on attractiveness was

calculated as the delta: open-lip VAS minus the closed-lip VAS.

Aim 2 of the study was to evaluate how different levels of quantified background facial and dental attractiveness of models influenced raters' opinions of the model's social attractiveness using the 9 questions from Shaw et al.[6]

In total, 36 photographs were viewed. The same 24 open-lip smiling images from aim 1 were viewed in a randomized order and 50% of these images were rerated to evaluate reliability.

For each image, the participants answered a paper survey consisting of 9 questions addressing integrity (honest), social (friendly, extroverted, high social class, compliant, popular, fun, kind), and intellectual (intelligent) dimensions. The 100-mm VAS was used with anchoring bipolar adjectives. Viewers were given 40 seconds to view each image and answer the paper survey questions. This time was tested and proved to be sufficient in pilot data collection.

Statistical analysis

A power analysis was completed to determine the appropriate sample size. Based on a previous study[24] using the VAS, with a nondirectional alpha risk of 0.05 and assuming a standard deviation of 17.4 mm, a sample size of 60 participants was necessary to detect a difference in VAS scores of ± 10 mm with a power of 0.979. An additional 10 participants were sought in recruitment to account for possible dropouts.

For the statistical analysis of aim 1, the difference between the open-lip VAS score and closed-lip VAS score was analyzed by a repeated-measures factorial analysis of variance. Post hoc testing was completed using the

Table. ICC and 95% confidence intervals for aim 1 and aim 2

Aim	Measure	ICC	Lower 0.95	Upper 0.95
1	Closed-mouth attractiveness	0.68	0.66	0.70
	Open-mouth attractiveness	0.85	0.84	0.86
	Delta (closed-open)	0.40	0.36	0.44
2	Q1	0.75	0.73	0.77
	Q2	0.50	0.47	0.53
	Q3	0.63	0.60	0.65
	Q4	0.73	0.71	0.75
	Q5	0.58	0.55	0.61
	Q6	0.67	0.65	0.69
	Q7	0.81	0.79	0.82
	Q8	0.81	0.79	0.82
	Q9	0.72	0.70	0.74

ICC, intraclass correlation coefficient.
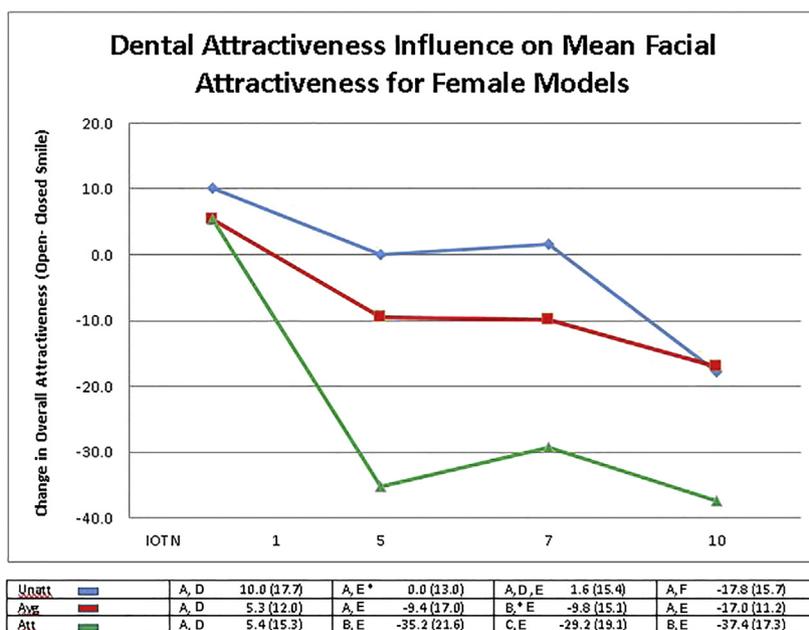
Fig 1. Dental attractiveness influence on mean facial attractiveness in female models (aim 1). Comparing attractiveness for female models of Unattractive, Average, and Attractive background facial attractiveness with IOTN 1, 5, 7, and 10 dental attractiveness rated by male and female individuals. **A-C** are comparisons within a column. **D-G** are comparisons within a row. The same letters are not significantly different. When letters are different, $P < 0.0001$ except for those marked with an asterisk, which are $P < 0.01$.

Tukey-Kramer procedure. For aim 2, the same analysis was applied to the responses for each of the 9 questions of attractiveness.
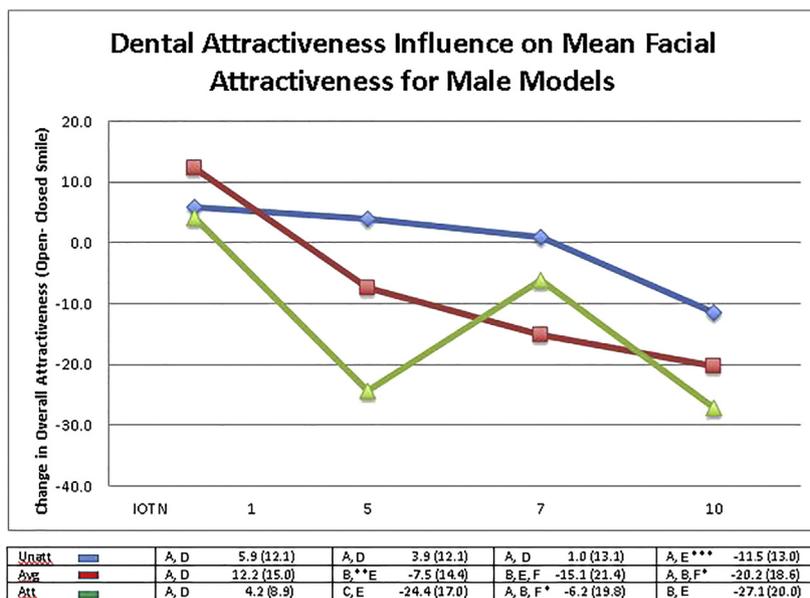
RESULTS

In total, 68 subjects were recruited. One participant was not Caucasian and was therefore excluded from the analysis. Two participants were excluded from aim 2 because they did not complete the survey questions correctly. Of the 67 subjects for aim 1, 50 (75%) were female and 17 (25%) were male. Of the 65 subjects for aim 2, 49 (75%) were female and 16 (25%) were male. The mean age of the subjects was 21.7 years, and the range was 18-28 years. Intrarater reliability was fair to excellent for both aim 1 and aim 2. For details, see Table.

Analysis of variance showed significant 3-way interactions for model sex, background facial attractiveness, and dental attractiveness for both aims ($P < 0.0001$ for aim 1; and $P < 0.005$ for Q1-9 in aim 2). A 4-way interaction including rater sex was not significant ($P = 0.42$).

Aim 1 (Fig 1) examined the influence of dental attractiveness on facial attractiveness for female individuals of the 3 different levels of background facial attractiveness: Unattractive, Average, and Attractive. This was the

difference the teeth made to overall attractiveness when they were exposed. At IOTN 1, there was a positive influence of the teeth on background attractiveness for all 3 groups that was not statistically significantly different among the groups. For all 3 groups, there was a significant decline in the delta (open-lip VAS minus the closed-lip VAS) from IOTN 1 to IOTN 5. From IOTN 5-7, all 3 groups had a plateau in the influence of dental attractiveness on background facial attractiveness. This plateau continued for the Average and Attractive groups through IOTN 10. There was another significant decrease in the delta from IOTN 7-10 in the Unattractive group. Unless the teeth were near ideal, they had a neutral or negative effect on the background attractiveness. Generally, for female individuals, the greatest impact was poor dental esthetics for Attractive models.

Figure 2 shows the influence of dental attractiveness on background attractiveness for male individuals. Delta trends were generally similar in the group of male individuals as compared with that of female individuals. Among male individuals, Unattractive faces suffered less from declining dental esthetics, whereas Attractive and Average faces suffered more. When the orthodontic treatment need was the greatest, as for the women, the Attractive group was most affected. There was a

Dental Attractiveness Influence on Mean Facial Attractiveness for Male Models

		IOTN 1	IOTN 5	IOTN 7	IOTN 10
Unatt		A, D 5.9 (12.1)	A, D 3.9 (12.1)	A, D 1.0 (13.1)	A, E*** -11.5 (13.0)
Avg		A, D 12.2 (15.0)	B,**E -7.5 (14.4)	B, E, F -15.1 (21.4)	A, B, F* -20.2 (18.6)
Att		A, D 4.2 (8.9)	C, E -24.4 (17.0)	A, B, F* -6.2 (19.8)	B, E -27.1 (20.0)

Fig 2. Dental attractiveness influence on mean facial attractiveness in male models (aim 1). Comparing attractiveness for male models of Unattractive, Average, and Attractive background facial attractiveness with IOTN 1, 5, 7, and 10 dental attractiveness rated by male and female individuals. **A-C** are comparisons within a column. **D-G** are comparisons within a row. The same letters are not significantly different. When letters are different, $P < 0.0001$ except for those marked with asterisks. Those P values are as follows: $*P < 0.05$, $**P < 0.01$, $***P < 0.001$.

significant increase in the delta for Attractive male individuals at IOTN 7 that was not seen in female individuals.
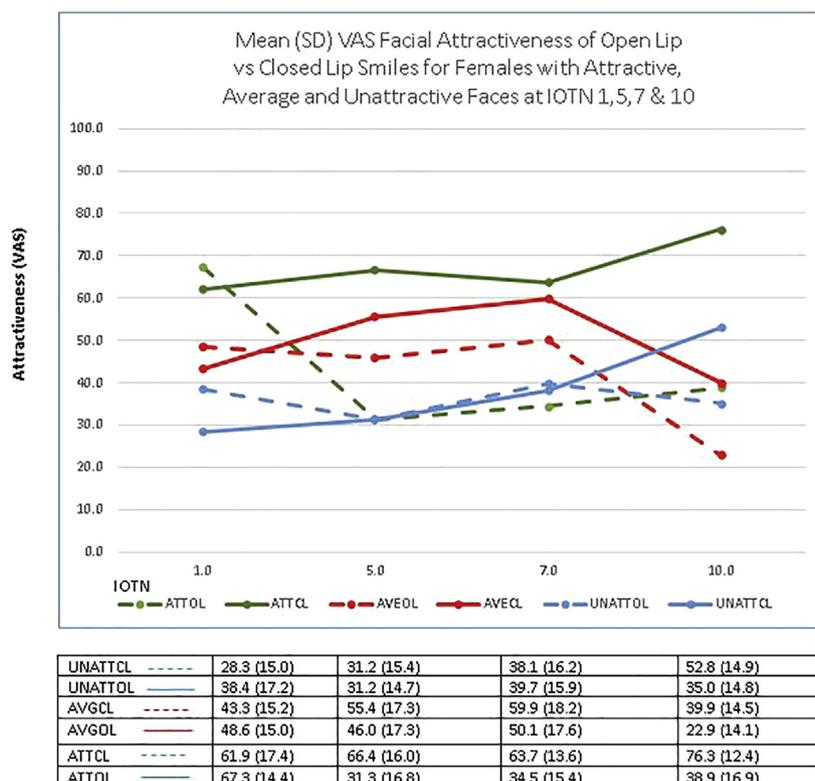
Figures 3 and 4 demonstrate the raw overall VAS of the open- and closed-lip images separately. This shows the relative impact for each group in relation to other groups of female and male individuals. First, the data support the level of background attractiveness determined by previous raters in separating the closed-lip models as Attractive, Average, and Unattractive, with few exceptions. Overall, women were rated as more attractive than men. The severity of the initial decline in attractiveness at IOTN 5 for the Attractive male and female faces can be appreciated in these graphs. For female faces, the attractiveness of the Attractive model with IOTN 5 dropped to the level of an Unattractive open- and closed-lip model (Fig 3). This low level was maintained until IOTN 10. Average female faces were most affected by poor dental esthetics. At IOTN 10 all open-lip models were viewed as less attractive than any closed-lip models.

The pattern for male faces of decline in attractiveness as dental attractiveness declined was similar for Average and Unattractive male faces (Fig 4). The initial decline at IOTN 5 that was seen in Attractive female faces was also present in male ones but not as severe. Open-lip

Attractive male faces at IOTN 10 fell to the level of attractiveness of closed-lip Average male faces at IOTN 10. At IOTN 10, Average male faces fell below the level of closed-lip Unattractive ones.

For aim 2, Figures 5 and 6 show the influence of dental attractiveness on integrity and social and intellectual attractiveness for each sex and background facial attractiveness level. These figures also display the significant differences between the ratings for the best (IOTN 1) and worst (IOTN 10) dental attractiveness for women and men, respectively. For women, the clusters generally had higher overall ratings as the models' background facial attractiveness increased, occupying the 38-78 VAS range. As the background facial attractiveness increased, the impact of dental esthetics on the judgments became less important (only 2 dimensions were significantly different in the Attractive group). Social class was always impacted by dental attractiveness, whereas compliance and honesty were not. Perceived intelligence was affected except when the model was Attractive.

Figure 6 shows the influence of dental attractiveness on integrity and social and intellectual attractiveness for men. The range of VAS scores was larger in men (both higher and lower). For men, the teeth had more effect as background facial attractiveness increased; it was

Mean (SD) VAS Facial Attractiveness of Open Lip vs Closed Lip Smiles for Females with Attractive, Average and Unattractive Faces at IOTN 1,5,7 & 10

		1.0	5.0	7.0	10.0
UNATTCL	-----	28.3 (15.0)	31.2 (15.4)	38.1 (16.2)	52.8 (14.9)
UNATTOL	———	38.4 (17.2)	31.2 (14.7)	39.7 (15.9)	35.0 (14.8)
AVGCL	-----	43.3 (15.2)	55.4 (17.3)	59.9 (18.2)	39.9 (14.5)
AVGOL	———	48.6 (15.0)	46.0 (17.3)	50.1 (17.6)	22.9 (14.1)
ATTCL	-----	61.9 (17.4)	66.4 (16.0)	63.7 (13.6)	76.3 (12.4)
ATTOL	———	67.3 (14.4)	31.3 (16.8)	34.5 (15.4)	38.9 (16.9)

Fig 3. Mean (SD) VAS facial attractiveness of open-lip vs closed-lip smiles for female models with Attractive, Average, and Unattractive faces at IOTN 1, 5, 7, and 10.

the opposite for women. All dimensions of social attractiveness were significantly affected by the dentition at some level of background facial attractiveness. In male faces, dental attractiveness had the most significant effects on social and intellectual attractiveness in Average and Attractive groups. Background facial attractiveness did not affect integrity. Perceived intelligence significantly increased in Average and Attractive groups over Unattractive groups for IOTN 1.

Average female and male faces have the most social judgments significantly affected by teeth, but in contrasting ways. For women, some are improved by teeth (social class, popularity, and intelligence), whereas an equal number are reduced by good teeth (friendliness, extroversion, and kindness). For Average men, all but compliance were significantly positively affected by good teeth.
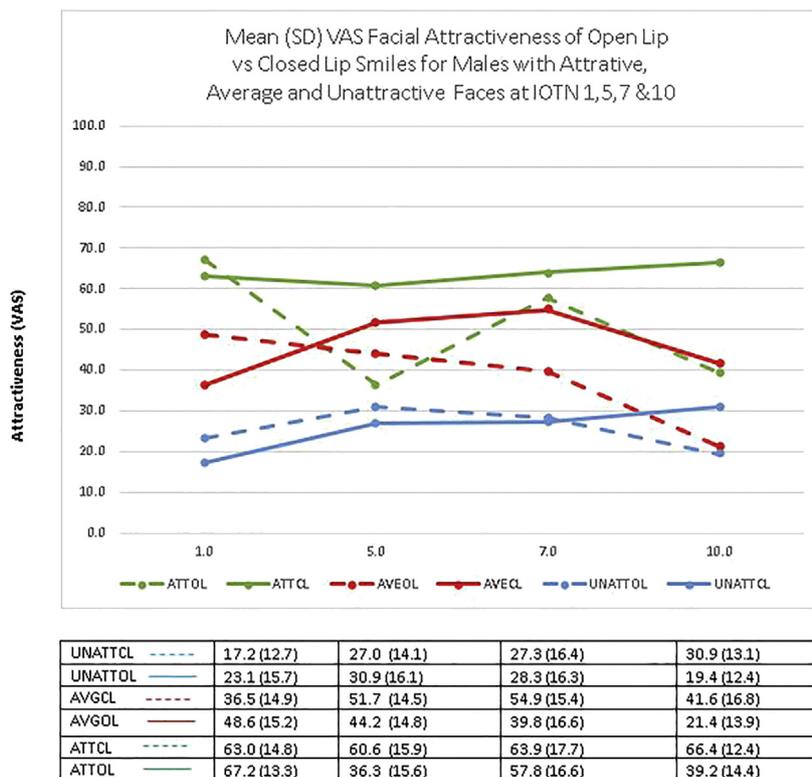
DISCUSSION

Intrarater reliability for this study was comparable or better than that demonstrated in eye-tracking studies.[9,10] Shaw et al[6] did not report reliability data to compare with the intrarater reliability for aim 2.

The results of this study showed that the smile does contribute to the attractiveness of the face in a measurable way, but the quantifiable contribution is not always positive or linear. Contrary to the findings of Kiekens et al[25], who identified dental contribution as 25% of the overall facial attractiveness for adolescent female individuals, our findings suggest that dental contribution is not fixed and is dependent on the background facial attractiveness and model sex.

For female individuals, only near ideal teeth (IOTN 1) enhance background facial attractiveness. At all other levels of dental attractiveness, and for all background facial attractiveness levels, the teeth were either neutral or reduced the facial attractiveness level when the teeth were categorized as needing any sort of orthodontic treatment (IOTN 5, 7, and 10 in Fig 1). For Attractive women this impact was most dramatic. For Unattractive faces, the impact was less severe. However, showing teeth in need of alignment reduced the facial attractiveness level substantially; therefore, the impact was not trivial. The impact on men was similar but slightly less marked (Fig 2).

Havens et al[26] reported that when an unattractive smile alone was viewed, the attractiveness level was lower than when it was placed in an attractive face. Similarly, Flores-Mir et al[27] found that the impact of dental

Mean (SD) VAS Facial Attractiveness of Open Lip vs Closed Lip Smiles for Males with Attrative, Average and Unattractive Faces at IOTN 1,5,7 &10

		1.0	5.0	7.0	10.0
UNATTCL	- - - - -	17.2 (12.7)	27.0 (14.1)	27.3 (16.4)	30.9 (13.1)
UNATTOL	———	23.1 (15.7)	30.9 (16.1)	28.3 (16.3)	19.4 (12.4)
AVGCL	- - - - -	36.5 (14.9)	51.7 (14.5)	54.9 (15.4)	41.6 (16.8)
AVGOL	———	48.6 (15.2)	44.2 (14.8)	39.8 (16.6)	21.4 (13.9)
ATTCL	- - - - -	63.0 (14.8)	60.6 (15.9)	63.9 (17.7)	66.4 (12.4)
ATTOL	———	67.2 (13.3)	36.3 (15.6)	57.8 (16.6)	39.2 (14.4)

Fig 4. Mean (SD) VAS facial attractiveness of open-lip vs closed-lip smiles for male models with Attractive, Average, and Unattractive faces at IOTN 1, 5, 7, and 10.

esthetics was decreased when the full face was viewed. This demonstrated that an attractive face will offset dental malocclusions, camouflaging the low dental attractiveness. In our study this was truer for men.

For men, at the most unattractive malocclusions (IOTN 10) the overall attractiveness of the Unattractive and Average groups converged, whereas Attractive faces were clearly rated higher (Fig 4). Baker et al[10] noted that reliability of identifying attractive male faces was poor. In spite of this, our results show that attractive men benefit from their facial attractiveness in camouflaging their dental deficits. This was not true for women, where Attractive and Unattractive faces converged at IOTN 10 (Fig 3).
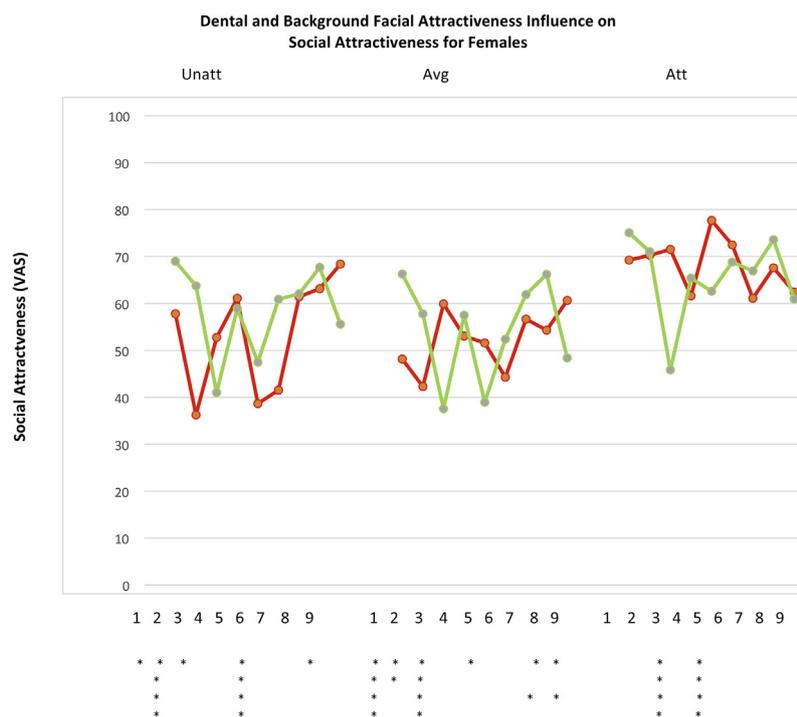
Eye-tracking visual attention does not appear to perfectly correlate with these findings, as men received more attention to their mouths (compared with the eyes) than women with poor dental attractiveness.[9,10] Open-lip, Attractive men and women had the same approximate level of attractiveness at IOTN 10 (~0.40), both above the Unattractive and Average models of the same IOTN level.

The significant reduction in facial attractiveness at IOTN 5 in Attractive male and female faces can be explained by research done on visual attention. Richards et al[9] reported that the more attractive the face, the lower the threshold for dental unattractiveness to draw attention to the mouth. Furthermore, this increased attention to the discordant mouth was greater in female faces than in male faces.[9,10] Harmony of the face appears to play a role in the attractiveness of a face, as poor dental attractiveness has a more significant effect on Attractive faces than the changes in Unattractive and Average faces.

It was interesting to find that this disharmony was recognized at IOTN 5 in our study. When studying the borderline IOTN levels, Johnson et al[19] found that the "tipping point" at which visual attention to the mouth approached that of the eyes was at IOTN 7 rather than IOTN 5. This suggests that visual attention does not necessarily mean a negative judgment, but interest.

Sutherland et al[28] found that viewers rely on broad and simple cues, such as a smile, to make overall impressions and social judgments using the complex Big 5 model. This model examines the personality in 5 dimensions (extroversion, agreeableness, openness, neuroticism, and conscientiousness) and is rated on a scale of 1-7. Each of the 5 components encompasses other facets of personality traits. We chose to use the dimensions used by Shaw et al[6] for comparability in our study as opposed to another model.

Dental and Background Facial Attractiveness Influence on Social Attractiveness for Females

Honesty, Social and Intellectual Dimensions

	IOTN								
	1	2	3	4	5	6	7	8	9
Unatt									
1 🟥	A 57.8 (17.7)	A 36.3 (20.5)	A 52.8 (18.8)	A 61.1 (18.9)	A 38.7 (15.7)	A 41.5 (14.5)	A 61.4 (20.5)	A 63.1 (19.1)	A 68.4 (15.4)
10 🟩	B*69.0 (14.7)	B****63.7 (19.0)	B* 41.0 (17.9)	A 58.9 (20.4)	A 47.5 (19.2)	B****60.9 (19.8)	A 62.0 (19.5)	A 67.7 (18.5)	B* 55.6 (18.6)
Avg									
1 🟥	A 48.2 (20.9)	A 42.3 (20.4)	A 59.9 (19.1)	A 53.1 (22.0)	A 51.6 (20.2)	A 44.3 (19.1)	A 56.7 (21.5)	A 54.3 (21.2)	A 60.6 (17.6)
10 🟩	B****66.3 (18.7)	B** 57.8 (22.2)	B****37.6 (15.3)	A 57.5 (19.7)	B* 39.0 (17.7)	A 52.4 (20.6)	A 61.9 (19.1)	B* 66.2 (18.6)	B* 48.4 (17.8)
Att									
1 🟥	A 69.2 (18.4)	A 70.3 (19.9)	A 71.5 (15.9)	A 61.6 (17.3)	A 77.7 (15.2)	A 72.5 (16.9)	A 61.1 (18.1)	A 67.6 (18.6)	A 62.4 (15.3)
10 🟩	A 75.1 (15.5)	A 71.0 (15.0)	B****45.8 (19.6)	A 65.4 (17.3)	B****62.6 (17.3)	A 68.8 (14.8)	A 66.9 (16.8)	A 73.6 (18.6)	A 61.0 (16.8)

Fig 5. Dental and background facial attractiveness influence on social attractiveness for female models (aim 2). This figure compares the values of Questions (1) friendly, (2) extroverted, (3) high social class, (4) compliant, (5) popular, (6) fun, (7) honest, (8) kind, and (9) intelligent for IOTN 1 (red) vs IOTN 10 (green) rated by male and female viewers. **A** and **B** are comparisons within a column for a background facial attractiveness level. The same letters are not significantly different. Asterisks identify level of significance: *$P < 0.05$, **$P < 0.01$, ***$P < 0.001$, ****$P < 0.0001$.

Using this method, we found that dental attractiveness has more effect on estimations of integrity, social, and intelligence for men than for women, especially Average men. Some dimensions, like intelligence, were affected in an opposite manner for men and women. It was found that well-aligned teeth only increased perceived intellectual attractiveness in Average and Attractive male faces, whereas it increased perceived intellectual attractiveness in Unattractive and Average female faces. We have no explanation for this

disparity. Shaw et al[6,12] and Olsen et al[13] found that models with normal dentition were viewed as more intelligent.

Some personality characteristics, such as integrity, were not significantly affected by dental or background facial attractiveness. Todorov et al[29] found that there is a functional and behavioral ability to determine trustworthiness from a face. The effect of dental esthetics on our study's proxy for trustworthiness (honesty) was small. Only Average men experienced an increase in perceived

Dental and Background Facial Attractiveness Influence on Social Attractiveness for Males

Honesty, Social and Intellectual Dimensions

		IOTN								
		1	2	3	4	5	6	7	8	9
Unatt										
1		A 66.2 (17.3)	A 41.8 (22.8)	A 38.2 (18.5)	A 62.0 (19.0)	A 26.2 (12.9)	A 45.2 (20.7)	A 62.9 (18.1)	A 68.0 (18.3)	A 46.0 (18.4)
10		B* 56.7 (18.5)	B* 29.1 (14.4)	A 33.9 (12.8)	A 58.3 (18.8)	A 28.5 (15.5)	B** 32.6 (15.7)	A 61.8 (16.2)	A 62.9 (17.0)	A 56.5 (20.0)
Avg										
1		A 76.2 (13.3)	A 68.2 (19.5)	A 61.7 (16.0)	A 61.2 (19.1)	A 66.7 (16.4)	A 71.6 (13.3)	A 67.3 (14.7)	A 74.2 (14.7)	A 58.0 (17.2)
10		B** 62.5 (20.0)	B** 50.5 (23.3)	B**** 28.3 (16.3)	A 50.7 (21.5)	B**** 34.4 (19.1)	B** 56.4 (19.5)	B* 55.3 (20.6)	B** 61.9 (17.2)	B**** 41.8 (19.2)
Att										
1		A 70.5 (14.1)	A 65.3 (20.6)	A 74.0 (13.0)	A 63.8 (15.0)	A 77.7 (13.6)	A 71.1 (18.2)	A 59.6 (14.9)	A 66.5 (12.9)	A 67.2 (12.2)
10		A 63.0 (14.8)	A 58.7 (18.6)	B**** 49.5 (18.0)	B** 51.0 (19.6)	B**** 60.9 (15.9)	A 65.5 (17.0)	A 54.6 (19.7)	A 61.3 (16.9)	B**** 50.8 (16.8)

Fig 6. Dental and background facial attractiveness influence on social attractiveness for male models (aim 2). This figure compares the values of Questions (1) friendly, (2) extroverted, (3) high social class, (4) compliant, (5) popular, (6) fun, (7) honest, (8) kind, and (9) intelligent for IOTN 1 (red) vs IOTN 10 (green) rated by male and female viewers. **A** and **B** are comparisons within a column for a background facial attractiveness level. The same letters are not significantly different. Asterisks identify level of significance: *$P < 0.05$, **$P < 0.01$, ***$P < 0.001$, ****$P < 0.0001$.

honesty when dental esthetics were improved (Fig 6). Integrity was unaffected by facial attractiveness in both male and female faces. Shaw et al[6] found that models with prominent incisors were perceived as the most compliant and honest.

In this study there was no statistically significant difference in ratings based on rater sex. This is in agreement with the results of other studies.[13,30,31] Contrary to these studies, Eli et al[11] found that physical attractiveness stereotyping was more evident when models were judged by the opposite sex. Flores-Mir et al[27] also found a sex effect on rating of model esthetics and that men were less critical than women viewers when rating the same models.

However, some eye-tracking studies reported that the sex of the rater mattered when viewing faces. Women viewed the eyes more, whereas men viewed the mouth and nose more.[9] Similarly, Baker et al[10] also reported that women raters showed more attention to eyes than men.

In this study, the rater groups were not equally balanced for male (25%) and female (75%) individuals. The 4-way ANOVA indicated that there was no significant interaction for rater gender ($P = 0.42$). The finding of no rater-sex effect could be because of the sex distribution.

Although the aim of the study was to focus on the effect of teeth on components of attractiveness, the entire

orofacial region was factored into the ratings. In addition to the intraoral components of a smile, extraoral factors (the symmetry of the smile, the thickness of the lips, the width of the smile) may have contributed to the overall attractiveness of the smile. For example, Scott et al[32] examined how the size of the vermilion border of the lip influenced perception of dental attractiveness. These types of extraoral characteristics were not controlled for and could have affected the results.

Furthermore, there are components of the dentition itself that evoke different judgment (eg diastemas, crowding, protrusive incisors). Keruosuo et al[33] found that models with incisal crowding and median diastemas were considered to be less intelligent, less sexually attractive, and belonging to a lower social class. When comparing 7 occlusions (normal, open bite, deep bite, underbite, overjet, crowding, and spacing), Olsen et al[13] found that there were significant differences between the ratings of the malocclusions. Models with an underbite (negative overjet) were rated least extroverted and drew the least desire to be interacted with; those with generalized spacing were rated least conscientious and least agreeable.

IOTN levels do not control for specific malocclusion characteristic; they only measure the need for orthodontic treatment. This may account for the distinct rise in attractiveness of the IOTN 7 for the Attractive male.

Our results only apply to young Caucasian adults rated by young Caucasian adults. Shaw[6,13] used children and young adults. Most studies, including this one, mainly have focused on young Caucasian models. Examining younger vs older participants and different ethnicities would broaden our understanding of the impact teeth have. History of past orthodontic treatment was not controlled in this study. This may have influenced viewer appreciation and consequently judgment of dental esthetics.

It has been shown that head orientation, emotional expression, and physical attractiveness influence whether people prefer a direct gaze or an averted gaze.[34] These findings only apply to evaluations of attractiveness, integrity, and social and intellectual attractiveness made with a direct gaze and a frontal orientation with a nonjudgmental expression. Lastly, a future study may want to combine previous eye-tracking designs with this survey design so that it can be determined not only what the same viewer is focusing on but also what judgments that viewer is making.

CONCLUSIONS

1. The contribution of dental esthetics to facial attractiveness is not fixed or linear.

2. The effect of dental esthetics on facial attractiveness is neutral or negative for both male and female faces when there is a need for treatment (IOTN 5 or higher) for all levels of background facial attractiveness.

3. For both men and women, lower dental esthetics had a greater effect on more attractive faces.

4. The impact of dental attractiveness on background facial attractiveness and social, integrity, and intellectual attractiveness was dependent on the dental attractiveness level, background facial attractiveness, and model sex.

5. Judgments about integrity, sociability, and intelligence were strongly affected by dental esthetics. These effects were more consistent for male faces.
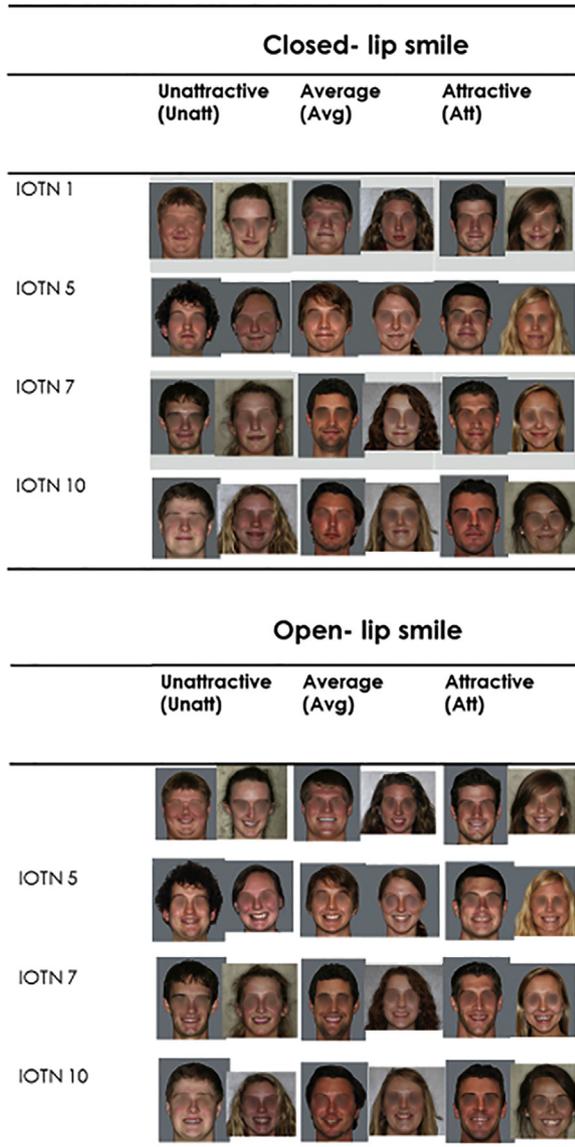
SUPPLEMENTARY DATA

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.ajodo.2018.10.021.

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APPENDIX

Supplementary Fig. These models were rated by peers for background facial attractiveness and by orthodontists for comparable IOTN dental attractiveness prior to final composite model construction. The eyes have been blurred here for publication and this has removed cues that raters might have used to make facial attractiveness determinations.