The Online ANGLE ORTHODONTIST
An International Journal of Orthodontics and Dentofacial Orthopedics
78th Anniversary 1930-2008

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doi: 10.2319/080306-314.1
The Angle Orthodontist: **Vol. 77, No. 6, pp. 1034–1039.**

The Perception of Children's Computer-Imaged Facial Profiles by Patients, Mothers and Clinicians

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ABSTRACT

Objective: To demonstrate the usefulness of a new imaging system for comparing the morphometric bases of children's self-perception of their facial profile with the perceptions of their mothers and treating clinicians.

Materials and Methods: Rather than choosing among a series of static images, a computer imaging program was developed to elicit a range of acceptable responses or tolerance for change from which a midpoint of acceptability was derived. Using the method of Giddon et al, three profile features (upper and lower lips and mandible) from standardized images of 24 patients aged 8– 15 years were distorted and presented to patients, parents, and clinicians in random order as slowly moving images (four frames per second) from retrusive and protrusive extremes. Subjects clicked the mouse when the image became acceptable and released it when it was no longer acceptable. Subjects responded similarly to a neutral facial profile.

Results: Patients and their mothers overestimated the protrusiveness of the mandible of the actual pretreatment profile. Consistent with related studies, mothers had a smaller tolerance for change in the soft tissue profile than the children or clinicians. The magnitudes of the children's self-preference and preferred change in a neutral face were also significantly correlated. Both patients and mothers preferred a more protrusive profile than that of the actual or neutral face for the patient and neutral face.

Conclusion: Imaging software can be used with children to compare their preferences with those of parents and clinicians to facilitate treatment planning and patient satisfaction.

KEY WORDS: Perception, Profiles, Computer imaging, Children.

Accepted: December 2006. Submitted: August 2006

INTRODUCTION Return to TOC

Although orthodontic treatment may be important for improving function, the reason many patients and parents, particularly mothers, cite for seeking treatment is a desire to improve facial esthetics.[1–3] Orthodontists, however, have not always been aware of the discrepancy between clinician and patient perceptions of expected treatment outcomes. The purpose of this project, therefore, was to try to reconcile these differences by demonstrating the usefulness of a new imaging system as a communication tool for children and their mothers for comparing the morphometric basis of the self-perceptions and perceptions of a neutral face with comparable perceptions of the patient, clinicians, and mothers. This method had been used previously with adults to determine the morphometric bases of the perception of existing and preferred changes in facial appearance across various gender and racial groups.[4–11]

Previous studies of the perception of the face have used various methods of stimulus presentation, such as drawings, caricatures, touched-up photos, and so on to represent faces.[12–14] Although responses to these stimuli may provide some information, these simulations may be too unrealistic to yield valid results.[15]

A cephalometric radiograph may be appropriate for assessing skeletal deformities, but it does not provide a meaningful stimulus for assessing perceptual responses to soft-tissue changes. Clinicians can only infer from responses to these representations of the soft-tissue configurations what mental image a patient has of his or her own or another's face or body, which may differ significantly from the clinician's ideas about a proposed treatment plan. Unfortunately, clinicians often overlook the fact that a person behaves in response to the perception and not to the actual physical characteristics of the face.[2] To address some of these issues, a new imaging system has been developed[16] that displays the features of facial profiles as slowly moving between retrusive and protrusive extremes. By creating a range rather than a series of static photographs to judge, this method permits participants to determine how much physical change there must be in a particular feature before the profile or face as a whole is perceived as acceptable, or conversely, how much morphometric change in an unacceptable feature must occur before the profile or face as a whole is perceived as unacceptable.

MATERIALS AND METHODS Return to TOC

Subjects were 24 white children, equally divided by gender, from a suburban orthodontic practice, their mothers, and two orthodontists, one of whom was the treating clinician. Information about duration of treatment was also collected. As shown in Tables 1 through 4, some subjects in each group did not complete all the tasks, however.

For each subject, a standardized digital photograph was obtained of the right profile in natural head position. The images were approximately 2/3 of the actual head size, which was shown in a previous study not to affect profile self-perception.[17] Discrete distortions of three facial features of the lower third of the soft-tissue profile were created using the imaging software: upper lip (UL), bimaxillary protrusion (BIM), and mandible (MAND). The image processing and morphing algorithms of the software were then used to create 40 digitally modified gradations of changing physical dimensions for each feature to appear as "animated" or continuous movement of four frames per second between retrusive to protrusive extremes, much like a flower blossoming in slow motion.

Based on the anthropometric landmarks used by Farkas,[18] the MAND was distorted in retrusive and protrusive (relative to the unaltered profile) directions to create retrusive and protrusive extremes. Similar retrusive and protrusive extreme distortions were created for the upper and lower lip moving together, or BIM, and for the UL alone, which included rotation of labiale around subnasale. The distance from the unaltered feature of the extreme distortions was determined psychophysically as the point at which 100% of subjects rejected the position as unacceptable. The magnitude of the retrusive and protrusive extremes also varied for each facial profile, which had been shown in a previous study to have no significant effect on the acceptability or unacceptability judgments.[19]

After a practice session, each feature was presented six times as a continuously changing image at the rate of four frames per second in counterbalanced order from the extreme retrusive or protrusive (ie, retrusive to protrusive, protrusive to retrusive, retrusive to protrusive, protrusive to retrusive, protrusive to retrusive, retrusive to protrusive). For each of the three following tasks, the patients, mothers, and clinicians, in order of their availability, were asked to respond by clicking the mouse as each feature moved between three protrusive and three retrusive extremes for a total of six trials. Each subject viewed his or her own profile (mothers viewed their own child's profile) and the same neutral "other" female face of a child approximately 13 years old. To minimize fatigue, habituation, and/or order effects, feature and task order were randomized across subjects except for the most accurate task, which was presented first.

Most Accurate (MA)

To determine how accurately subjects could reproduce the patient's actual or pretreatment MAND in profile, patients, parents, and treating clinician were asked to respond to the MAND moving between retrusive and protrusive extremes by clicking the mouse and holding it down for each of the six trials when the image looked most like the child (MA).

Zone of Acceptability

To determine the zone or range of acceptability— which can also be defined as the tolerance for change of the three features of the patient's and neutral profile—patients, mothers, and clinicians were asked to click the mouse when the moving profile became acceptable, hold it down as long as the image remained acceptable, and release it when the image became unacceptable. This endpoint of "acceptable" was used as the superordinate term to include all other words with positive connotations, such as pretty, beautiful, cute, and so on; and conversely unacceptable was used to include all other words with negative connotations, such as ugly or unattractive.[2] As described below, the midpoint of acceptability (MD) is derived from the zone of acceptability (ZA).

Neutral Image

To control for possible response bias, hand-eye coordination, or other factors that might affect profile perceptions, patients, parents, and clinicians were asked to indicate the ZA for three moving features in a neutral female face.

RESULTS Return to TOC

Mean age of the 24 child patients was 11.4 ± 1.77. For each feature, the magnitude (in millimeters) of distortion from the unaltered profile image was corrected for actual head size.

For the three respondent groups (patients, mothers, and clinicians), the results for each of the tasks for each feature were based on the mean of the three completed retrusive to protrusive and three protrusive to retrusive trials. The MAND measures were represented by the position of pogonion (pg), BIM by labiale superius (LS) and labiale inferius (li), and UL by ls. Because the subjects in each group could not be matched on the basis of seeing the same faces, a one-way analysis of variance (ANOVA) was used.

MA for MAND

Subjects' accuracy in reproducing the unaltered profile was based on the difference in millimeters between MAND pg on the unaltered profile image and PG when subjects indicated their most accurate representation of their own (or their child's) unaltered profile image. The images for the least accurate patient/mother pair are shown in Figure 1. As shown in Table 1 for the most accurate task, the greater the significance, the less accurate was the group; thus, patients were less accurate ($P \leq .001$) than mothers ($P \leq .007$), who were less accurate than the treating clinician ($P \leq .044$). However, using ANOVA, no significant differences were found across patients, mothers, and treating clinician in the magnitude of these inaccuracies ($P \leq .322$). Accuracy was related in part to gender and age, as indicated by the significant negative correlation (rho = −0.634, $P \leq .036$) for male patients only; that is, younger male children were less accurate than the older males. The moderate negative correlation for females, however, was not significant (rho = −.503, $P \leq .138$). Also, there was no relationship between accuracy and length of time in treatment.

ZA for MAND

For both self and neutral face, the size of the ZA was determined by the distance in millimeters between the mean retrusive and protrusive boundaries of acceptability, or ($\bar{X}_{(P1\text{-}6)} - \bar{X}_{(R1\text{-}6)}$). As shown in Table 1, ANOVA revealed no significant differences across patients, mothers, and clinicians in the magnitude of the ZA ($P \leq .196$). Similar to previous work, however, there were ordinal differences among the three groups[5]; mothers had the smallest ZA or tolerance for change, followed by patients and clinicians.

MD for MAND

The MD was derived mathematically as half the distance in millimeters between the mean retrusive and protrusive boundaries of the ZA. As shown in Table 1, ANOVA revealed no significant differences across patients, mothers, and clinicians in the means of the magnitudes of the derived MD ($P \leq .614$) for the MAND. All three groups preferred a mandibular position that was significantly more protrusive relative to the unaltered profile ($P \leq .001$). An example of one patient is shown in Figure 2.

ZA for BIM

The mean ZAs for the BIM are shown in Table 2. ANOVA revealed significant differences across patient, mother, and clinician groups in the magnitudes of the ZA for the ls ($P \leq .050$) and li ($P \leq .008$). Post hoc (Bonferroni) comparisons revealed that the mothers had significantly less tolerance for change in the position of the ls than their children ($P \leq .018$). For the li, mothers had a significantly smaller ZA than clinicians ($P \leq .006$) and a nearly significant difference from their children ($P \leq .063$).

MD for BIM

For the MD of BIM, ANOVA revealed significant differences across patient, mother, and clinician groups for the mean ls ($P \leq .033$) and li ($P \leq .008$), as shown in Table 2. Post hoc comparisons (Bonferroni), however, did not quite reach statistical significance for the ls ($P \geq .076$) or li ($P \geq .059$), most likely because of the small number of subjects. There was also a significant difference between the unaltered and preferred positions for the ls ($P \leq .05$) and li ($P \leq .005$) for the mothers only, indicating that mothers preferred a slightly more protrusive BIM than the unaltered profile.

ZA for UL

Results obtained for the ZA of the UL are shown in Table 3. ANOVA revealed no significant differences across the means for the patient, mother, and clinician groups in the magnitudes of the ZA for the ls ($P \leq .228$). Similar to the results for MAND and BIM, the mothers had a smaller magnitude of ZA or less tolerance for change than their children or the clinicians.

MD for UL

Also shown in Table 3, ANOVA revealed a nearly significant difference across the patient, mother, and clinician groups ($P \leq .056$) for the means of the magnitudes of the MD of the ls of the UL. For the patients and clinicians there was a significant difference between the unaltered and preferred positions of ls ($P \leq .010$ and $P \leq .001$, respectively).

Relationship of Self Data to Neutral Face

As shown in Table 4, the means of the preferred changes in the MD of the MAND and BIM were significantly greater for the neutral female face for both the children and their parents. Correlational analyses were used to describe the relationship between the perceptual responses to the child and to the neutral face. For the MAND, only the ZA between the patients and their responses to the neutral face (rho = .672, $P \leq .01$) and the patients' MA and the MD for the neutral face were significant (rho = .470, $P \leq .05$). For the BIM for both li and ls, there was a significant relationship between the patients' and the neutral face ZA (ls rho = .638, $P \leq .01$; li rho = .610, $P \leq .01$).

Other Intercorrelations

A significant correlation (rho > .431, $P \leq .050$) was found within groups between the magnitudes of the error in reproducing the unaltered profile and the derived MDs. No correlations were found among the perceptual responses and gender, age, or length of treatment.

DISCUSSION Return to TOC

As noted by Giddon,[1] patients and parents have a great need for a means for communicating the ideational representation or mental image of their preferred changes to clinicians. Therefore, it is important to be able to determine the magnitude of any discrepancy between the patients' or parents' mental image and the clinician's anticipated clinical outcome. In contrast to other static displays the clinician may use to show anticipated treatment outcome, the use of this new psychophysical method by the patient, parent, or clinician provides a range, rather than a static or discrete image, of acceptable outcomes from which an MD can be derived and compared. This new imaging software may also permit clinicians to identify patients or their parents who have unrealistic treatment expectations that may affect patient satisfaction, compliance, and outcomes.

The results of this study demonstrate that both patients and their mothers may not be aware of the actual pretreatment profile and tend to overestimate the position and protrusion of the MAND; that is, the MA in this study was found to be more protrusive than the unaltered pretreatment profile image. This overestimation of mandibular position was found in a previous study by our group[20] as well as for both BIM and MAND for the neutral face in this study. It has also been found to exist for estimations of body size.[21] Mothers also preferred more protrusive MAND and BIM for both their children and the neutral face, while the children preferred more protrusiveness of their self MAND, self UL, and the neutral face.

The MD may well be a subliminal response (below the level of consciousness) because respondents are only asked to indicate the boundaries of the ZA from which the MD is derived. Based on the magnitudes of the ZA, mothers also had a smaller tolerance for change in the soft tissue profile than either their children or clinicians, which is consistent with previous work using this psychophysical method.[5] It was also interesting and possibly validated by clinical observation that the preferred position of the UL (ls) was more retrusive when viewed in isolation than when viewed as part of the ls–li of the BIM.

Although the overall results across the patients, mothers, and clinicians indicate that small differences of less than a millimeter were statistically significant, these small-effect sizes cannot be applied to individual patients. Such group data, which only indicate that significantly more responders went in one direction, can only be translated into probability statements for likely clinical outcomes for any given patient. Moreover, these results should not be interpreted as establishing definitive differences among patients, parents, and clinicians; they should only serve as a demonstration of a useful clinical adjunct. Even with these small differences, however, the results using this method can be used clinically to dramatically illustrate the differences in profile feature preferences among patients, mothers, and clinicians by superimposing or overlaying the preferred positions upon each other.

CONCLUSIONS Return to TOC

- The imaging software system used here provides quantitative differences among child patients, their parents, and clinicians in preferred changes in the soft-tissue profile.
- Young patients have inaccurate self-images of their profiles but become more accurate with age. Patients perceive themselves as having a more protrusive MAND than their actual profile, in agreement with their mothers.
- Mothers consistently preferred that their children have a BIM appearance with full lips and a strong chin. Orthodontists should consider these parentally preferred profile features as part of treatment planning.
- Young patients, their mothers, and clinicians have similar perceptions of their most preferred profiles, although mothers exhibit a smaller ZA than patients or clinicians.
- These findings are consistent with the work of others in the US, Europe and Asia who have found that mothers' perceptions are the primary motivating factor for seeking orthodontic treatment. Mothers are more critical in their esthetic judgments and have less tolerance for change from their most preferred facial configuration than do their children.[22–27]
- The use of the ZA and “subliminal” midpoint of the ZA rather than a single discrete photograph can help clinicians compare their own perceptions of preference, expectations, and tolerance for change in soft-tissue profiles with those of patients and parents.
- Using this imaging system before treatment to compare patient and parent expectations with the expectations of clinicians will help identify and resolve unrealistic outcome expectations.

ACKNOWLEDGMENTS

Supported in part by NIH grant DE10292.

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TABLES Return to TOC

Table 1. Mean ± SD Across Judgment Groups for Responses to Mandible[a]

Task	Patients (N = 24)	Parents (N = 15)	Clinicians (N = 2)[b]	ANOVA Across Groups
Most accurate (millimeters from unaltered profile)	1.7 ± 1.84 ($P < .001$)	1.2 ± 1.69 ($P < .007$)	0.9 ± 2.04 ($P < .044$)	NS
Zone of acceptability (millimeters between boundaries of acceptable/unacceptable changes)	4.8 ± 2.68 (NS)	4.2 ± 1.82 (NS)	5.0 ± 1.76 (NS)	NS
Midpoint of acceptability (millimeters from unaltered profile)	2.5 ± 1.53 ($P < .001$)	2.1 ± 1.71 ($P < .001$)	2.8 ± 1.64 ($P < .001$)	NS

[a] SD indicates standard deviation; ANOVA, analysis of variance; and NS, not significant.
[b] Treating clinician only for most accurate task (N = 1).

Table 2. Mean ± SD Across Judgment Groups for Response to Bimax[a]

Task	Patients (N= 24)	Parents (N = 15)	Clinicians (N = 2)	ANOVA Across Groups
Zone of acceptability for ls (millimeters between boundaries of acceptable/unacceptable changes)	4.4 ± 2.92 ($P < .018$ (post hoc))	2.8 ± 1.61 ($P < .018$ (post hoc))	4.3 ± 1.52	$P \leq .050$
Zone of acceptability for li (millimeters between boundaries of acceptable/unacceptable changes)	4.2 ± 2.70	2.6 ± 1.33 ($P < .006$ (post hoc))	4.2 ± 1.41 ($P < .006$ (post hoc))	$P \leq .008$
Midpoint of acceptability for ls (millimeters from unaltered profile)	0.2 ± 1.27	0.4 ± 0.75 ($P < .05$)	-0.2 ± 1.74	$P \leq .033$
Midpoint of acceptability for li (millimeters from unaltered profile)	0.3 ± 1.28	0.5 ± 1.11 ($P < .005$)	-0.2 ± 1.74	$P \leq .008$

[a] SD indicates standard deviation; ANOVA, analysis of variance; ls, labiale superius; and li, labiale inferius.

Table 3. Mean Score Across Judgment Groups for Response to Upper Lip[a]

Task	Patients (N = 24)	Parents (N = 15)	Clinicians (N = 2)	ANOVA Across Groups
Zone of acceptability for ls (millimeters between boundaries of acceptable/unacceptable changes)	3.3 ± 2.01	2.6 ± 1.81	3.5 ± 1.27	n.s.
Midpoint of acceptability for ls (millimeters from unaltered profile)	-0.4 ± 0.67 ($P < .010$)	-0.4 ± 1.13	-0.8 ± 1.22 ($P < .001$)	$P < .056$

[a] ls indicates labiale superius; li, labiale inferius.

Table 4. Paired Comparison of Mean Differences ± SD in Responses to Child, Patient, and Neutral Face[a]

	Patients		Parents	
Mandible	1.5 ± 1.94	$P \leq .004$ (n=18)	2.2 ± 2.40	$P \leq .005$ (n=14)
Bimax ls	1.9 ± 1.97	$P \leq .001$ (n=19)	1.9 ± 1.39	$P \leq .001$ (n=19)
Bimax li	2.2 ± 1.89	$P \leq .001$ (n=18)	1.7 ± 1.10	$P \leq .001$ (n=15)

[a] ls indicates labiale superius; li, labiale inferius.
SD indicates standard deviation.

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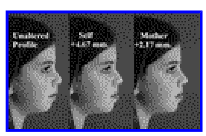
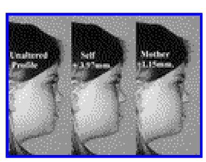


Click on thumbnail for full-sized image.

Figure 1. Results for most accurate task displaying least accurate patient/mother



Click on thumbnail for full-sized image.

Figure 2. Results for derived midpoint of acceptability displaying preferred image for patient/mother

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