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Threshold Levels of Patient and Parent Esthetic Concern in the Mixed Dentition

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Threshold Levels of Patient and Parent Esthetic Concern in the Mixed Dentition

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

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Abstract

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MIXED DENTITION

By: Justin Josell, DDS

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Purpose: The mixed dentition is a period of unique dental changes for developing children and
their parents. The purpose of this study is to determine threshold levels of concern regarding
diastema spacing and angulation of maxillary incisors during the "Ugly Duckling Stage" in
pediatric patients and their parents.

Methods: This study is modeled as a cross sectional-survey among pediatric patients and parents.
The surveys contain photographs of a sex-neutral, mixed-dentition smile with variations of
midline spacing and incisal angulation which randomly differ in quantifiable values. Participants
were asked to rate each photograph on a visual analog scale.

Results: The interaction between respondent type and image was not statistically significant.
Children aged 8-12 years old showed less concern with appearance of diastema and angulation
variations within the anterior maxillary dentition relative to the adult parent population. Parents
who have experienced a child through the mixed dentition (oldest child that was 12 years or
older) showed significantly more concern with appearance of diastema and midline discrepancies
in the mixed dentition. Overall, images of maxillary central incisors in the mixed dentition with
30 or 40 degree rotation were rated significantly lower than the baseline image and the images
with 5 degrees of rotation, 10 degrees of rotation, and 1mm diastema.

Conclusions: Dental professionals can use this information to better understand the concerns of
their patient population and for purposes of anticipatory guidance and treatment planning.

Introduction

Mixed dentition which occurs from 6 to 12 years of age is a period of physical, emotional, and behavioral growth for children and is characterized by the eruption of maxillary central and lateral incisors prior to the eruption of canines in the esthetic zone. This frequently nicknamed "Ugly Duckling Stage" may be a time of considerable esthetic concern for both parents and children. The pediatric dentist often receives questions and concerns from parents and patients regarding the positioning of newly erupted maxillary incisors. There is a strong correlation between mixed dentition age and concerns regarding tooth alignment. Prior research suggests that as many as 50% of 10 year-old patients reported to the dentist with a chief complaint concerning anterior tooth alignment.[1]

The transition from primary to permanent incisors is completed by the age of 8. During eruption of the permanent maxillary incisors, a space persists between the teeth for approximately three years prior to the eruption of the maxillary canines which typically occurs following exfoliation of the primary maxillary canines around 11-12 years. When central incisors erupt, they are flared laterally because unerupted lateral incisors constrain the root of central incisors. This leads to flaring in the early mixed dentition, often called the "Ugly Duckling Stage." Such flaring reaches its maximum at approximately 10 years old.[2,3] Prominent maxillary midline diastemas are part of normal development during this mixed dentition period

and occur in approximately 50% of children between 6-8 years old. This space tends to decrease in size as the child gets older.[2] Nonetheless, these transient occlusal and space anomalies in the dentition may adversely affect body image in children and continue through adolescence into adulthood.[4] A survey conducted among mothers found that 55% of respondents rated the "Ugly Duckling" stage as esthetically unpleasant.[5]

Multiple studies have assessed threshold levels of concern in adult dentition in an attempt to assist patient-centered treatment planning.[6,7,8] Very few studies, however, have addressed mixed dentition esthetic analysis as it pertains to both patient and parent concerns. Kokich et al. compared perceptions of dental professionals and lay people and noted that an incisal plane angulation of 1mm was rated significantly less esthetic by general dentists and orthodontists. In contrast, lay people were unable to detect an incisal plane asymmetry until 3mm.[9] Thomas et al. noted statistically significant threshold values between acceptable and unacceptable midline angulations, indicating that discrepancies of 10 degrees were unacceptable by 68% of orthodontists and 41% of laypeople.[10] In another study, a small midline diastema was not rated unattractive by orthodontists, general dentists, and laypeople. The threshold level of 1.0-1.5 mm was found acceptable for orthodontists and 2.0 mm for both lay people and dentists.[11]

It has been shown that ideal and unacceptable ranges in dentition can be identified reliably. Computer-based ratings of digitally altered smile images provided a means of accurately and reliably identifying ideal values for many smile characteristics and, hence, provide an outline for patient-centered treatment planning.[12] Parrini conducted a systematic review analyzing laypeople's thresholds of smile acceptance esthetics and found that the threshold tolerance of central diastema spacing was 0-2 mm with a cutoff of 1.5mm. Additionally, layperson subjects approved of a 0-3 mm midline discrepancy (with cutoff value of

2.38 mm) and 0 to 4 degrees of occlusal canting.[13] Silva reported that the degree and direction of a canted dental midline influences ratings of attractiveness and, as such, the midline should be as vertically straight as possible.[14]

Another systematic review that analyzed 1667 articles found that esthetic perceptions in patients under 18 years old did not produce any threshold values as a quantitative and qualitative way to assess perceptions of smile anomalies.   However, the study concluded that smile esthetics influence social perception in the pediatric and adolescent population, despite the absence of quantitative threshold values in the literature.[15] Though many studies exist regarding concerns with diastema and incisor angulation in the permanent dentition, very few studies have evaluated mixed dentition or attempted to quantify the esthetics of the "Ugly Duckling Stage". Previous research by Cannon et al. has investigated parental satisfaction with mixed dentition esthetics via questionnaire; however, it analyzed fluorosis and opacity of teeth rather than diastema and angulation commonly seen during the mixed dentition age.[16] Additionally, there are few examples in literature that assess pediatric patient opinions. As such, this study will survey parents and patients to assess concern regarding diastema spacing and angulation of new erupted maxillary incisors during this period. The aim is to distinguish if there are threshold levels of spacing and angulation which cause parental and pediatric patient concern.

Methods

This study was modeled as a cross sectional-survey among pediatric patients and parents
at Virginia Commonwealth University School of Dentistry Pediatric Dental Clinic. Pediatric
patients and parents were selected for participation during their visits to the pediatric dental
clinic for routine dental treatment or prophylaxis. There were two surveys provided: one for
parents, one for pediatric patients. Both surveys contained 10 photographs of a sex-neutral,
mixed-dentition smile extending from subnasale to mento-labial fold which was digitally altered
such that each image appeared with varying midline spacings in 1mm increments (1mm, 2mm,
and 3mm) or incisal angulation which differed in values of 5 to 10 degrees (5, 10, 15, 20, 30, and
40 degrees) from the papilla. Images were measured and calibrated accordingly with Adobe
Photoshop software (v.22.1.0). The baseline photo without angulation or diastema discrepancies
was also included in the survey. Photographs were calibrated such that they were all identical in
image resolution and size. Survey images are displayed in Figure 1.

The parent survey contained demographic information including relationship to the child
as (a) Mother, (b.) Father, or (c.) Other and the age of his/her oldest child. Images were scored
on a scale from 0 to 10 by both adults and children, however the scale for adults ranged from 0
which indicated "absolutely no concern with appearance" to 10 which indicated "absolutely
concerned with this appearance." The ratings for children were reversed such that a 0 indicated
"I do not like how these teeth look" and a 10 indicated "I like how these teeth look." The adult

responses were reversed so higher numbers would indicate greater approval of the image for both types of respondents.

Similar to the parent survey, the pediatric patient survey asked for the age of the patient. Additionally, it asked for the child's gender as either a boy or girl. The range for pediatric participants was limited to between 8 and 12 years.

Patients and parents surveyed were selected at random and were offered to decline participation with no penalty. Study participants were not limited by race and sex, though participation required English as a first language. The survey was administered digitally on an Apple iPad Pro device via REDCap survey software.[17] The screen and all images were in color.

Figure 1: Survey Images

Baseline No Diastema	1mm Diastema
2mm Diastema	3mm Diastema
5° Rotation	10° Rotation
15° Rotation	20° Rotation

30° Rotation	40° Rotation

*Note that images appeared in randomized order on survey.

Statistical Methods

A two-way repeated measures ANOVA model with interaction term was fit to predict average approval ratings based on respondent type and image viewed, allowing for the ratings based on the image to be dependent on the respondent type. Adult respondents were separated into two groups based on the age of their oldest child. These groups were those who have experienced a child through the mixed dentition, which was defined as an oldest child that was 12 years or older and those who are new to mixed dentition, which was defined as all those whose oldest child is less than 12. Those who failed to answer this question were excluded. A repeated measures model was fit to estimate the effect of oldest child age on ratings of the images among the adult responses only. Post hoc pairwise comparisons were adjusted using Tukey's adjustment. The significance level was set at 0.05. SAS EG v.8.2 (SAS Institute, Cary, NC) was used for all analyses.

A total of 107 parents and guardians and 25 children participated in the survey. For the adults, 73 (69%) identified as "Mother," 22 (21%) as "Father," and 11 (10%) identified as "Other." The children were equally split between boy (n=12) and girl (n=12), with one subject not responding. Respondent demographics are presented in Table 1.

Table 1: Respondent Demographics

	n, % or Mean, SD
Respondent	
Parent/Guardian	107, 81%
Child	25, 19%
Adults (n=107)	
Relationship to Child	
Mother	73, 69%
Father	22, 21%
Other	11, 10%
Age of Oldest Child (Mean, SD)	14, 6.8
Children (n=25)	
Child's Gender	
Boy	12, 50%
Girl	12, 50%
Child's Age (Mean, SD)	11, 3.2

The average rating for the baseline image was 4.9 for the adults and 6.1 for the children out of a possible 10 points where higher scores indicate greater acceptance. Images with varying levels of diastema ranged from 3.2 to 4.2 for adults and 4.8 to 5.7 for children. Average scores for the varying degrees of rotation ranged from 2.3 to 4.6 for adults and 3.9 to 6.3 for children. Average ratings are presented in Table 2, Figure 2.

Table 2: Average Image Rating by Respondent

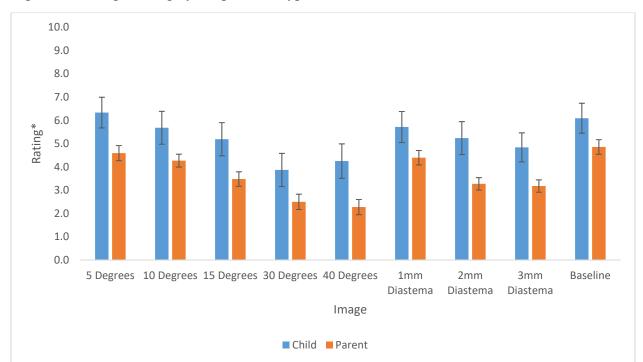| Image	Mean, SD	
	Child	**Parent**
5 Degrees	6.3, 3.02	4.6, 3.13
10 Degrees	5.7, 3.31	4.3, 2.61
15 Degrees	5.2, 3.27	3.5, 3.02
30 Degrees	3.9, 3.42	2.5, 3.25
40 Degrees	4.3, 3.63	2.3, 3.29
1mm Diastema	5.7, 3.05	4.4, 3.05
2mm Diastema	5.2, 3.24	3.3, 2.5
3mm Diastema	4.8, 3.12	3.2, 2.67
Baseline	6.1, 3.02	4.9, 3.11

Figure 2: Average Rating by Respondent Type

*Note: Ratings range from 0-10 where higher numbers indicate greater acceptance. Error bars are Standard Error

The interaction between respondent type and image was not statistically significant (p-value=0.9966). Ratings from the children were on average, 1.6 points higher than adults (p-value<0.0001). Post hoc pairwise comparisons for the images demonstrated that those with 30 or 40 degree rotation were rated significantly lower than the baseline image (adjusted p-value=0.0002, 0.0003, respectively), the images with 5 degrees of rotation (adjusted p-values=0.0003, 0.0004, respectively), 10 degrees of rotation (adjusted p-value: 0.0116, 0.0175, respectively), and 1mm diastema (adjusted p-value=0.0072, 0.0109, respectively). None of the other pairwise comparisons were statistically significant. Pairwise comparisons are presented in Table 4. The average scores for all respondents combined are presented in Table 3 and Figure 3.

More than half of respondents were categorized as having experienced mixed dentition (n=62, 59%) and 41% (n=43) were considered new to mixed dentition. Adult ratings were significantly associated with the image viewed (p-value<0.0001) and the age of their oldest child (p-value<0.0001). Results of this model are presented in Table 5. Again, images with the 30 and 40 degree rotation were rated the lowest on average. The 2 and 3mm diastema images were also rated significantly lower than baseline and 3mm was significantly lower than 5 degrees of rotation. Respondents who were considered new to the mixed dentition (oldest child <12years old) rated images on average 0.95 points higher than those who have experienced the mixed dentition (oldest child 12 or older).

Although there were only 24 children included in the study, the difference in ratings was assessed between boys and girls. The difference was not statistically significant (5.2 vs 5.4, males vs females, p-value=0.6836).

Table 3: Estimated Average Ratings for All Respondents Combined

Image	Average Rating	SE	
Baseline	5.5	0.3573	a
5deg	5.5	0.3659	a
10deg	5.0	0.3606	a
15deg	4.3	0.3655	a, b
30deg	3.2	0.3509	b
40deg	3.3	0.3436	b
1mm	5.1	0.3648	a
2mm	4.3	0.3678	a, b
3mm	4.0	0.3383	a, b

*Images with the same letter were not statistically significantly different

Table 4: Pairwise Comparisons to Evaluate Differences in Average Image Ratings

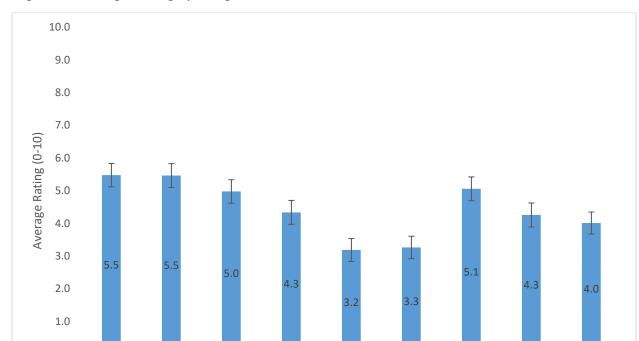| Comparison	Estimated Difference	SE	Adjusted P-value
10deg vs. 15deg	0.6	0.51	0.9453
10deg vs. 1mm	-0.1	0.51	1
10deg vs. 2mm	0.7	0.52	0.8984
10deg vs. 30deg	1.8	0.50	0.0116
10deg vs. 3mm	1.0	0.49	0.5753
10deg vs. 40deg	1.7	0.50	0.0175
10deg vs. 5deg	-0.5	0.51	0.9901
10deg vs. baseline	-0.5	0.51	0.9875
15deg vs. 1mm	-0.7	0.52	0.8997
15deg vs. 2mm	0.1	0.52	1
15deg vs. 30deg	1.1	0.51	0.3619
15deg vs. 3mm	0.3	0.50	0.9993
15deg vs. 40deg	1.1	0.50	0.448
15deg vs. 5deg	-1.1	0.52	0.4192
15deg vs. baseline	-1.1	0.51	0.3874
1mm vs. 2mm	0.8	0.52	0.8345
1mm vs. 30deg	1.9	0.51	0.0072
1mm vs. 3mm	1.0	0.50	0.4722
1mm vs. 40deg	1.8	0.50	0.0109
1mm vs. 5deg	-0.4	0.52	0.9972
1mm vs. baseline	-0.4	0.51	0.9963
2mm vs. 30deg	1.1	0.51	0.4695
2mm vs. 3mm	0.2	0.50	0.9999
2mm vs. 40deg	1.0	0.50	0.5625
2mm vs. 5deg	-1.2	0.52	0.3271
2mm vs. baseline	-1.2	0.51	0.298
30deg vs. 3mm	-0.8	0.49	0.7519
30deg vs. 40deg	-0.1	0.49	1
30deg vs. 5deg	-2.3	0.51	0.0003
30deg vs. baseline	-2.3	0.50	0.0002
3mm vs. 40deg	0.7	0.48	0.8318
3mm vs. 5deg	-1.5	0.50	0.0861
3mm vs. baseline	-1.5	0.49	0.0729
40deg vs. 5deg	-2.2	0.50	0.0004
40deg vs. baseline	-2.2	0.50	0.0003
5deg vs. baseline	0.0	0.51	1
Child vs. Parent	1.6	0.24	<.0001

Figure 3: Average Rating by Image

*Note: Ratings range from 0-10 where higher numbers indicate greater acceptance. Error bars are Standard Error

Table 5: Results from Repeated Measures ANOVA Model for Adult Respondents Only

	Estimated Mean	SE	P-value
Age of Oldest Child			<0.0001
Experienced with Mixed Dentition (12 or older)	3.28	0.13	
New to Mixed Dentition (Less than 12)	4.23	0.16	
Image			<0.0001
Baseline	5.04	0.30	
5deg	4.73	0.31	
10deg	4.40	0.31	
15deg	3.57	0.31	
30deg	2.54	0.30	
40deg	2.25	0.29	
1mm	4.56	0.30	
2mm	3.41	0.31	
3mm	3.26	0.29	

*P-value from Repeated Measures ANOVA model

Discussion

This study compared smile esthetics in the mixed dentition phase among pediatric patients and parents/guardians. The two features adjusted were midline diastema and angulation of incisors. Overall, ratings were low among all the images. Participants did not strongly accept any image. Interestingly, the pediatric population had significantly high approval of all the images when compared to the parent population. This suggests that children may not be as concerned about the appearance of maxillary anterior dentition as their parents. Research has indicated that parental influence is the single strongest predictor of a pre-adolescent child's orthodontic treatment demand.[18] Additionally, children 12 years old and older are associated with increasing concern about themselves and the opinion of others[19] which suggests that the patients surveyed are less likely to prioritize esthetics than their slightly older peers. In contrast, teenage children may be more concerned about their appearance than children of mixed-dentition age. A study noted that attitudes about desirable and acceptable dental esthetics differ in younger children compared with older children and parents. Ten-year-old children found good function with poor esthetics more pleasing, while 14-year-old children find esthetics with bad function as more pleasing.[20]

The interaction between respondent type and image was not statistically significant which may suggest few differences in the concerns of diastema and angulation discrepancies among parents and children. Neither respondent type was significantly more or less accepting of a

particular feature versus the other respondent type. Additionally, differences in acceptance between boy and girl pediatric participants was not significant. This is despite research which indicates that young adolescent females value self-worth as it related to appearance more than males.[21] However, research analyzing tooth positioning concerns was found to have no significant difference amongst participants varying in both sex and age.[22] An additional study found that concern for appearance is commonplace among the population at large; however, the majority of such concerns focus on one particular physical feature only[23], which suggests that perhaps incisor angulation and midline diastema is of a lesser priority for many within an appearance-concerned population. As with most studies regarding esthetics, subjectivity is a necessary consideration. For instance, some research has indicated that a "golden proportion" of teeth sizes is difficult to statistically quantify.[24] Additional evidence suggests there can be highly variable associations between self-perception of orthodontic treatment need and orthodontist's assessment of treatment need.[25]

In the current study, images with 30 and 40 degree rotation were rated significantly lower than the baseline image and images with 5 degrees of rotation, 10 degrees of rotation, and 1mm diastema. This suggests that incisor angulation was a significant area of concern relative to diastema spacing. No diastema spacing, even the most extreme diastema spacing of 3mm, proved to generate statistically significantly lower ratings; whereas, rotations of both 30 and 40 degrees were significantly lower relative to baseline and other images of mild angulation discrepancy.

This study defined parents into two groups: those who have experienced a child through the mixed dentition, which was defined as an oldest child that was 12 years or older; and those who are new to mixed dentition, which was defined as all those whose oldest child is less than

12. Interestingly, the average score for parents new to the mixed dentition was 0.95 points higher than those who have experienced it before (4.23 vs 3.28). This was opposite to the initial hypothesis which assumed that parents who had likely experienced a child develop through the mixed dentition would be less concerned about the temporary appearance. After all, the name "Ugly Duckling," based on the children's allegory, implies that mixed dentition is a phase of temporary esthetic disharmony which self-corrects during development into adulthood. However, the discrepancy in concern between those who have experienced and have not experienced a child through mixed dentition may reflect the former group associating more concern with images that would reflect a lasting appearance; whereas the latter group (not having experienced a child grow through mixed dentition) may recognize that, at present, their child is in a transitory period of rapid growth and frequent change. Parents who have experienced mixed dentition may reflect on the negative aspects of raising a child through a potentially difficult period. As such, raising another child through this period could potentially cause unease. Nonetheless, perceptions in the esthetic zone are multifactorial not dependent solely on image alone. Research suggests that young adults in areas of low orthodontic treatment frequency are generally less aware of their anterior dental appearance.[26] Interestingly, a study noted that children's perception of orthodontic treatment need and satisfaction with the appearance of their teeth was statistically associated with their mothers' perception.[27] Dental professionals may use this information for purposes of anticipatory guidance and treatment planning with their patients and patients' parents.

Limitations to this study include limited sample size, particularly with the pediatric population surveyed. Additionally, all research was completed at a single teaching institution's Pediatric Dental Clinic which does not reflect the parent and pediatric population as a whole.

This study failed to incorporate a means of finding a truly acceptable image as all images, including the baseline image, did not have particularly favorable ratings. Further studies with larger sample sizes and diverse populations will increase the understanding of esthetic concern in the mixed dentition. Parameters such as socioeconomic status, race, and previous exposure to orthodontic treatment could also be explored.

Conclusion

Children aged 8-12 years old showed less concern with appearance of diastema and angulation variations within the anterior maxillary dentition relative to the parent population. Parents who have experienced a child through the mixed dentition in which the oldest child was 12 years or older showed significantly more concern with appearance of diastema and midline discrepancies in the mixed dentition. Overall, images of maxillary central incisors in the mixed dentition with 30 or 40 degree rotation were rated significantly lower than the baseline image and the images with 5 degrees of rotation, 10 degrees of rotation, and 1mm diastema.

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Appendix

Esthetic Concerns in Mixed Dentition

Please complete the survey below.

Thank you!

I am a:

○ Parent
○ Child

I am a

○ Mother
○ Father
○ None of the Above

My oldest child is _____ years old.

_____
(Enter as a single number.)

I am _____ years old.

_____
(Enter as a single number.)

I identify as a

○ Boy
○ Girl
○ None of the above

Please rate the following photos on a scale from 0 to 10 with "0 - absolutely no concern with appearance" to "10 - absolutely concerned with appearance"

Please rate the following photos on a scale from 0 to 10 with "0 - I do not like how these teeth look" to "10 - I like how these teeth look"

Image 1

Rating for Image 1 above	0	10

(Place a mark on the scale above)

Please rate the following photos on a scale from 0 to 10 with "0 - absolutely no concern with appearance" to "10 - absolutely concerned with appearance"

Please rate the following photos on a scale from 0 to 10 with "0 - I do not like how these teeth look" to "10 - I like how these teeth look"

Image 2

Rating for Image 2 above	0	10

(Place a mark on the scale above)

Please rate the following photos on a scale from 0 to 10 with "0 - absolutely no concern with appearance" to "10 - absolutely concerned with appearance"

Please rate the following photos on a scale from 0 to 10 with "0 - I do not like how these teeth look" to "10 - I like how these teeth look"

Image 3

Rating for Image 3 above

0   10

(Place a mark on the scale above)

Please rate the following photos on a scale from 0 to 10 with "0 - absolutely no concern with appearance" to "10 - absolutely concerned with appearance"

Please rate the following photos on a scale from 0 to 10 with "0 - I do not like how these teeth look" to "10 - I like how these teeth look"

Image 4

Rating for Image 4 above	0	10

(Place a mark on the scale above)

Please rate the following photos on a scale from 0 to 10 with "0 - absolutely no concern with appearance" to "10 - absolutely concerned with appearance"

Please rate the following photos on a scale from 0 to 10 with "0 - I do not like how these teeth look" to "10 - I like how these teeth look"

Image 5

Rating for Image 5 above	0	10

(Place a mark on the scale above)

Please rate the following photos on a scale from 0 to 10 with "0 - absolutely no concern with appearance" to "10 - absolutely concerned with appearance"

Please rate the following photos on a scale from 0 to 10 with "0 - I do not like how these teeth look" to "10 - I like how these teeth look"

Image 6

Rating for Image 6 above

0   10

(Place a mark on the scale above)

Please rate the following photos on a scale from 0 to 10 with "0 - absolutely no concern with appearance" to "10 - absolutely concerned with appearance"

Please rate the following photos on a scale from 0 to 10 with "0 - I do not like how these teeth look" to "10 - I like how these teeth look"

REDCap

Image 7

Rating for Image 7 above

0   10

(Place a mark on the scale above)

Please rate the following photos on a scale from 0 to 10 with "0 - absolutely no concern with appearance" to "10 - absolutely concerned with appearance"

Please rate the following photos on a scale from 0 to 10 with "0 - I do not like how these teeth look" to "10 - I like how these teeth look"

Image 8

Rating for Image 8 above	0	10

(Place a mark on the scale above)

Please rate the following photos on a scale from 0 to 10 with "0 - absolutely no concern with appearance" to "10 - absolutely concerned with appearance"

Please rate the following photos on a scale from 0 to 10 with "0 - I do not like how these teeth look" to "10 - I like how these teeth look"

Image 9

Rating for Image 9 above

0   10

(Place a mark on the scale above)

Please rate the following photos on a scale from 0 to 10 with "0 - absolutely no concern with appearance" to "10 - absolutely concerned with appearance"

Please rate the following photos on a scale from 0 to 10 with "0 - I do not like how these teeth look" to "10 - I like how these teeth look"

Image 10

Rating for Image 10 above

0   10

(Place a mark on the scale above)