The Effect of Cleft Orthognathic and Nasal Reconstruction on Perceived Social Traits

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Background: The investigators hypothesized that a layperson's social perceptions of an adolescent cleft lip and palate (CL/P) patient are more favorable after orthognathic surgery and definitive nasal reconstruction.

Methods: The investigators implemented a survey comparing layperson's perception of specific social traits before and >6 months after jaw and nasal reconstruction in CL/P adolescent subjects by viewing standardized facial photographs. The sample was composed of 10 consecutive subjects treated by 1 surgeon from birth through completion of their staged reconstruction. The outcome variable was changed in 6 perceived personality, 6 emotional expression traits, and 7 perceptions of likelihood of positive interpersonal experiences. Descriptive and bivariate statistics were computed ($P < 0.05$).

Results: Five hundred respondents (raters) completed the survey. The respondents were 58% male with 53% age 25–34. After cleft reconstruction, study subjects were perceived to be significantly more dominant, trustworthy, friendly, intelligent, attractive, and less threatening ($P < 0.05$). They were also perceived as happier and less angry, surprised, sad, afraid, or disgusted than before surgery ($P < 0.05$). The subjects were also perceived to be more likely to have positive interpersonal experiences ($P < 0.05$).

Conclusion: We confirmed that laypeople consistently report positive changes in adolescent CL/P subject's perceived social traits after bimaxillary and chin orthognathic surgery followed by definitive nasal reconstruction. *(Plast Reconstr Surg Glob Open 2019;7:e2422; doi: 10.1097/GOX.0000000000002422; Published online 31 October 2019.)*

INTRODUCTION

Cleft lip and palate is a common major birth defect in the craniofacial region. It is estimated that there are currently 10 million humans in the world with cleft lip and palate.[1] By adolescence, the negative naso-maxillary growth effects after primary cleft lip and palate repair in infancy are well known.[2–4] Mulliken and colleagues[2] reviewed the prevalence of severe naso-maxillary deformity recognized by the teenage years in their patients with repaired cleft lip/palate treated at Boston Children's Hospital. Forty-eight percent of their primary repaired unilateral cleft lip and palate (UCLP) patients and 77% of their primary repaired bilateral cleft lip and palate (BCLP) patients required orthognathic surgery.[2] Similarly, The Hospital for Sick Children (Toronto, Canada) found that 48% of their primary repaired UCLP patients and 65% of the BCLP patients required orthognathic surgery.[3,4]

The cleft lip and palate malformation and resulting facial disfigurement after primary repair in infancy can have stigmatizing social effects.[5,6] The quality of everyday social interactions that occur in ones life begin with first impressions, which are made instinctively, and are known to be at least partially influenced by an individual's facial appearance.[7–10] Facial appearance influences social interactions with multiple positive qualities being attributed to those considered more attractive, including the impression of greater competence, likeability, and trustworthiness.[10,11]

Adolescents with repaired cleft lip and palate report experiencing ongoing social stigmata from residual facial deformities.[12–15] Gkantidis et al[12] studied adult sub-

jects, documenting that despite surgical reconstruction, significant negative influences of clefting on social activity level and personal life remained. Meyer-Marcotty and Stellzig-Eisenhauer[13] reported that both professionals and laypeople were dissatisfied with the facial appearance of UCLP adults and found a strong desire by the subjects to undergo further surgical improvements. Pai et al[14] reported that after completion of staged reconstruction, 16% of their UCLP adults wished to have further corrective facial surgery. In 2016, Ranganathan et al[15] studied adolescent UCLP subjects and demonstrated unfavorable social health including a high incidence of being bullied and a strong desire for further facial surgery in the hopes of reducing the social stigmata.

This study tests the hypothesis that orthognathic surgery and definitive nasal reconstruction positively influences a layperson's perception of social traits for adolescent cleft subjects presenting with naso-maxillary deformity. The specific aims of this study was to (1) gather unbiased, large sample layperson data regarding social perceptions of adolescent cleft subjects with naso-maxillary deformity before and then after both bimaxillary and chin orthognathic surgery and definitive nasal reconstruction by viewing standardized facial photographs and (2) compare any documented social perception changes to a group of noncleft primary maxillary deficiency (PMD) developmental dentofacial deformity subjects also undergoing the same bimaxillary and chin orthognathic surgery.

METHODS

Study Sample

The sample was derived from patients treated by 1 surgeon (J.C.P.) in a private practice setting (Posnick Center) with surgery carried out at a single hospital (MedStar Georgetown University Hospital, Washington, D.C.). A group of subjects born with UCLP or BCLP, who developed significant naso-maxillary deformity by adolescence and then followed through completion of their reconstruction, were identified. These subjects were followed from the time of birth through adolescence with staged cleft lip and palate reconstruction carried out by the primary investigator (J.C.P.). In each case, the staged reconstruction included bimaxillary and chin orthognathic surgery followed by definitive cleft rhinoplasty using a rib cartilage caudal strut graft (open approach). Subjects with associated syndromes were excluded. A comparison group of noncleft PMD subjects who required and then underwent bimaxillary and chin orthognathic surgery by the primary investigator was also identified. PMD is a pattern of developmental facial disharmony that presents with horizontal deficiency in the maxilla and a symmetric class III negative overjet malocclusion as essential components of the deformity.[16] The methods of orthognathic surgery and definitive cleft nasal reconstruction were consistent for all study subjects and previously reported.[16–19] The Georgetown University Institution Review Board approved this study protocol (#2018-1260).

Cleft Study Subject Data

Demographic data, staging of cleft reconstruction, and extent of jaw deformity before orthognathic surgery data were recorded. Demographic variables consisted of sex and type of cleft. Type of cleft was recorded as either UCLP or BCLP (complete or incomplete).

Age at each stage of cleft reconstruction, and any additional procedures, was recorded for each subject. Consistent stages of cleft reconstruction included primary lip/nasal repair, primary palate repair, mixed dentition bone grafting, cleft orthognathic surgery, and definitive cleft nasal reconstruction. Additional procedures were documented if performed, specifically the elevation and insertion of a pharyngeal flap and cleft lip scar revision.

The extent of jaw deformity documented just before orthognathic surgery for each cleft subject was recorded as planned surgical movements to achieve a harmonious facial appearance and occlusion. The maxillary data points reported for this study include horizontal and vertical change at the incisors, maxillary occlusal plane change (clockwise, counter-clockwise, or neutral), cant correction, and dental midline correction. The mandibular data points reported for this study included horizontal change at the incisors and mandibular occlusal plane change (clockwise, counter-clockwise, or neutral).

Crowdsourcing Raters

Mechanical Turk (Amazon.com, Inc., Seattle, Wash.) was used to gather unbiased layperson impressions of facial photographic images taken before and then after reconstruction in the study subjects to determine perception of 6 specific personality traits, 6 specific emotional facial expressions, and 7 perceptions of interpersonal experiences. This survey was limited to Mechanical Turk (mTurk) respondents (raters) who had a minimum 95% approval rating and were living in the USA. A series of demographic questions (about each rater) preceded each survey, which included their age, sex, race, education level, and the annual income. Dispersed within this set of questions were 2 quality assessment questions to ensure a thoughtful effort was made on the survey; we asked for the current year and the current month. Survey respondents (raters) were excluded if they did not answer the 2 quality assessment questions correctly. The preoperative and postoperative facial photograph images for review by raters were delivered in a random order.[20] Each respondent (rater) was blinded to the purpose of the study, to the specific knowledge of subjects having been born with facial clefting, and to having undergone any face-altering procedures. Each respondent (rater) was prevented from completing the survey >1 time and was compensated with $3 to complete the survey. The number of Mechanical Turk respondents was limited to 500. Study subject facial photographs were included at the beginning and end of each page to allow for immediate reference by the rater.

Survey Design

A series of 19 questions were asked with Likert scale responses requested regarding the respondent's (rater's)

perception of 6 specific personality traits, 6 specific emotional expressions, and 7 perceptions of interpersonal experiences for each subject. The raters' perception of each social trait for each subject (both cleft and noncleft subjects) was based on viewing a standardized facial photograph image set before and >6 months after completion of reconstruction (Figs. 1–4). The methodology used to rate each subject for each personality trait, emotional facial expression, and likelihood of interpersonal experiences in this study was drawn from prior research of the effects of facial appearance on character impressions.[21–24]

A single standardized facial image set was created for each subject before orthognathic surgery. This included a 3-quarter (oblique facial) view, a lateral (profile facial) view, and a frontal view in repose (Figs. 1 and 3). A similar facial image set was replicated from each subject's postoperative photographs (Figs. 2 and 4). For subjects with UCLP, the cleft side was presented in the 3-quarter and lateral views. During the course of treatment, each subject underwent 6 standardized facial view photographs before orthognathic surgery (T$_1$), and at a minimum of 6 months postoperatively (T$_2$). The T$_1$ and T$_2$ photographs were used to create the standardized image sets described for each subject.

Collection, Management, and Analysis of Data

The data were abstracted and recorded on a standardized data collection form from the inpatient and outpatient medical records. This included review of facial photographs before orthognathic surgery (T$_1$) and then after completion of reconstruction (T$_2$). Data were iteratively entered into a database (Microsoft Excel, Microsoft Inc. Redmond, Wash.) and were subsequently analyzed using a statistical software package (SPSS v.25.0, IBM Corp., Armonk, N.Y.).

Descriptive and bivariate analyses were performed. Wilcoxon signed-rank tests were used to compare social perceptions before and then after reconstruction. Mann-Whitney U tests were performed to analyze the net change in preoperative to postoperative social perceptions of the CL/P subjects as compared with the noncleft PMD dentofacial deformity subjects. $P < 0.05$ were considered significant.

Fig. 1. Example of a cleft lip and palate study subject before orthognathic surgery and definitive nasal reconstruction. The standardized facial photographic image set formatted for review by each layperson rater is shown.

Fig. 2. The cleft lip and palate study subject in Figure 1 is shown after bimaxillary and chin orthognathic surgery and definitive nasal reconstruction. The standardized facial photographic image set formatted for review by each layperson rater is shown.
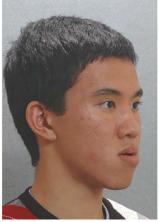
Fig. 3. Example of a primary maxillary deficiency dentofacial deformity (DFD) study subject before orthognathic surgery. The standardized facial photographic image set formatted for review by each layperson rater is shown.

Fig. 4. The primary maxillary deficiency dentofacial deformity (DFD) study subject in Figure 3 is shown after bimaxillary and chin orthognathic surgery. The standardized facial photographic image set formatted for review by each layperson rater is shown.

During the time frame of the study, no qualifying cleft lip and palate adolescent patient followed by the primary investigator (J.C.P.) through to completion of their staged reconstruction that included bimaxillary and chin orthognathic and then definitive rhinoplasty reconstruction was excluded or lost to follow-up and no data points were missing for any of the study parameters for any of the subjects.

RESULTS

Ten consecutively treated cleft lip and palate subjects followed from birth through completion of their staged reconstruction were identified for inclusion in this study. Five subjects (age 15–22) were also selected from our larger noncleft PMD developmental dentofacial deformity database (n = 66) as a comparison group. The cleft lip and palate subject's demographics, age at staged reconstructive procedures, and extent of jaw deformity are reported in Tables 1 and 2.

Demographic Analysis of Mechanical Turk Raters

Five hundred respondents (raters) completed the survey in <10 hours. Five respondents were excluded due to incorrect answers of the control questions, with a final sample size of 495 respondents. On average, 38 minutes was required to complete the survey. The majority of respondents within each demographic group were male (58%), 25–34 year of age (53%), White (68%), college graduates (55%) with an annual income between $20,000 and $50,000 (47%). The detailed demographics of the Mechanical Turk raters are summarized in Table 3.

Perceived Personality Traits of Cleft Lip and Palate Adolescent Subjects before and after Orthognathic Surgery and Definitive Nasal Reconstruction

After completion of jaw and nasal reconstruction, cleft lip and palate adolescent study subjects were perceived to be significantly more trustworthy, more friendly, more intelligent, more attractive, more dominant, and less threatening ($P < 0.05$). Table 4 summarizes the differences in each perceived personality trait from before to after bimaxillary and chin orthognathic surgery and then definitive nasal reconstruction for the cleft subjects.

Table 1. Cleft Study Subjects: Staging of Reconstruction and Age at Operation

Subject	Sex	Type of Cleft	Primary Lip Repair	Primary Palate Repair	Mixed Dentition Bone Grafting	Orthognathic Surgery	Cleft Nasal Reconstruction
1	F	Complete BCLP	11 wk	10 mo	8 y + pharyngeal flap	14 y + maxillary bone graft	15 y + bilateral otoplasty
2	F	Complete UCLP	11 wk	10 mo	9 y	15 y + LF 2 segments + maxillary bone graft	16 y + pharyngeal flap + lip scar revision
3	F	Complete UCLP	13 wk	10 mo	8 y	15 y	15 y + pharyngeal flap + lip scar revision
4	M	Complete UCLP	11 wk	9 mo	8 y + pharyngeal flap	17 y + maxillary bone graft	17 y + lip scar revision
5	M	Complete UCLP	12 wk	8 mo	None	16 y + LF 2 segments + maxillary bone graft	16 y + pharyngeal flap + lip scar revision
6	F	Complete UCLP	9 wk	11 mo	8 y + lip scar revision	19 y + maxillary bone graft	20 y + pharyngeal flap
7	M	Complete BCLP	20 wk	10 mo	9 y	16 y + maxillary bone graft	17 y + lip scar revision
8	F	Incomplete UCLP	11 wk	N/A	5 y	14 y	16 y
9	F	Incomplete UCLP	10 wk	9 mo	8 y + pharyngeal flap	15 y	16 y + lip scar revision
10	F	Complete UCLP	11 wk	8 mo	8 y	14 y + maxillary bone graft	15 y + lip scar revision

Primary cleft lip/nasal repair: modified Millard advancement/rotation flaps and primary nasal tip reconstruction. Primary cleft palate repair: Bardach 2 flap technique with intra-velo-veloplasty. Mixed dentition bone graft: anterior iliac crest graft and oro-nasal fistula closure. Pharyngeal flap: superiorly based pharyngeal flap. Cleft orthognathic surgery: Le Fort I, bilateral sagittal split osteotomies, osteotomy of the chin, bilateral inferior turbinate reduction, septoplasty, and removal of third molars. Cleft nasal reconstruction: open approach with use of rib cartilage caudal strut graft.
BCLP, bilateral cleft lip/palate; LF, Le Fort; UCLP, unilateral cleft lip/palate.

Table 2. Cleft Study Subjects: Planned Skeletal Change Associated with Orthognathic Surgery

Subject	Maxillary					Mandibular	
	Horizontal Change (mm)	Anterior Vertical Change (mm)	Pitch Correction	Cant Correction (mm)	Dental Midline Correction (mm)	Horizontal Change (mm)	Pitch Correction
1	+11	+3	CW	0	0	+8	CW
2	+10	0	Neutral	0	2	+8	CCW
3	+10	0	CW	2	2	+2	CW
4	+13	+2	CW	0	0	−1	CW
5	+6	+1	Neutral	4	2	+2	Neutral
6	+10	0	CW	0	5	+4	Neutral
7	+7	+3	Neutral	2	1	+1	Neutral
8	+5	−7	Neutral	2	0	+8	CCW
9	+10	0	Neutral	2	1	+11	Neutral
10	+8	+3	Neutral	0	0	+2	CW

CCW, counter-clockwise rotation; CW, clockwise rotation.

Perceived Emotions of Cleft Lip and Palate Adolescent Subjects before and after Orthognathic Surgery and Definitive Nasal Reconstruction

After completion of jaw and nasal reconstruction, cleft lip and palate adolescent subjects were perceived to be significantly happier and less angry, less surprised, less sad, less afraid, and less disgusted than they were before surgery ($P < 0.05$). Table 4 summarizes the differences in each perceived emotional facial expression from before to after bimaxillary and chin orthognathic surgery and nasal reconstruction for the cleft subjects.

Perceived Likelihood of Positive Interpersonal Experiences of Cleft Lip and Palate Adolescent Subjects before and after Orthognathic Surgery and Definitive Nasal Reconstruction

After completion of jaw and nasal reconstruction, cleft lip and palate adolescent subjects as a group, were perceived to feel less lonely, less likely to be teased or bullied by others and less likely to feel anxious around others. They were also perceived more likely to have romantic relationships, be praised by others, and have friends than they were before bimaxillary and chin orthognathic sur-

gery and definitive nasal reconstruction ($P < 0.05$). Table 4 summarizes the differences in perceived likelihood of interpersonal experiences for the cleft subject before and then after reconstruction.

Social Perception Changes in CL/P Adolescent Subjects before and after Orthognathic Surgery and Definitive Nasal Reconstruction in Comparison to Noncleft PMD Developmental Dentofacial Deformity Subjects

Table 5 summarizes the perceived personality traits, emotions, and social perception changes among subjects with PMD before and after bimaxillary orthognathic and chin surgery. Cleft lip and palate subjects, as compared with subjects with PMD, experienced a greater magnitude of change for multiple social traits after completion of reconstruction. Cleft subjects were documented to have a greater improvement in the perception of dominance and attractiveness and a lesser extent in being perceived as less threatening when compared with the PMD subjects. Cleft subjects were found to have a greater perceived change than the PMD subjects in being less angry, less sad, less afraid, and less disgusted. Cleft subjects also experienced

Table 3. Demographic Information of the Mechanical Turk Raters

Characteristic	No. (%)
Sex	
Male	287 (58.0)
Female	206 (41.6)
Other	2 (0.4)
Age (y)	
18–24	45 (9.1)
25–34	260 (52.5)
35–44	113 (22.8)
45–54	42 (8.5)
55–64	33 (6.7)
>65	2 (0.4)
Race	
White	338 (68.3)
African American	65 (13.1)
Hispanic	45 (0.8)
Asian American	32 (6.5)
Middle Eastern	1 (0.2)
Other	14 (2.8)
Chose not to answer	1 (0.2)
Education	
GED	119 (24.0)
Technical	34 (6.9)
College graduate	271 (54.7)
Postgraduate	71 (14.3)
Income	
<$20,000	76 (15.4)
$20,000–$50,000	233 (47.1)
$50,000–$100,000	157 (31.7)
>$100,000	29 (5.9)

GED, general education development.

a greater improvement than noncleft PMD subjects in being perceived to be less likely to feel lonely, less likely to be teased or bullied by others, less likely feel anxious around other and more likely to have romantic relationships, have friendship, and be praised by others (Table 6).

DISCUSSION

The purpose of this study was to assess a layperson's social perceptions of cleft lip and palate adolescent subjects presented with naso-maxillary deformity and then after undergoing orthognathic surgery and nasal reconstruction. Our null hypothesis stated that orthognathic surgery followed by definitive nasal reconstruction would result in no change in social perceptions. The study results reject the null hypothesis. We confirmed that after bimaxillary and chin orthognathic surgery and nasal reconstruction, cleft lip and palate adolescent subjects experienced positive changes in perceptions for a wide range of traits.

Treatment objectives for the reconstruction of cleft naso-maxillary deformities in the adolescent frequently include correction of malocclusion, opening documented sites of upper airway obstruction, and optimizing facial esthetics. The evaluation of facial esthetics before and after reconstruction has proven difficult to quantify and is typically reported from the perspective of either the surgeon or the patient.[12–15] Layperson's opinions, as measured through social perceptions, provide valuable, unbiased, input regarding surgical outcomes. We found statistically significant positive changes reported by laypersons for the adolescent cleft subjects in the social traits studied after completion of staged reconstruction.

Cleft lip and palate adolescent subjects presenting with a naso-maxillary deformity were compared with young adult noncleft subjects presenting with a maxillary deficiency dentofacial deformity (DFD). As a group, the cleft lip and palate adolescents with naso-maxillary deformity experienced a greater extent of change after reconstruction than the noncleft group in being perceived as less angry, less sad, less afraid, and less disgusted. Both groups experienced a similar change in the perception of happiness. Cleft lip and palate adolescent subjects also experienced a greater magnitude of change after reconstruction in being perceived as more attractive and more dominant while a lesser change in being perceived as less threatening in comparison to PMD developmental DFD subjects after reconstruction. Interestingly, the cleft subjects experienced a greater extent of improvement than the PMD subjects in the perception of all 7 interpersonal event experiences.

Our findings are in contrast to those reported by Lin et al[21] for cleft and noncleft subjects. Their group reported the social perceptions of laypersons of cleft lip and palate subjects undergoing a wide spectrum of orthognathic procedures and compared this to a mixed group of noncleft class II and class III malocclusion subjects. Lin et al[21] found that 13 of 19 perception item score changes favored noncleft patients. This is in contrast to our study findings of positive social perception changes which overwhelmingly favor cleft over noncleft subjects.

Crowdsourcing via MTurk has proved to be a valuable tool to rapidly gather unbiased opinions of large numbers of laypersons. It has been used in healthcare-related research to assess surgical technical skills, outcomes of treatment for cosmetic procedures, and patient preferences when seeking surgery.[21–34] The quality of participant (rater) responses collected through mTurk have been found similar to responses collected in person and are capable of producing a more diverse group of respondents.[25] Mechanical Turk respondents have also been shown to produce results that rival the work of highly paid, domain-specific experts and due to the greater number of available respondents less inter-rater variability is reported.[26–28]

Strengths of this study include a focus on the subgroup of cleft lip and palate adolescent subjects all presenting with significant naso-maxillary deformities and all undergoing a consistent set of orthognathic procedures (bimaxillary and chin osteotomies) and a specific type of nasal reconstruction (use of a rib cartilage caudal strut graft through open approach). In an effort to present the full extent of the deformity and to decrease bias, a set of 3 standardized facial photographs just before orthognathic surgery and at a minimum of 6 months after completion of both orthognathic surgery and then definitive nasal reconstruction were used. Consecutive cleft subjects were taken from our database without patient dropout or surgeon bias. Additional strengths of this study include the raters were blinded to knowledge that the subjects were born with facial clefting, had undergone any facial surgery, and the subject's before and after photographs were presented in a random, nonsynchronous, order.

Table 4. Social Perceptions of Cleft Adult Subjects before and after Orthognathic Surgery* and Nasal Reconstruction†

Personality traits	Preoperative	Postoperative	Difference	P	95% CI	Postoperatively, Subjects Appear
Submissive to dominant	3.54 ± 1.75	3.70 ± 1.66	0.16	**<0.001**	(0.11–0.21)	More dominant
Untrustworthy to trustworthy	4.43 ± 1.50	4.72 ± 1.46	0.30	**<0.001**	(0.26–0.34)	More trustworthy
Nonthreatening to threatening	3.24 ± 1.90	3.11 ± 1.86	−0.13	**<0.001**	(−0.19 to −0.08)	Less threatening
Unfriendly to friendly	4.41 ± 1.56	4.86 ± 1.45	0.45	**<0.001**	(0.41–0.49)	More friendly
Unintelligent to intelligent	4.32 ± 1.47	4.68 ± 1.42	0.35	**<0.001**	(0.31–0.39)	More intelligent
Unattractive to attractive	3.54 ± 1.66	4.23 ± 1.60	0.70	**<0.001**	(0.65–0.74)	More attractive
Expressed emotional traits						
Angry	2.92 ± 1.92	2.42 ± 1.79	−0.50	**<0.001**	(−0.55 to −0.45)	Less angry
Surprised	2.92 ± 1.85	2.86 ± 1.84	−0.06	**0.02**	(−0.11 to −0.01)	Less surprised
Happy	3.21 ± 1.91	4.06 ± 1.86	0.86	**<0.001**	(0.80–0.91)	Happier
Sad	3.07 ± 1.88	2.69 ± 1.87	−0.38	**<0.001**	(−0.43 to −0.33)	Less sad
Afraid	2.85 ± 1.91	2.61 ± 1.89	−0.23	**<0.001**	(−0.29 to −0.18)	Less afraid
Disgusted	2.64 ± 1.89	2.42 ± 1.88	−0.22	**<0.001**	(−0.27 to −0.17)	Less disgusted
Likelihood to experience interpersonal events						
Feel lonely	4.05 ± 1.71	3.45 ± 1.75	−0.61	**<0.001**	(−0.66 to −0.56)	Less likely to feel lonely
Teased by others	4.29 ± 1.69	3.49 ± 1.77	−0.80	**<0.001**	(−0.85 to −0.75)	Less likely to be teased by others
Romantic relationships	3.59 ± 1.72	4.35 ± 1.67	0.77	**<0.001**	(0.72–0.81)	More likely to have romantic relationships
Praised by others	3.74 ± 1.61	4.27 ± 1.56	0.53	**<0.001**	(0.49–0.58)	More likely to be praised by others
Friendships	4.31 ± 1.54	4.85 ± 1.47	0.54	**<0.001**	(0.50–0.58)	More likely to have friendships
Bullied by others	4.16 ± 1.71	3.43 ± 1.79	−0.73	**<0.001**	(−0.78 to −0.68)	Less likely to be bullied by others
Feel anxious around others	4.22 ± 1.71	3.59 ± 1.78	−0.63	**<0.001**	(−0.68 to −0.58)	Less likely to feel anxious around others

Statistically significant associations ($P \leq 0.05$) are in bold. Each personality trait ranked on a Likert scale (1: not at all; 7: very).
*All subjects underwent bimaxillary and chin orthognathic surgery.
†All subjects underwent open rhinoplasty with rib cartilage caudal strut graft.

Table 5. Social Perceptions of Primary Maxillary Deficiency Adult Subjects before and after Orthognathic Surgery*

Personality traits	Preoperative	Postoperative	Difference	P	95% CI	Postoperatively, Subjects Appear
Submissive to dominant	4.22 ± 1.73	4.13 ± 1.63	−0.09	**<0.01**	(−0.15 to −0.02)	Less dominant
Untrustworthy to trustworthy	4.30 ± 1.56	4.51 ± 1.52	0.21	**<0.001**	(0.15–0.27)	More trustworthy
Nonthreatening to threatening	3.69 ± 1.85	3.51 ± 1.84	−0.18	**<0.001**	(−0.26 to −0.11)	Less threatening
Unfriendly to friendly	4.29 ± 1.53	4.64 ± 1.55	0.36	**<0.001**	(0.30–0.42)	More friendly
Unintelligent to intelligent	4.36 ± 1.52	4.63 ± 1.47	0.27	**<0.001**	(0.22–0.33)	More intelligent
Unattractive to attractive	3.92 ± 1.56	4.15 ± 1.48	0.24	**<0.001**	(0.18–0.30)	More attractive
Expressed emotional traits						
Angry	2.94 ± 1.89	2.76 ± 1.94	−0.18	**<0.01**	(−0.26 to −0.10)	Less angry
Surprised	3.00 ± 1.88	2.84 ± 1.83	−0.17	**<0.01**	(−0.24 to −0.09)	Less surprised
Happy	3.28 ± 1.96	4.06 ± 1.94	0.79	**<0.001**	(0.71–0.86)	Happier
Sad	2.70 ± 1.84	2.56 ± 1.84	−0.15	**<0.01**	(−0.22 to −0.07)	Less sad
Afraid	2.66 ± 1.88	2.57 ± 1.88	−0.08	**<0.01**	(−0.16 to −0.01)	Less afraid
Disgusted	2.54 ± 1.89	2.47 ± 1.90	−0.07	**<0.01**	(−0.14 to 0.01)	Less disgusted
Likelihood to experience interpersonal events						
Feel lonely	3.55 ± 1.76	3.31 ± 1.76	−0.23	**<0.001**	(−0.30 to −0.16)	Less likely to feel lonely
Teased by others	3.37 ± 1.76	3.22 ± 1.74	−0.15	**<0.01**	(−0.22 to −0.08)	Less likely to be teased by others
Romantic relationships	3.93 ± 1.72	4.32 ± 1.61	0.39	**<0.001**	(0.32–0.45)	More likely to have romantic relationships
Praised by others	3.93 ± 1.60	4.27 ± 1.53	0.34	**<0.001**	(0.28–0.40)	More likely to be praised by others
Friendships	4.55 ± 1.49	4.81 ± 1.50	0.26	**<0.001**	(0.20–0.32)	More likely to have friendships
Bullied by others	3.29 ± 1.80	3.21 ± 1.76	−0.08	**0.01**	(−0.15 to −0.01)	Less likely to be bullied by others
Feel anxious around others	3.50 ± 1.80	3.41 ± 1.79	−0.09	**0.02**	(−0.16 to −0.02)	Less likely to be anxious around others

Statistically significant associations ($P \leq 0.05$) are in bold. Each personality trait ranked on a Likert scale (1: not at all; 7: very).
*All subjects underwent bimaxillary and chin orthognathic surgery.

Table 6. Comparison of Changes in Social Perceptions between Cleft Subjects and PMD Study Subjects

Personality traits	Group	N	Mean Difference (Postoperative – Preoperative)	SD	P*
Submissive to dominant	Noncleft	2,475	−0.09	1.55	**<0.001**
	Cleft	4,950	0.16	1.57	—
Untrustworthy to trustworthy	Noncleft	2,475	0.21	1.62	0.16
	Cleft	4,950	0.30	1.52	—
Nonthreatening to threatening	Noncleft	2,475	−0.18	1.77	**0.048**
	Cleft	4,950	−0.13	1.60	—
Unfriendly to friendly	Noncleft	2,475	0.36	1.77	0.11
	Cleft	4,950	0.45	1.64	—
Unintelligent to intelligent	Noncleft	2,475	0.27	1.45	0.08
	Cleft	4,950	0.35	1.50	—
Unattractive to attractive	Noncleft	2,475	0.24	1.29	**<0.001**
	Cleft	4,950	0.70	1.57	—
Expressed emotional traits					
Angry	Noncleft	2,475	−0.18	2.02	**<0.001**
	Cleft	4,950	−0.50	1.65	—
Surprised	Noncleft	2,475	−0.17	1.59	**<0.001**
	Cleft	4,950	−0.06	1.60	—
Happy	Noncleft	2,475	0.79	2.46	0.96
	Cleft	4,950	0.86	2.07	—
Sad	Noncleft	2,475	−0.15	1.54	**<0.001**
	Cleft	4,950	−0.38	1.68	—
Afraid	Noncleft	2,475	−0.08	1.45	**<0.001**
	Cleft	4,950	−0.23	1.48	—
Disgusted	Noncleft	2,475	−0.07	1.38	**<0.001**
	Cleft	4,950	−0.22	1.36	—
Likelihood to experience interpersonal events					
Feel lonely	Noncleft	2,475	−0.23	1.67	**<0.001**
	Cleft	4,950	−0.61	1.78	—
Teased by others	Noncleft	2,475	−0.15	1.58	**<0.001**
	Cleft	4,950	−0.80	1.83	—
Romantic relationships	Noncleft	2,475	0.39	1.57	**<0.001**
	Cleft	4,950	0.77	1.72	—
Praised by others	Noncleft	2,475	0.34	1.59	**<0.001**
	Cleft	4,950	0.53	1.63	—
Friendships	Noncleft	2,475	0.26	1.57	**<0.001**
	Cleft	4,950	0.54	1.62	—
Bullied by others	Noncleft	2,475	−0.08	1.50	**<0.001**
	Cleft	4,950	−0.73	1.80	—
Feel anxious around others	Noncleft	2,475	−0.09	1.54	**<0.001**
	Cleft	4,950	−0.63	1.75	—

All subjects underwent bimaxillary and chin orthognathic surgery; cleft subjects also underwent open rhinoplasty with rib cartilage caudal strut graft. Statistically significant associations ($P \le 0.05$) are in bold.
*Mann-Whitney U test.
PMD, primary maxillary deficiency.

Study weaknesses include our inability to control the effort of raters in completing the survey and the inherent limitations of our study design. In addition, the rating group in our study may not replicate the exact population that each specific subject interacts with on a daily basis. The cleft and noncleft PMD comparison group both required and underwent consistent bimaxillary and chin osteotomies; however, the cleft study group also presented with significant nasal deformity and then underwent consistent nasal reconstruction. The noncleft PMD group did not require or undergo nasal reconstruction. This may be a confounder however we believe that the noncleft PMD dentofacial deformity subjects represent a reasonable and interesting comparison group. Also, as photographs were taken during routine appointments at standard time frames but without forewarning the subject in advance, we acknowledge that hairstyle and make-up changes may be con-

founders. Finally, although the Likert scale responses to questions were generated from validated studies, the transference of the perception of these studied personality traits and emotional facial expressions to real-world scenarios remains unknown.[21,22]

CONCLUSIONS

We confirmed that laypeople consistently report improved social perceptions of cleft lip and palate adolescent subjects after bimaxillary and chin orthognathic surgery followed by definitive nasal reconstruction using a rib cartilage caudal strut graft compared with before surgery. The improved social perceptions reported in the cleft lip and palate study subjects are for a broad spectrum of the individual's personality traits and perceiving emotional facial expressions. Cleft subjects achieved a greater extent of positive social perception change than noncleft maxillary deficiency subjects

after correction of their presenting naso-maxillary deformity.

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