Impact of Surgical Orthodontics on Facial Attractiveness and Perceived Age

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THESIS

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SUMMARY

Orthodontic treatment involving orthognathic surgery has become a widely used combined treatment approach in correcting severe dentofacial discrepancies. Motivation to undergo treatment is often influenced by expectations that surgery will lead to improved function and facial esthetics. While the functional and occlusal benefits of surgical orthodontics are readily quantifiable, esthetic improvements after surgery are difficult to evaluate numerically.

This study was designed to investigate the relationship between surgical orthodontics and the perceived facial attractiveness and estimated age of surgically-treated patients. Evaluations were completed by a panel of orthodontists and laypersons using a series of pre-surgical and post-surgical facial photographs.

The patients studied consisted of individuals treated surgically at the University of Illinois at Chicago (UIC) College of Dentistry and affiliated hospitals. The orthodontic component for all patients was completed either by UIC orthodontic residents, or by non-UIC orthodontists in private practice. Patients with concave soft tissue profiles who had undergone either single-jaw or double-jaw orthognathic surgery were included in this study. Patients with craniofacial anomalies or syndromes were excluded from the sample. Pre-treatment and post-treatment facial photographs in three views (frontal at repose, frontal when smiling, profile) were gathered for all eligible individuals. 17 total subjects, both male and female, were included in the study. Patient ages at the pre-surgical timepoint ranged from 15 to 25. Pre-surgical and post-surgical photographs were de-identified, randomized, and evaluated by a panel of 10 orthodontist and 10 laypersons who were not involved in the treatment of any patients in the sample. Evaluations for two criteria, facial attractiveness and perceived age, were judged by each evaluator on a visual analog scale. Each evaluator completed the assessment twice in order to evaluate for consistency in ratings.

Results showed that scores for both facial attractiveness and perceived age were highly consistent among each evaluator for both sittings. Patients were rated significantly higher in facial attractiveness in the post-surgical timepoint as compared to the pre-surgical timepoint for both evaluator groups. Ratings from orthodontists and laypersons showed average post-surgical attractiveness improvements of 52.7% and 27.3%, respectively. No significant changes in the perception of age were found to occur as a result of surgical treatment. On average, the perceived age change for both orthodontists and laypersons was less than the actual time elapsed between pre-surgical and post-surgical photographs. Our results suggest that perception of age is a very complex variable, showing significantly greater variability between evaluators and within the same evaluator as compared to facial attractiveness assessments. Isolating the effects of surgical treatment on perceived age from the natural aging process is a challenging endeavor.

1. INTRODUCTION

1.1 Background

Orthodontic treatment involving adjunctive orthognathic surgery has become an increasingly common method of treating skeletal discrepancies. While traditional surgical orthodontics has been largely based on hard tissue relationships, the information provided is often incomplete because it undervalues the importance of facial form. The predictability of “attractiveness” or “beauty” by conventional osseous cephalometric norms is also unreliable, and hard tissues are not consistently related to facial soft tissues. In the patient’s eyes, esthetics is often paramount, and standards of modern orthodontics should fulfill both occlusal and facial treatment objectives. Few studies in the current literature have been designed to quantify the change in facial attractiveness before and after orthodontic treatment involving orthognathic surgery, and literature on the impact of surgery on age perception of the face is unavailable. This study is conducted to aid clinicians in providing an objective approach to predicting esthetic improvements when considering a surgical-orthodontic treatment option.

1.2 Objective

To study whether a relationship exists between facial attractiveness ratings and perceived age ratings given by evaluators in patients before and after surgical orthodontic treatment.

1.3 Null Hypotheses

Null hypothesis #1: There is no difference in facial attractiveness in patients before and after surgical orthodontic treatment.

Null hypothesis #2: There is no difference between perceived age change and actual age change in patients before and after surgical orthodontic treatment.

2. BACKGROUND/LITERATURE REVIEW

2.1 Traditional Treatment Objectives in Orthodontics

Classical orthodontic diagnosis and treatment planning is largely based on hard tissue relationships using model analysis and cephalometry (Andrews, 1972). Edward Angle, the father of modern orthodontics, described an ideal occlusion as “nature’s intended form” (Ackerman, Proffit, & Sarver, 1999). For over a century, orthodontic practice has been principally based on the Angle belief system that if one possessed perfectly aligned dental arches, nature would allow the face to be in perfect harmony and the dentofacial skeleton would function ideally (Mhatre, Tandur, Gaikwad, Doshi, & Khushalani, 2012). Using these traditional analyses systematized orthodontists to aim for Class I dental alignment of the dentition, rather than looking at facial changes that occurred throughout orthodontic treatment (Sarver, 2015).

2.2 Soft Tissue Paradigm Shift

In the early 1960s, dentist and anatomist Melvin Moss developed the *functional matrix theory*, which proposed that facial growth occurs as a result of functional needs and is partially mediated by the soft tissue envelope (Moss, 1960). During the next several decades, this theory gained attention in many aspects of growth and development and dentistry, as practitioners increasingly realized the vital role that soft tissue structure had on the overall form and shape of the craniofacial skeleton (Moss-Salentijn, 1997). Ackermann and Profit (1999) highlighted the importance of this “emerging soft tissue paradigm” in not only achieving ideal occlusion, but also pleasing facial outcomes. To the patient, esthetics is often paramount, and orthodontists must plan treatment within the patient’s limits of soft tissue adaptations and contours (Mhatre et al., 2012).

While traditional orthodontic hard tissue analysis focuses on a patient's existing skeletal discrepancy, this information is largely incomplete for the modern orthodontist as it de-emphasizes facial form and esthetics. According to Hambleton (1990), "…the facial curtain is more than just the underlying bone, it is also made up of muscles, fatty tissues, nerve, and blood vessels.". The predictability of "attractiveness" or "beauty" by conventional osseous cephalometric norms has also been historically unreliable (Adamu, Ojo, Danborno, Adebisi, & Taura, 2017). Clinical comparison of human soft tissue profiles provides some ability to localize hard tissue structures, but is largely inconsistent across patients of different ethnicities, genders and ages due to significant variability in soft tissue thickness (Ligthelm-Bakker, Prahl-Andersen, Wattel, & Uljee, 1991).

2.3 Evolution of Esthetics in Orthodontics

During the 1980s, rapid innovation in dental biomaterials introduced many new esthetic types of restorative materials to the field, which led to an increased awareness and demand for "esthetic dentistry". During this time, development in other specialties such as oral and maxillofacial surgery similarly began evolving towards surgical goals that were increasingly esthetically driven (Sarver & Ackerman, 2000). While ideal occlusion was still considered the primary treatment goal, esthetic outcomes were recognized as being critical for patient satisfaction. Discussion on esthetic trade-offs in orthodontic treatment modalities, such as expansion versus extraction and dental camouflage versus skeletal correction, came to the forefront in many professional orthodontic circles.

De Paula et al. (2017) evaluated the corrective effects produced by a mandibular advancement appliance on the facial silhouettes of 54 Class II patients. Between 60 orthodontists and 60 laypersons, most evaluators preferred post-treatment over pre-treatment silhouettes using a visual analog scale.

Laypersons were able to identify greater differences ($p<0.001$) between T1 and T2 than did the orthodontists.

While there are no hard and fast rules that will guarantee ideal esthetic treatment results, Sarver (2000) suggests three general guidelines that orthodontists should strive for. Firstly, dental and facial relationships must be evaluated in all three dimensions in a dynamic fashion. Resting posture and animated smiles must be appraised in conjunction with one another. Secondly, anterior tooth prominence at rest and during animation are extremely important parameters pertaining to facial attractiveness, even more so than anteroposterior tooth positions in a profile view. Lastly, broadening the soft tissue envelope by treatment modalities such as dental arch expansion can help increase hard tissue support for the lips and cheeks. This generally produces much improved esthetic results than constricting forces such as those performed in extraction mechanics.

2.4 Commonly used methods for assessing facial attractiveness

In the 1950s, Riedel published a paper in *Angle Orthodontics* where he used outlines of 29 soft tissue profiles from cephalometric tracings and asked 72 orthodontists to assess them as either “good”, “fair” or “poor” (Figure 1). Using this rudimentary categorization system, a correlation between facial convexity and the reported facial attractiveness ratings was established. Numerically, for all of the “good” profiles labeled by orthodontist, the following criteria were met: ANB did not exceed 2.5, the distance from upper incisors to the facial plane was less than 6.5mm, L1-MP was never less than 72 degrees, and convexity did not exceed 4 degrees (Riedel, 1950).

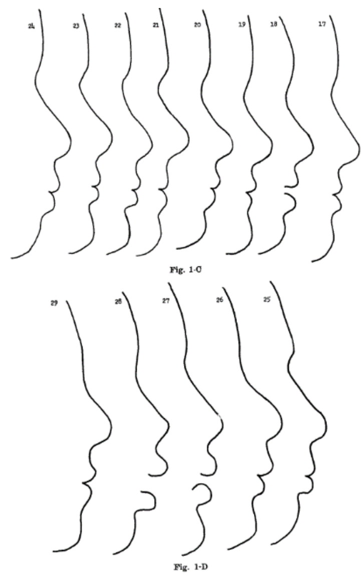


Figure 1. Outlines of soft tissue profiles used for judging by orthodontists (Riedel, 1950)

While these early studies on esthetics described relatively subjective and categorical data, later research has shown that facial harmony can more strictly defined in a mathematical sense. In the 1980s, Ricketts suggested that our evolved human mind is rooted at the limbic level to be attracted to the *golden proportion* of 1.618 and its reciprocal 0.618 (Ricketts, 1982). Such geometric ratios are also expressed in the mathematical sequence named after Fibonacci (Yalta, Ozturk, & Yetkin, 2016). Ricketts initially examined frontal photographs of models in magazines and found that 8 out of the 10 models possessed facial proportions that were in significant harmony with the golden proportion. Other authors including Zeising (2007) have found that each section of the face was aligned in relation to this important ratio. Ricketts conducted further studies and found that the distance between the lateral canthi of the eyes was in a 0.618 ratio to the total face length (i.e. from trichion to menton) in esthetically pleasing subjects. In addition, the ala of the nose and commissures of the mouth also follow this geometric ratio when compared to the total facial height (M. Ricketts, 1983). These findings strongly suggest that esthetics can be quantified and expressed in an objective scientific manner.

Simon et al. (1927) developed a photographic method (which was termed *photostatics*), that was used to relate facial form to the orbital plane and Frankfort horizontal plane. Bell (1985) used serial profile drawings that were on a spectrum of skeletal disharmony (Figure 2). She found that laypersons' ratings were similar to those given by dental specialists, but they tended to view subjects as being more "normal" than dental professionals. Orthodontists and oral surgeons evaluated facial profiles similarly but varied in their tendency to recommend surgical correction. In a similar study design, Denize et al. (2014) used profile silhouettes to assess variations in the size of facial features such as the nose, lips, and chin. Subjects were instructed to indicate the profile that most closely resembled ideal esthetics in a male and female. Results revealed that the *interlabial prominence angle* had the greatest numerical sexual difference, and indicated that dental prominence is preferred in females (Denize et al., 2014).

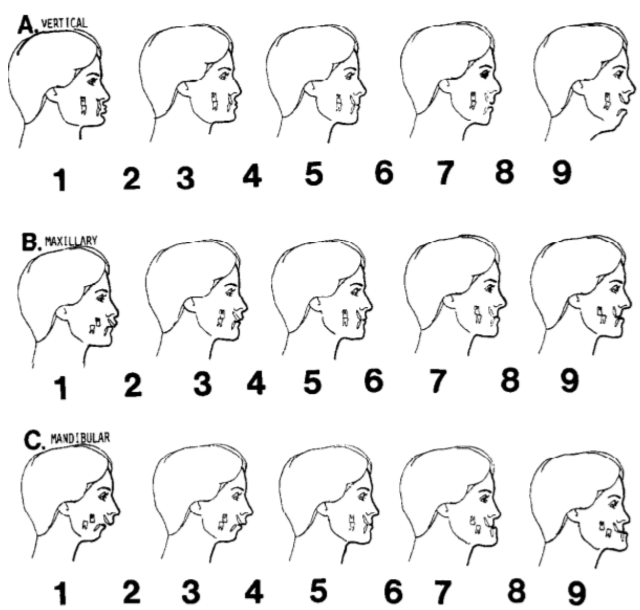


Figure 2. Serial profile drawings showing a spectrum of skeletal disharmony in various dimensions (Bell et al., 1985)

Dempsey et al. (2017) employed a visual analog scale of 100mm and asked 6 orthodontists to evaluate 336 pre-surgical and post-surgical composite photos of orthognathic surgery Class II patients with retrognathic mandibles. A visual analog scale is a useful tool that provides a simple and reliable method of quantifying effects of continuous variables (Klimek et al., 2017). Dempsey found that the average patient facial attractiveness score was increased by 36% after orthognathic surgery, and facial convexities normalized with treatment. Judges also evaluated for perceived age, and while there was no statistically significant change in age perception between the pre-surgical and post-surgical groups, the evaluators tended to overestimated ages in both pre and post surgical photographs by 1.6 years (Dempsey, Tsay, 2017). This study, however, was limited to Class II skeletal patients, only examined female patients in a narrow demographic range, and only studied orthodontic specialists.

2.5 Dentofacial deformities and effects on Quality of Life

The World Health Organization (1995) has defined *quality of life* (QOL) as an individual's "perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards, and concerns." More recently, the term health-related quality of life (HRQL) has been increasingly used in healthcare research. This term refers to an individual or group's perceived physical and mental health over time (Cunningham & Hunt, 2001), a parameter that and orthodontists strive to improve throughout the course of treatment.

Dentofacial deformities can have significant negative social implications to those affected due to esthetic and functional impairments. Orthognathic surgery has been demonstrated to dramatically improve these handicaps; a combination of orthodontic treatment and orthognathic surgery is a very well-accepted multidisciplinary approach used to treat severe dentofacial deformities (Corso et al., 2016).

Much of the literature available on surgical orthodontics have focused on the technical results of surgical treatments (e.g. hard-tissue improvements to SNA, SNB, FMA, U1-SN, L1-MP, etc.) but neglect to explore the effects of treatment in the patient's own eyes. Indeed, research suggests that psychometric components of having a dentofacial imbalance can be more damaging to an individual's sense of well-being than any quantifiable structural impairment (Gava, Miguel, de Araújo, & de Oliveira, 2013).

The Oral Health Impact Profile (OHIP) was introduced by Slade in 1994. A considered version named OHIP-14 was constructed in 1997 (Slade & Spencer, 1994) (Figure 3). The OHIP and OHIP-14 evaluate the effects of dental issues on the physical, psychological and social conditions of individuals. This metric and has been determined to be valid , precise and reliable according to a number of authors (Slade et al., 1998). The indicator is divided into seven categories: limitations in function, physical suffering, physical pain, physical shortcomings, physical incapacity, social shortcomings, and overall deficiency. This tool has been predominantly used in cross-sectional, observational studies, but there is little literature from their use in long term studies.

Item	... because of problems with your teeth, mouth or dentures?
OH-1	Have you had trouble pronouncing any words because…
OH-2	Have you felt that your sense of taste has worsened…
OH-3	Have you had painful aching in your mouth?
OH-4	Have you found it uncomfortable to eat any foods…
OH-5	Have you been worried by dental problems?
OH-6	Have you felt tense…
OH-7	Has your diet been unsatisfactory...
OH-8	Have you had to interrupt meals...
OH-9	Have you found it difficult to relax…
OH-10	Have you been a bit embarrassed…
OH-11	Have you been a bit irritable with other people...
OH-12	Have you had difficulty doing your usual jobs...
OH-13	Have you felt that life in general was less satisfying...
OH-14	Have you been totally unable to function…

Figure 3. Condensed Oral Health Impact Profile (OHIP-14) Questionnaire (Slade & Spencer, 1994)

Soh et al. (2013) conducted a systematic review to examine the quality of life assessments in patients with dentofacial deformities who have undergone orthognathic surgery. 21 total articles between 2001 and 2012 revealed that orthognathic patients experience a statistically significant improvement in quality of life after surgery (Figure 4).

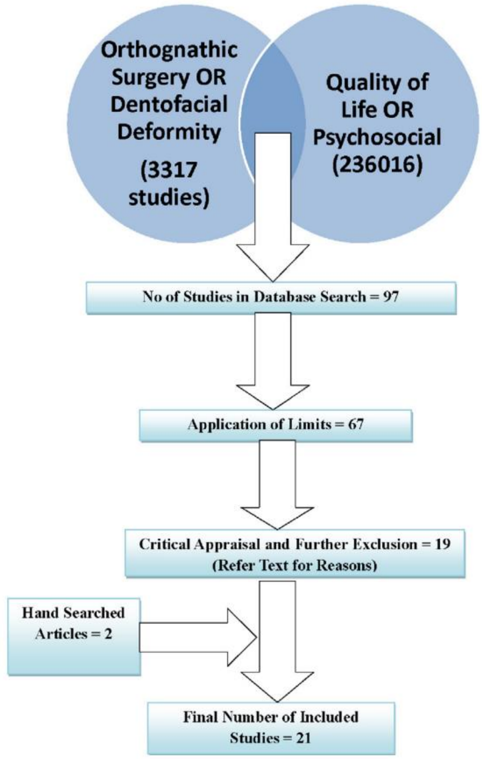


Figure 4. Flowchart of literature selection in systematic review regarding *dentofacial deformities* and *quality of life* (Soh & Narayanan, 2013)

Of the papers investigated in this meta-analysis, Motegi et al. (2003) had the longest follow-up of all subjects of 5 years. These authors studied 93 patients after bilateral split sagittal osteotomy to correct Class II malocclusions, and found significant improvement in OHIP score from pre-surgery to 2 and 5 years post-surgery ($p<0.05$). Change in OHIP score between years 2 and 5 was not statistically significant, suggesting that surgical results were stable between years 2 and 5. Findings from other papers mentioned in this systematic review (Hutton, 1967) and (Kiyak, West, Hohl, & McNeill, 1982) have reported that the primary motivating factor for patient undergoing treatment is esthetic concerns, and that satisfaction after treatment was both significantly positive, and long-lasting (greater than 2 years). Data obtained from Rustemeyer (2012) and Khadka (2011) support these findings. On the contrary, Stirling (2007) and Proothi (2010) have reported that for the majority of orthognathic patients, the primary motivating factor to undergo surgical treatment was bite improvement, rather than appearance. A very small percentage of patients in the papers investigated report dissatisfaction with treatment results, with authors reporting 7% of patients having a deterioration in function, 15% in overall discomfort from surgical side effects, and 4% in having a worsening in speech. (Choi, Lee, McGrath, & Samman, 2010)

Individual variations in self-perception are extremely important when evaluating treatment goals and treatment success. Johnston et al. (2009) studied a set of 162 orthodontic patients with varying genders, ages, and treatment modalities by issuing questionnaires, and found that among all combinations of subjects, older patients, women, and orthognathic patients were less happy with their pre-treatment dental and facial appearance than non-treated control groups.

2.6 A History of Surgical Orthodontics and Patient Satisfaction

Orthognathic surgery has been used as an adjunct to treat severe skeletal discrepancies and malocclusions. The first recorded operation for the correction of malocclusion was performed by S.R. Hillihan in 1849 and only involved the mandible (Steinhäuser, 1996). Edward Angle worked closely with an oral surgeon named Vilray Blair in the late 1800s, and they together described the first ostectomy of the horizontal ramus for correcting mandibular prognathism (Whipple, 1898). It wasn't until 1955 that the world-renowned technique of an "intraoral sagittal split of the mandible" was developed by Hugo Obwegeser and his teacher Richard Trauner that would ultimately revolutionize surgical orthodontics. The innovation of this technique involved connecting two horizontal cortical cuts along the lateral oblique ridge and leaving the posterior border of the mandible untouched, allowing for the inferior alveolar nerve intact (Figure 5). The increased distance between the lingual and buccal cuts compared to previous techniques increased the bony overlap of the segments, which resulted in better stability and a much lower risk of pseudoarthrosis (Böckmann, Meyns, Dik, & Kessler, 2015). Obwegeser also began studying maxillary surgeries, and in 1969 was the first maxillofacial surgeon report on a large collection of Le Fort I osteotomies (Obwegeser, 1969). The advent of combined maxillary and mandibular surgeries allowed for a greater envelope of surgical correction for a much wider combination of skeletal deformities that mandibular surgery alone could not sufficiently correct.

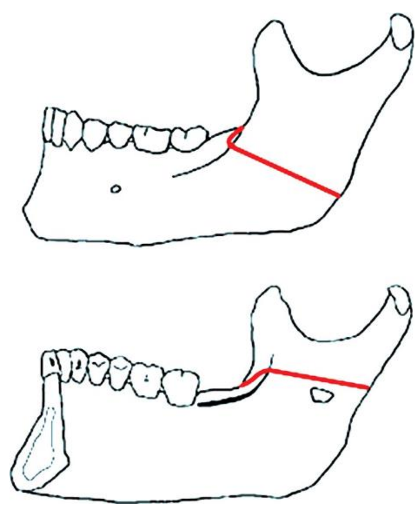


Figure 5. The anatomy of the sagittal split osteotomy, as described by Obwegeser (1969)

Gomes et al. (2018) surveyed Brazilian patients with skeletal malocclusions prior to undergoing orthognathic surgery using the Oral Health Impact Profile 14 (OHIP-14) and the Orthognathic Quality of Life Questionnaire (OQLQ). Among factors such as “problems biting”, “difficulty talking”, “altered sense of taste”, “pain in my jaws”, “I don’t like my smile”, Gomes found that “facial esthetics” was the most represented factor, with an 81.13% prevalence of impact on QOL. Marital status of the individual also had a significant effect on the quality of life (P=0.0119), with single or divorced people reporting a statistically significant worse QOL than married individuals. Women were found in this study to be 11.78 more likely to reported an impact on QOL than men (P=0.0005). Most of the orthognathic patients displayed a temporary negative change in the perioperative phase. The quality of life improved drastically in patients 3 months after their surgeries according to the OHIP-14 index. There was a smaller effect noted for deformities in the transverse dimension when compared with issues in either the anteroposterior or vertical dimensions (Mendes de Paula Gomes et al., 2019).

Asada et al. (2015) assessed satisfaction with orthognathic surgery in skeletal Class III patients with either single-jaw mandibular setback or bimaxillary surgery. Through questionnaires, patients within the double-jaw group reported significantly higher satisfaction ratings in the appearance of the mouth ($p<0.05$), smile ($p<0.05$) and treatment results ($p<0.001$). In addition to these scores, ANB, ANS-Me, and NLA displayed significant correlations in the double-jaw group, and moderate correlations in the single-jaw group.

In minor cases of Class III dentofacial deformity, single-jaw surgeries involving mandibular setbacks can yield great results. Gjorup et al. (1991) found that mandibular setback surgery led to many favorable improvements in both hard and soft tissue measurements, such as increased rate of competency of lips and posture, and normalization of SNB, ANB, N-Po, overjet. Related studies involving double-jaw surgery in Turkish Class III patients by Enacer et al. (1999) suggest that soft tissue responses to 2-jaw surgery were comparable to results from mandibular setback (1-jaw) surgery alone, with the exceptions of nasal tip projection and the anteroposterior position of the upper lip at rest. These findings have been supported by other authors, who have found favorable changes in numerous soft and hard tissue measurements, including increases in nasolabial angle, decrease in labiomental angle, and overall improved dentofacial esthetics. (Marşan, Cura, & Emekli, 2009)

A predictability study involving the use of TIOPS (a cephalometric, orthognathic surgical planning system) by Donatsky et al. (2009) based on a prospectively treated group of 52 patients suggests that bimaxillary surgery for Class III patients has a relatively high predictability of immediate postsurgical hard tissue outcome ($p<0.01$), but less accurate soft tissue outcome for the majority of variables ($p>0.2$). Authors of similar studies have also noted a high variability of predicted individual outcomes, and suggest that practitioners should be cautious when presenting virtually planned changes to each individual patient.

Joss et al. (2010) sought to quantify the hard tissue to soft tissue changes after BSSO and found that in general, the ratio of lower lip movement to lower incisor improvement before and after surgery was generally consistent at around 50%. That is, if the lower incisor moved 2mm, the lower lip would roughly be moved 1mm.

2.7 Ethnic differences in the appraisal of beauty and unattractiveness

The perception of physical attractiveness is regarded as an evolutionary adaptation that can increase one's reproductive success by appealing to potential mates of the opposite sex (Apicella, Little, & Marlowe, 2007). In humans, one of the most important aspects of physical attractiveness is facial form (Currie & Little, 2009). Research conducted in industrial European societies suggests that many features of the face such as geometric proportions, secondary sexual characteristics, symmetry (Perrett et al., 1999), skin condition (Zebrowitz, 2004) and fat amount are universally accepted as good measures of intrinsic biological quality amongst all human populations across the globe (Gallup Jr. & Frederick, 2010). Many authors have reported a high degree of interracial and cross-cultural similarities in the appraisal of facial attractiveness (Langlois et al., 2000). However, many of these existing studies were performed in populations with a significant Western influence, and such groups may have developed European preferences of facial esthetics through social learning behaviors (Currie & Little, 2009).

Foster et al. (1973) studied facial preferences of different ethnicities on profile views. 30 Chinese, 30 black and 30 white subjects were instructed to judge 7 silhouette facial profiles (Figure 6). Each silhouette was the same except for the anteroposterior positioning of the upper and lower lips. Results show the groups did seem to share a common esthetic standard for lip posture within a margin of 1-2mm. All of the studied groups preferred fuller lips for silhouettes of younger patients, and preferred 3mm fuller lips for females than males.

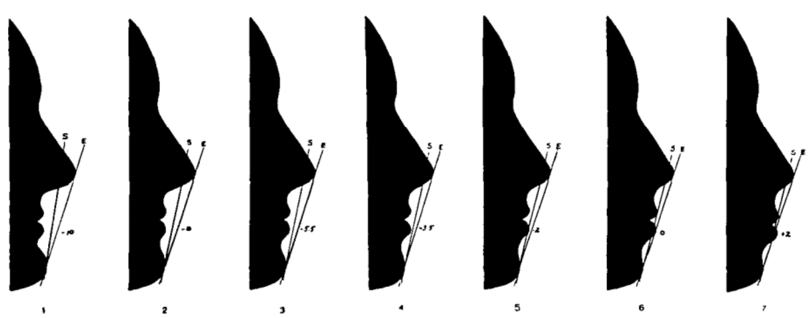


Figure 6. Silhouette facial profiles differing in lip position (Foster, 1973)

On the contrary, some authors have described several mechanisms that can account for systematic differences in perceptions of facial attraction among different human populations. If two human subgroups have differences in facial proportions to a significant degree, they can interpret their preference for “normal” facial proportions in dissimilar ways (Barber, 1995). A preference towards a particular facial feature can be adaptive in nature due to different local ecological environments. DeBruine et al. (2010) have described female preferences for strong masculine features in a potential mates in populations of poor health and a high threat of pathogens.

Of interest is a theory proposed by Sorokowski (2013) that while “beauty is in the eye of the beholder, ugliness is universal”. Sorokowski suggests that across many different cultures, unattractiveness could be more reliably assessed based on their inferences to an individual’s biological health and genetic quality. Compared with unappealing traits, variables for attractiveness appear to be much more complex, unique to individual populations , and related to certain ecological factors and local morphological characteristics (Sorokowski et al., 2013). In Asia, many woman strive to have fair skin and tapered faces with sharp chins, whereas in Western cultures, having a tanned complexion and a defined, square-shaped jawline is seen as desirable amongst women. Boski (2009) has supported this theory and claims that similarities in attitudes towards *unattractiveness* between populations may be greater than the similarities of attractiveness.

3. METHODS AND MATERIALS

3.1 Study design

The sample of the current study consisted of 34 sets of composite photographs compromised of 17 pre-treatment (T1) and 17 post-treatment (T2) records (frontal at repose, frontal when smiling, and profile views) of 17 eligible patients. Lateral cephalograms at T1 were digitized and traced by the principal investigator using Dolphin Imaging Software for each of the 17 patients to confirm eligibility criteria of Legan convexities values of less than 8. Random number generation was conducted to assign codes numbered from 1 to 34 for each set of the composite photographs. Assignment of codes to each set of records was completed by an individual not from the core research team. The association between codes and the collected data were discarded. Only the codes, and not the patients' personal information was used for data analysis.

Twenty total evaluators, consisting of 10 orthodontists and 10 laypersons, were tasked with evaluating a randomized sequence of the 34 patient composite photographs in one sitting. Evaluators were given a time limit of 30 minutes to complete the assessments in their entirety. Each evaluator scored each set of photographs on a 100mm visual analog scale for both variables: *facial attractiveness* and *perceived age* (Figure 8). Evaluators repeated this assignment with the same data sets in a re-randomized order in one week's time to test for intra-evaluator reliability. Figure 11 summarizes the general study design.

3.2 Subjects

Patients were treated surgically by the staff of the Oral and Maxillofacial Surgery department and affiliated hospitals of the University of Illinois at Chicago College of Dentistry (UIC). All surgical procedures were performed by the same board-certified oral and maxillofacial surgeon. The pre-orthodontic and post-orthodontic treatment of patients were completed by residents in the Orthodontic clinic at UIC as well as non-UIC orthodontists.

3.2.1 Inclusion Criteria

- Patients with concave soft tissue profiles between the ages of 15 and 50 who have undergone either one-jaw (mandibular bilateral split sagittal osteotomy setback) or two-jaw surgery (maxillary advancement PLUS mandibular bilateral split sagittal osteotomy setback), with or without adjunctive genioplasty procedures.
- Having both pre-operative and 6-month post-operative photographs (frontal at repose, frontal when smiling, and profile views).
- Having pre-operative and post-operative cephalometric radiographs available.

3.2.2 Exclusion Criteria

- Subjects with craniofacial anomalies or syndromes.
- Patients with initial Legan facial convexity (Gn’-Sn-Po’) of 8 or greater.
- Patients with orthodontic appliances present in their initial or post-treatment photographs.

3.3 Patient photographs

Photographs were collected and stored digitally in Dolphin Imaging Software (Dolphin Imaging Systems, Chatsworth, California, Version 11.9 Premium). Records were gathered and presented to evaluators as a standard orthodontic composite consisting of the following views: frontal at repose, frontal when smiling, and profile. All patient photographs were de-identified by blocking out the eyes with black bars. A sample patient composite is shown (Figure 7):

Figure 7. Sample of a patient composite used in this study

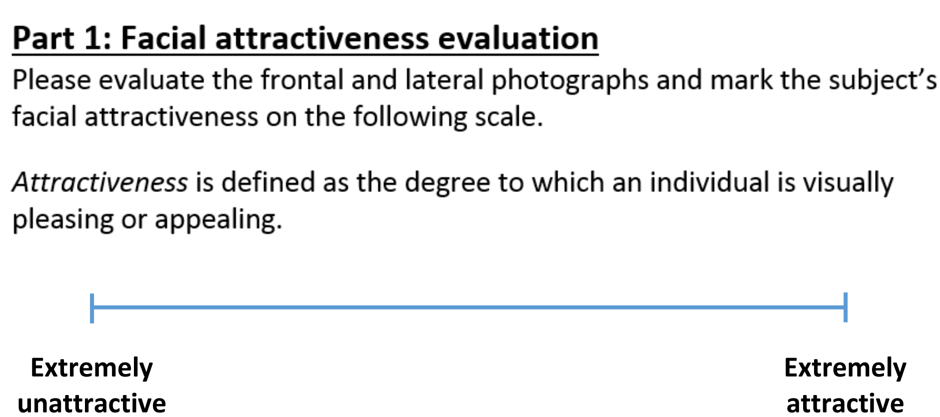
During the data collection portion of the study, the composite photos were color-printed in high resolution on 8.5x11” 100lb card stock.

3.4 Evaluators

Evaluators consisted of 10 orthodontists and 10 laypersons from non-dental backgrounds. Within the orthodontist subgroup, 5 were male and 5 were female. Within the laypersons subgroup, 5 were male and 5 were female. Evaluators in the Orthodontists group who identified as having involvement in the orthodontic treatment of any of the patient subjects were excluded from the study.

3.5 Visual Analog Scale

Each evaluator gave assessments of *visual attractiveness rating* and *perceived age* for each of the 34 composite photographs on a 100mm visual analog scale (Figure 8). Evaluations were completed by hand on paper printouts of the visual analog scales as shown. Evaluators were asked to notate their markings as a single straight vertical line along the 100mm scale for each criteria. Sixty-eight data points were collected from each evaluator (34 patient composites and 2 appraised variables per composite) during each of the two sessions, resulting in 136 data points being collected from each individual evaluator. An aggregate total of 2730 data points was collected between all 20 evaluators.



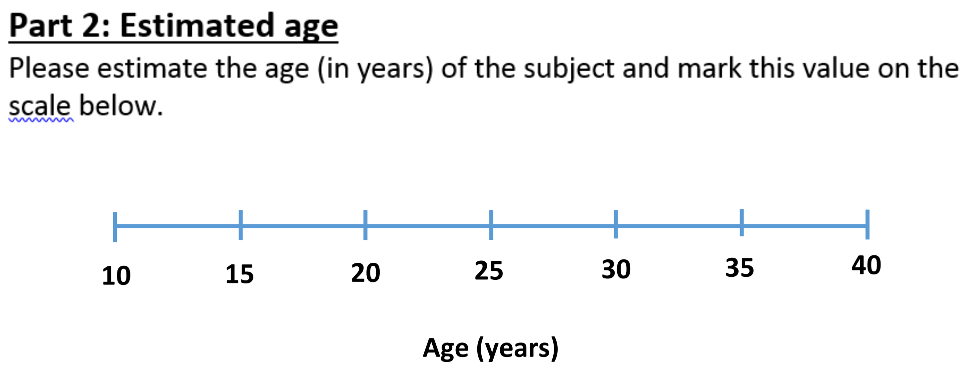


Figure 8. 100mm visual analog scales used for evaluator ratings on

Facial Attractiveness and Estimated Age

3.5.1 Conversion from Visual Analog Scale to Numerical Data

Each of the evaluator markings were measured by the principal investigator using a digital caliper accurate to the nearest hundredth of a millimeter (Figures 9 and 10). Each data point was quantified as the length of the marking from the left-most point on the visual analog scale and converted into a score from 0 to 100. Data was obtained and rounded to the nearest tenth of a millimeter. All measurements were repeated by the principal investigator for reliability.

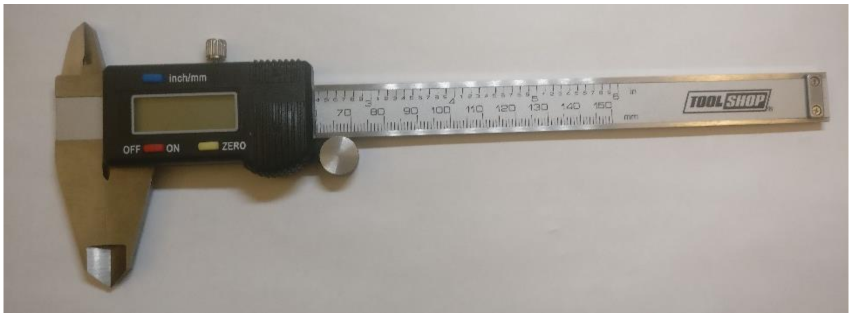


Figure 9. 0-6” (150mm) digital caliper produced by *Tool Shop* in Eau Clarie, WI. Resolution accuracy of 0.01mm / 0.0005”

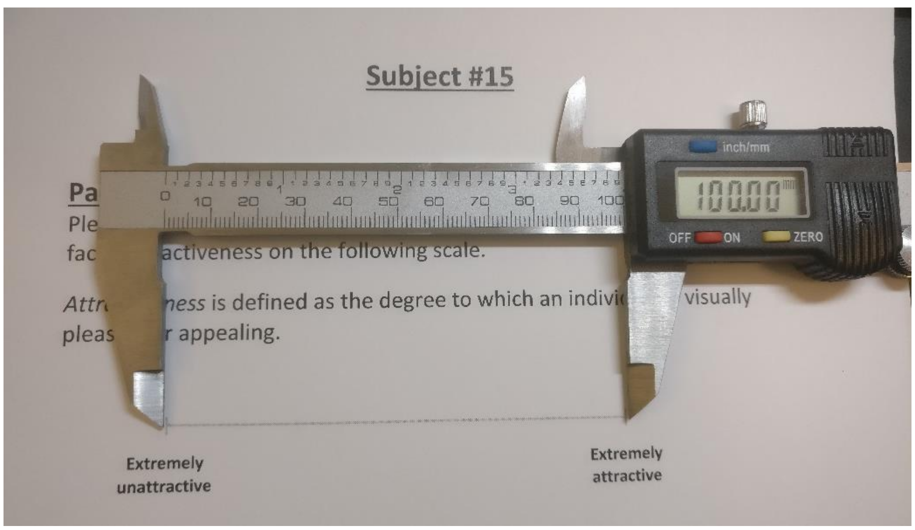


Figure 10. Digital caliper calibrated onto the 100mm visual analog scale

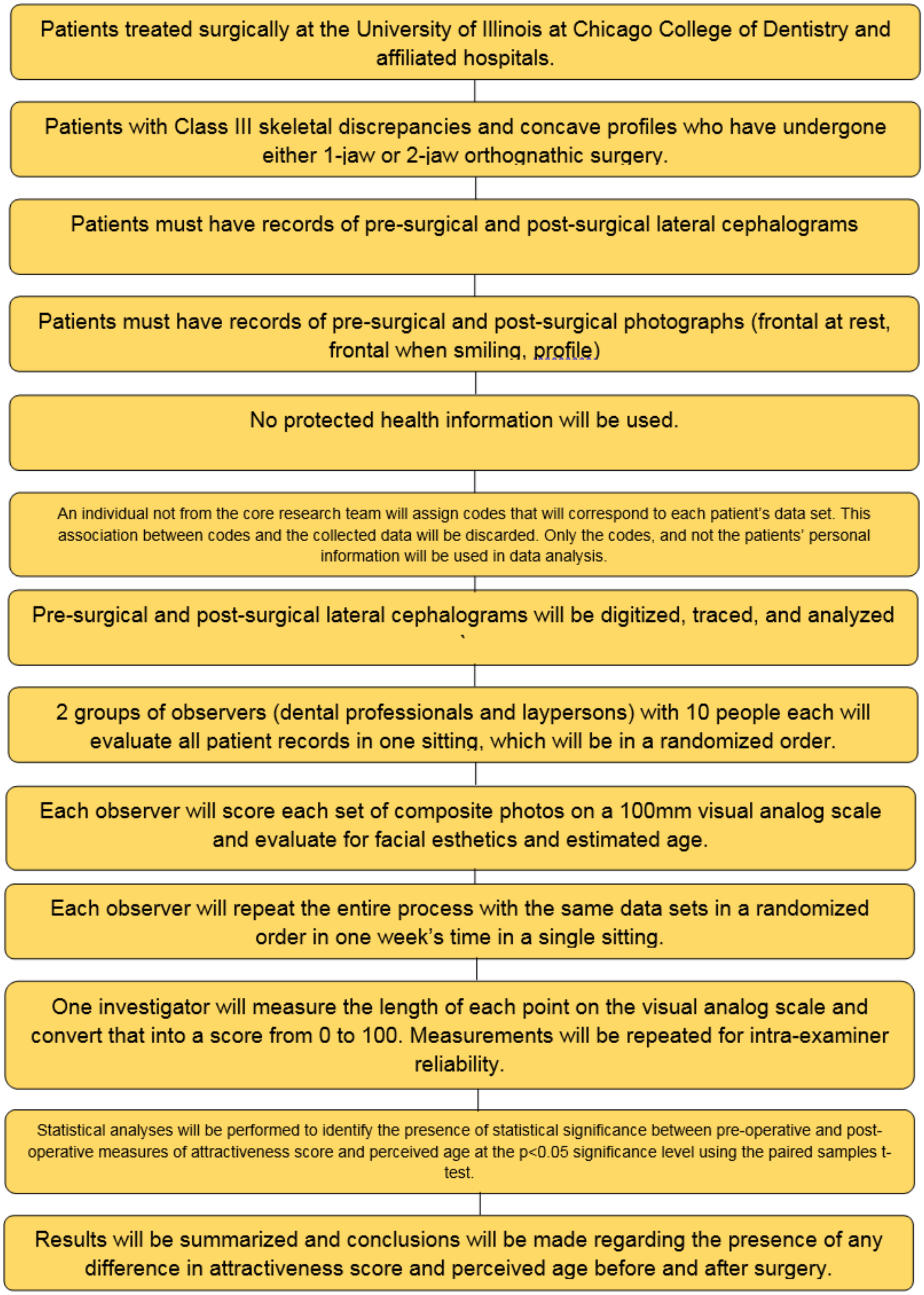


Figure 11. Flowchart of General Study Design

3.6 Data Analysis

Evaluators were divided into two groups for statistical analyses: orthodontists and laypersons. Each group further had its data values separated into the two measured variables for each patient composite: *facial attractiveness rating* and *perceived age*. Week 1 and Week 2 values were separated. Data was reorganized and separated into initial (T1) and post-surgical (T2) values for each individual patient.

Assumption of normality of each variable was evaluated using the Shapiro-Wilk test. The majority of the variables were shown to have a normal distribution. Parametric tests were utilized to compare values between groups.

Week 1 vs. Week 2 ratings (for both facial attractiveness and perceived age) were compared using a paired samples t-test. T1 vs. T2 ratings (of the same patient) were compared using a paired samples t-test. Furthermore, for the perceived age variable, difference in perceived age between T1 and T2 of each patient was compared with actual elapsed time between T1 and T2 using a paired samples t-test. Mean values from orthodontists were compared with mean values from laypersons using a paired samples t-test. Statistical significance was set at $p<0.05$. Data analysis was performed using IBM SPSS Statistics® for Windows (Version 22.0, IBM Corp., Armonk NY). Inter-examiner reliability was confirmed by having the principal investigator measure each data point twice. If repeated measurements differed by 0.2mm or greater, the average of the two measurements was used for data analysis.

4. RESULTS

4.1 Descriptive Statistics and Tests for Normality

4.1.1 Facial Attractiveness Ratings (FAR)

The majority of variables for Facial Attractiveness Rating were shown to follow a normal distribution. For orthodontists, the repeated measures of the Shapiro-Wilk test (Table I) indicated that 17 out of 20 variables were normally distributed ($p>0.05$). For laypersons, 14 out of 20 variables were normally distributed, with all 6 non-normally distributed variables occurring in Week 1 (Table II). Parametric and non-parametric tests yielded similar quantitative results. Parametric test results will be presented in this report due to a sufficient sample size and greater statistical power.

TABLE I

FACIAL ATTRACTIVENESS RATINGS BY ORTHODONTISTS 1 TO 10 IN WEEKS 1 AND 2

INCLUDING TESTS FOR NORMALITY USING SHAPIRO-WILK

Subject	Mean	Std. Deviation	Min	Max	Range	95% Confidence Interval for Mean		Shapiro-Wilk		
						Lower	Lower	Statistic	df	P-value
WEEK 1 RESULTS										
Ortho1	44.8035	13.8990	12.00	70.20	58.20	35.7363	35.7363	0.988	34	0.962
Ortho2	46.3532	14.13521	17.20	69.60	52.40	41.4212	41.4212	0.961	34	0.253
Ortho3	42.6353	12.48946	24.40	66.80	42.40	38.2775	38.2775	0.946	34	0.095
Ortho4	31.5118	9.68750	14.00	55.70	41.70	28.1316	28.1316	0.984	34	0.893
Ortho5	47.7882	22.14510	11.50	82.00	70.50	40.0614	40.0614	0.938	34	0.052
Ortho6	46.4088	14.53210	17.40	70.50	53.10	41.3383	41.3383	0.956	34	0.183
Ortho7	44.3059	17.99566	8.10	72.80	64.70	38.0269	38.0269	0.954	34	0.163
Ortho8	35.8147	15.63245	11.10	57.90	46.80	30.3603	30.3603	0.880	34	0.001
Ortho9	27.4029	9.51084	10.60	55.70	45.10	24.0845	24.0845	0.961	34	0.253
Ortho10	59.4294	15.23456	34.60	93.20	58.60	54.1138	54.1138	0.945	34	0.088
WEEK 2 RESULTS										
Ortho1	34.1588	17.88285	0.20	79.00	78.80	27.9192	40.3984	0.938	34	0.52
Ortho2	46.8647	10.71145	27.10	67.50	40.40	43.1273	50.6021	0.966	34	0.351
Ortho3	40.9941	12.42880	19.60	64.30	44.70	36.6575	45.3307	0.955	34	0.170
Ortho4	27.2794	10.38188	12.50	53.20	40.70	23.6570	30.9018	0.942	34	0.072
Ortho5	48.7000	21.80817	10.70	83.50	72.80	41.0908	56.3092	0.945	34	0.088
Ortho6	47.4176	10.06008	27.50	68.40	40.90	43.9075	50.9278	0.967	34	0.390
Ortho7	45.5559	17.42289	14.20	77.00	62.80	39.4767	51.6350	0.947	34	0.097
Ortho8	34.1471	16.37748	6.40	61.30	54.90	28.4327	39.8614	0.922	34	0.019
Ortho9	26.3735	11.03672	10.50	57.10	46.60	22.5226	30.2244	0.934	34	0.041
Ortho10	56.8147	16.87335	24.30	87.00	62.70	50.9273	62.7021	0.946	34	0.092

TABLE II

FACIAL ATTRACTIVENESS RATING BY LAYPERSONS 1 TO 10 IN WEEKS 1 AND 2

INCLUDING TESTS FOR NORMALITY USING SHAPIRO-WILK

Subject	Mean	Std. Deviation	Min	Max	Range	95% Confidence Interval for Mean		Shapiro-Wilk		
						Lower	Lower	Statistic	df	p-value
WEEK 1 RESULTS										
Lay1	34.7853	15.94080	14.20	67.60	53.40	29.2233	40.3473	0.909	34	0.008
Lay2	38.8029	7.27651	23.40	50.00	26.60	36.2640	41.3418	0.929	34	0.029
Lay3	37.6059	21.18197	6.60	69.00	62.40	30.2151	44.9966	0.915	34	0.012
Lay4	60.5676	6.62771	46.00	77.10	31.10	58.2551	62.8802	0.988	34	0.969
Lay5	37.1324	10.80044	13.90	58.60	44.70	33.3639	40.9008	0.985	34	0.900
Lay6	28.8029	8.14436	12.40	44.20	31.80	25.9612	31.6446	0.976	34	0.643
Lay7	23.4882	15.55186	2.80	55.50	52.70	18.0619	28.9145	0.899	34	0.004
Lay8	31.0118	9.78675	20.30	65.70	45.40	27.5970	34.4265	0.799	34	0.000
Lay9	45.9471	11.29170	29.20	70.10	40.90	42.0072	49.8869	0.935	34	0.045
Lay10	37.0029	10.80994	12.60	59.50	46.90	33.2312	40.7747	0.987	34	0.943
WEEK 2 RESULTS										
Lay1	30.5088	16.10158	10.50	70.70	60.20	24.8907	36.1269	0.905	34	0.006
Lay2	37.8029	5.79903	24.40	49.50	25.10	35.7796	39.8263	0.916	34	0.012
Lay3	34.9735	21.08362	1.40	72.30	70.90	27.6171	42.3300	0.952	34	0.144
Lay4	62.7209	5.07532	53.90	73.30	19.40	60.9500	64.4917	0.958	34	0.209
Lay5	37.1000	11.68610	14.00	60.40	46.40	33.0225	41.1775	0.971	34	0.497
Lay6	35.9000	10.87048	17.00	57.80	40.80	32.1071	39.6929	0.949	34	0.114
Lay7	27.4029	11.92871	7.00	47.20	40.20	23.2408	31.5651	0.942	34	0.071
Lay8	30.3706	8.41627	15.60	44.20	28.60	27.4340	33.3072	0.950	34	0.120
Lay9	46.7382	13.68078	23.90	79.30	55.40	41.9648	51.5117	0.975	34	0.599
Lay10	37.2500	11.77082	13.40	62.40	49.00	33.1430	41.3570	0.979	34	0.733

4.1.2 Perceived Age Ratings (PAR)

The majority of variables for Perceived Age Rating were shown to follow a normal distribution. For orthodontists, the repeated measures of the Shapiro-Wilk test (Table III) indicated that 15 out of 20 variables were normally distributed (p>0.05). For laypersons, 15 out of 20 variables were normally distributed (Table IV). Parametric and non-parametric tests yielded similar quantitative results. Parametric test results will be presented in this report due to a sufficient sample size and greater statistical power.

TABLE III

PERCEIVED AGE RATING BY ORTHODONTISTS 1 TO 10 IN WEEKS 1 AND 2

INCLUDING TESTS FOR NORMALITY USING SHAPIRO-WILK

Subject	Mean	Std. Deviation	Min	Max	Range	95% Confidence Interval for Mean		Shapiro-Wilk		
						Lower	Lower	Statistic	df	P-value
WEEK 1 RESULTS										
Ortho1	42.7853	9.11486	16.80	53.70	36.90	39.6050	45.9656	0.895	34	0.003
Ortho2	36.7588	17.64815	11.30	74.00	62.70	30.6011	42.9166	0.946	34	0.091
Ortho3	28.5588	8.64723	12.30	49.40	37.10	25.5417	31.5760	0.977	34	0.681
Ortho4	26.0382	12.05518	10.30	50.80	40.50	21.8320	30.2445	0.899	34	0.004
Ortho5	27.5324	6.89610	14.10	42.90	28.80	25.1262	29.8385	0.971	34	0.476
Ortho6	28.0206	7.24325	13.10	47.10	34.00	25.4933	30.5479	0.986	34	0.930
Ortho7	35.7253	15.89330	11.40	79.50	68.10	30.1799	41.2707	0.964	34	0.315
Ortho8	29.0206	10.25227	11.00	57.70	46.70	25.4434	32.5978	0.950	34	0.126
Ortho9	40.0794	10.96349	27.70	62.90	35.20	40.0794	1.88022	0.881	34	0.002
Ortho10	27.1559	9.22478	5.20	53.40	48.20	23.9372	30.3746	0.979	34	0.736
WEEK 2 RESULTS										
Ortho1	45.9618	8.32947	28.20	57.80	29.60	43.0555	48.8681	0.888	34	0.002
Ortho2	34.6853	20.76653	2.90	73.10	70.20	27.4395	41.9311	0.948	34	0.105
Ortho3	26.9647	7.98889	13.10	53.40	40.30	24.1773	29.7522	0.944	34	0.083
Ortho4	25.4118	13.36122	5.40	66.60	61.20	20.7498	30.0737	0.880	34	0.001
Ortho5	31.9559	12.23465	14.30	57.70	43.40	27.6870	36.2248	0.954	34	0.166
Ortho6	24.5265	5.41016	13.30	33.30	20.00	22.6388	26.4142	0.955	34	0.179
Ortho7	38.2059	13.44788	9.50	62.00	52.50	33.5137	42.8981	0.971	34	0.476
Ortho8	31.9529	9.01800	16.60	49.60	33.00	28.8064	35.0995	0.962	34	0.283
Ortho9	48.4382	14.84326	26.90	74.30	47.40	43.2592	53.6173	0.915	34	0.011
Ortho10	26.9971	7.85989	9.70	49.40	39.70	24.2546	29.7395	0.971	34	0.497

TABLE IV

PERCEIVED AGE RATING BY LAYPERSONS 1 TO 10 IN WEEKS 1 AND 2

INCLUDING TESTS FOR NORMALITY USING SHAPIRO-WILK

Subject	Mean	Std. Deviation	Min	Max	Range	95% Confidence Interval for Mean		Shapiro-Wilk		
						Lower	Lower	Statistic	df	P-value
WEEK 1 RESULTS										
Lay1	25.9412	11.18384	7.30	51.80	44.50	22.0390	29.8434	0.973	34	0.551
Lay2	20.9912	7.73475	4.90	35.00	30.10	18.2924	23.6900	0.977	34	0.681
Lay3	32.9471	14.74240	5.60	56.80	51.20	27.8032	38.0909	0.951	34	0.132
Lay4	40.3471	17.28678	8.20	81.60	73.40	34.3154	46.3787	0.977	34	0.688
Lay5	42.8235	19.44785	7.80	82.70	74.90	36.0379	49.6092	0.971	34	0.495
Lay6	42.6559	17.18931	14.10	75.70	61.60	36.6582	48.6535	0.964	34	0.311
Lay7	24.7000	12.22794	5.60	58.20	52.60	20.4335	28.9665	0.906	34	0.007
Lay8	40.8676	13.30217	22.80	75.70	52.90	36.2263	45.5090	0.909	34	0.008
Lay9	30.1676	5.46109	19.70	38.90	19.20	28.2622	32.0731	0.935	34	0.043
Lay10	25.9912	11.04046	7.50	52.20	44.70	22.1390	29.8434	0.974	34	0.582
WEEK 2 RESULTS										
Lay1	25.3412	9.47862	2.70	41.20	38.50	22.0339	28.6484	0.967	34	0.373
Lay2	20.5000	7.35704	5.20	33.80	28.60	17.9330	23.0670	0.972	34	0.510
Lay3	31.3618	12.08365	12.90	51.70	38.80	27.1456	35.5779	0.937	34	0.510
Lay4	38.6912	18.39538	10.10	76.20	66.10	32.2727	45.1096	0.956	34	0.183
Lay5	40.1394	20.12052	9.30	82.60	73.30	33.1190	47.1598	0.962	34	0.286
Lay6	48.5618	16.76595	16.80	73.70	56.90	42.7118	54.4117	0.950	34	0.125
Lay7	25.3647	8.69235	11.30	43.90	32.60	22.3318	28.3976	0.898	34	0.004
Lay8	39.1324	14.49996	20.90	73.00	52.10	34.0731	44.1916	0.884	34	0.002
Lay9	28.1324	9.11292	7.20	48.90	41.70	24.9527	31.3120	0.981	34	0.789
Lay10	24.8735	8.39943	5.50	41.30	35.80	21.9428	27.8042	0.981	34	0.793

4.2 Reliability of Ratings between Week 1 and Week 2

For Facial Attractiveness Rating, paired sample t-tests showed that there were statistically significant mean differences ($p<0.05$) between Week 1 and Week 2 values within each evaluator in 4 out of 20 groups (Orthodontist 1, Orthodontist 4, Orthodontist 10, Layperson 6). (Table V)

For Perceived Age Rating, paired sample t-tests showed that there were statistically significant mean differences ($p<0.05$) between Week 1 and Week 2 values within each evaluator in 4 out of 20 groups (Orthodontist 5, Orthodontist 6, Orthodontist 8, Orthodontist 9). (Table VI)

TABLE V

INTRA-EVALUATOR RELIABILITY IN FACIAL ATTRACTIVENESS RATING BETWEEN WEEKS 1 AND 2 IN ORTHODONTISTS AND LAYPERSONS BY PAIRED SAMPLES T-TEST

Descriptive Statistics / Paired Variables	Mean Difference	Std. Deviation	95% Confidence Interval of the Mean Difference		t	df	P-value (2-tailed)
			Lower	Upper			
Orthodontists							
Ortho1 (Week 1 - Week 2)	6.42353	9.05147	3.26532	9.58174	4.138	33	0.000
Ortho2 (Week 1 - Week 2)	-0.51147	8.47619	-3.46895	2.44601	-0.352	33	0.727
Ortho3 (Week 1 - Week 2)	1.64118	4.83015	-0.04414	3.32650	1.981	33	0.056
Ortho4 (Week 1 - Week 2)	4.23235	7.30470	1.68362	6.78108	3.378	33	0.002
Ortho5 (Week 1 - Week 2)	-0.91176	4.59412	-2.51473	0.69120	-1.157	33	0.255
Ortho6 (Week 1 - Week 2)	-1.00882	10.10902	-4.53603	2.51838	-0.582	33	0.565
Ortho7 (Week 1 - Week 2)	-1.25000	9.35992	-4.51583	2.01583	-0.779	33	0.442
Ortho8 (Week 1 - Week 2)	1.66765	10.48166	-1.98958	5.32487	0.928	33	0.360
Ortho9 (Week 1 - Week 2)	1.02941	7.78836	-1.68807	3.74690	0.771	33	0.446
Ortho10 (Week 1 - Week 2)	2.61471	7.22756	0.09289	5.13652	2.109	33	0.043
Laypersons							
Lay1 (Week 1 - Week 2)	4.27647	15.48734	-1.12732	9.68026	1.61	33	0.117
Lay2 (Week 1 - Week 2)	1.00000	9.46576	-2.30276	4.30276	0.616	33	0.542
Lay3 (Week 1 - Week 2)	2.63235	17.33699	-3.41681	8.68152	0.885	33	0.382
Lay4 (Week 1 - Week 2)	-2.15324	8.52394	-5.12738	0.82091	-1.473	33	0.150
Lay5 (Week 1 - Week 2)	0.03235	3.31294	-1.12359	1.18829	0.057	33	0.955
Lay6 (Week 1 - Week 2)	-7.09706	10.1894	-10.6523	-3.54181	-4.061	33	0.000
Lay7 (Week 1 - Week 2)	-3.91471	12.40162	-8.24183	0.41242	-1.841	33	0.075
Lay8 (Week 1 - Week 2)	0.64118	9.04538	-2.51491	3.79726	0.413	33	0.682
Lay9 (Week 1 - Week 2)	-0.79118	12.96691	-5.31555	3.73319	-0.356	33	0.724
Lay10 (Week 1 - Week 2)	0.24706	2.63913	-1.16789	0.67378	-0.546	33	0.589

TABLE VI

INTRA-EVALUATOR RELIABILITY IN PERCEIVED AGE RATING BETWEEN WEEKS 1 AND 2 IN ORTHODONTISTS AND LAYPERSONS BY PAIRED SAMPLES T-TEST

Descriptive Statistics / Paired Variables	Mean Difference	Std. Deviation	95% Confidence Interval of the Mean Difference		t	df	P-value (2-tailed)
			Lower	Upper			
Orthodontists							
Ortho1 (Week 1 - Week 2)	-3.17647	9.60051	-6.52625	0.17330	-1.929	33	0.062
Ortho2 (Week 1 - Week 2)	2.07353	12.11816	-2.15470	6.30176	0.998	33	0.326
Ortho3 (Week 1 - Week 2)	1.59412	4.64360	-0.02611	3.21435	2.002	33	0.054
Ortho4 (Week 1 - Week 2)	0.62647	8.92356	-2.48711	3.74005	0.409	33	0.685
Ortho5 (Week 1 - Week 2)	-4.42353	9.70505	-7.80978	-103728	-2.658	33	0.012
Ortho6 (Week 1 - Week 2)	3.49412	5.20081	1.67947	5.30877	3.917	33	0.000
Ortho7 (Week 1 - Week 2)	-2.48059	8.28325	-5.37075	0.40957	-1.746	33	0.090
Ortho8 (Week 1 - Week 2)	-2.93235	8.07228	-5.74890	-0.11580	-2.118	33	0.042
Ortho9 (Week 1 - Week 2)	-8.35882	12.08393	-12.57510	-4.14254	-4.033	33	0.000
Ortho10 (Week 1 - Week 2)	0.15882	5.16504	-1.64334	1.96099	0.179	33	0.859
Laypersons							
Lay1 (Week 1 - Week 2)	0.6	10.98155	-3.23165	4.43165	0.319	33	0.752
Lay2 (Week 1 - Week 2)	0.49118	1.89087	-0.16858	1.15093	1.515	33	0.139
Lay3 (Week 1 - Week 2)	1.58529	10.34294	-2.02353	5.19412	0.894	33	0.378
Lay4 (Week 1 - Week 2)	1.65588	9.0688	-1.50837	4.82014	1.065	33	0.295
Lay5 (Week 1 - Week 2)	2.68412	14.92774	-2.52442	7.89265	1.048	33	0.302
Lay6 (Week 1 - Week 2)	-5.90588	17.34449	-11.9577	0.1459	-1.985	33	0.055
Lay7 (Week 1 - Week 2)	-0.66471	7.78351	-3.3805	2.05109	-0.498	33	0.622
Lay8 (Week 1 - Week 2)	1.73529	14.06685	-3.17286	6.64345	0.719	33	0.477
Lay9 (Week 1 - Week 2)	2.03529	8.27658	-0.85254	4.92313	1.434	33	0.161
Lay10 (Week 1 - Week 2)	1.11765	8.18341	-1.73768	3.97297	0.796	33	0.432

4.3 Differences between Initial (T1) vs. Post-Treatment (T2) Ratings

For Facial Attractiveness Rating, paired sample t-tests showed that there were statistically significant mean differences (p<0.05) between T1 and T2 for 10 out of 10 orthodontists sampled. For laypersons, 6 out of 10 displayed statistically significant mean differences (p<0.05) between T1 and T2 (Table VII).

For Perceived Age Rating, paired sample t-tests showed that there were statistically significant mean differences (p<0.05) between T1 and T2 for 5 out of 10 orthodontists. All laypersons sampled (10 out of 10) displayed statistically significant mean differences (p<0.05) between T1 and T2 (Table VIII).

TABLE VII

DIFFERENCES IN FACIAL ATTRACTIVENESS RATING BETWEEN INITIAL (T1) TO POST-SURGERY (T2) IN ORTHODONTISTS AND LAYPERSONS BY PAIRED SAMPLES T-TEST

Descriptive Statistics / Paired Variables	Mean Difference	Std. Deviation	95% Confidence Interval of the Mean Difference		t	df	P-value (2-tailed)
			Lower	Upper			
Orthodontists							
Ortho1 (T1 - T2)	-21.2118	16.72013	-29.8085	-12.6151	-5.231	16	0.000
Ortho2 (T1 - T2)	-11.1003	12.07523	-17.3088	-4.89178	-3.79	16	0.002
Ortho3 (T1 - T2)	-11.8118	13.68203	-18.8464	-4.77711	-3.559	16	0.003
Ortho4 (T1 - T2)	-6.78529	8.15858	-10.9801	-2.59054	-3.429	16	0.003
Ortho5 (T1 - T2)	-36.6059	17.31724	-45.5096	-27.7022	-8.716	16	0.000
Ortho6 (T1 - T2)	-10.2324	11.69177	-16.2437	-4.221	-3.608	16	0.002
Ortho7 (T1 - T2)	-26.2441	12.23968	-32.5372	-19.9511	-8.841	16	0.000
Ortho8 (T1 - T2)	-24.45	13.47055	-31.3759	-17.5241	-7.484	16	0.000
Ortho9 (T1 - T2)	-5.76471	8.90903	-10.3453	-1.1841	-2.668	16	0.017
Ortho10 (T1 - T2)	-19.1853	12.52636	-25.6258	-12.7448	-6.315	16	0.000
Laypersons							
Lay1 (T1 - T2)	-15.9529	16.70256	-24.5406	-7.36528	-3.938	16	0.001
Lay2 (T1 - T2)	-3.20588	5.98621	-6.2837	-0.12806	-2.208	16	0.042
Lay3 (T1 - T2)	-25.9794	22.96941	-37.7892	-14.1696	-4.663	16	0.000
Lay4 (T1 - T2)	-1.48265	4.90453	-4.00433	1.03903	-1.246	16	0.231
Lay5 (T1 - T2)	-5.53235	13.05361	-12.2439	1.1792	-1.747	16	0.100
Lay6 (T1 - T2)	-5.42647	9.21115	-10.1624	-0.69053	-2.429	16	0.027
Lay7 (T1 - T2)	-13.4618	13.50204	-20.4039	-6.51965	-4.111	16	0.001
Lay8 (T1 - T2)	-10.4294	6.88306	-13.9684	-6.89047	-6.247	16	0.000
Lay9 (T1 - T2)	-3.72059	11.99744	-9.8891	2.44792	-1.279	16	0.219
Lay10 (T1 - T2)	-5.71176	13.26404	-12.5315	1.10798	-1.775	16	0.095

TABLE VIII

DIFFERENCES IN PERCEIVED AGE RATING BETWEEN INITIAL (T1) TO POST-SURGERY (T2) IN ORTHODONTISTS AND LAYPERSONS BY PAIRED SAMPLES T-TEST

Descriptive Statistics / Paired Variables	Mean Difference	Std. Deviation	95% Confidence Interval of the Mean Difference		t	df	P-value (2-tailed)
			Lower	Upper			
Orthodontists							
Ortho1 (T1 - T2)	-0.72647	8.00676	-4.84317	3.39022	-0.374	16	0.713
Ortho2 (T1 - T2)	-8.35588	18.96988	-18.1093	1.39753	-1.816	16	0.088
Ortho3 (T1 - T2)	-7.02353	7.60348	-10.9329	-3.11418	-3.809	16	0.002
Ortho4 (T1 - T2)	-10.2971	9.17307	-15.0134	-5.5807	-4.628	16	0.000
Ortho5 (T1 - T2)	-3.88235	8.40848	-8.20559	0.44089	-1.904	16	0.075
Ortho6 (T1 - T2)	-3.13529	4.84751	-5.62765	-0.64293	-2.667	16	0.017
Ortho7 (T1 - T2)	-6.49	15.97419	-14.7032	1.72317	-1.675	16	0.113
Ortho8 (T1 - T2)	-10.3618	7.97448	-14.4619	-6.26166	-5.357	16	0.000
Ortho9 (T1 - T2)	-9.71765	9.84484	-14.7794	-4.6559	-4.07	16	0.001
Ortho10 (T1 - T2)	-1.79412	11.38042	-7.64539	4.05716	-0.65	16	0.525
Laypersons							
Lay1 (T1 - T2)	-5.58529	9.31437	-10.3743	-0.79629	-2.472	16	0.025
Lay2 (T1 - T2)	-4.36176	8.00813	-8.47917	-0.24436	-2.246	16	0.039
Lay3 (T1 - T2)	-12.4353	13.22725	-19.2361	-5.63447	-3.876	16	0.001
Lay4 (T1 - T2)	-14.3912	16.52793	-22.8891	-5.8933	-3.59	16	0.002
Lay5 (T1 - T2)	-15.3688	16.87519	-24.0452	-6.6924	-3.755	16	0.002
Lay6 (T1 - T2)	-11.1441	15.24584	-18.9828	-3.30543	-3.014	16	0.008
Lay7 (T1 - T2)	-5.22059	9.54134	-10.1263	-0.31488	-2.256	16	0.038
Lay8 (T1 - T2)	-7.57941	13.69742	-14.622	-0.53685	-2.282	16	0.037
Lay9 (T1 - T2)	-3.50294	6.06314	-6.62032	-0.38556	-2.382	16	0.030
Lay10 (T1 - T2)	-5.13235	8.11932	-9.30692	-0.95778	-2.606	16	0.019

4.4 Perceived Age Change vs. Actual Age Change for Individual Evaluators

Separate paired sample t-tests for each individual evaluator showed that there were statistically significant mean differences ($p<0.05$) between perceived and actual age differences for 5 out of 10 orthodontists (Orthodontist 1, Orthodontist 3, Orthodontist 5, Orthodontist 6, Orthodontist 10) and 4 out of 10 laypersons (Layperson 2, Layperson 7, Layperson 9, Layperson 10) (Table IX).

TABLE IX

DIFFERENCES IN PERCEIVED AGE CHANGE VERSUS ACTUAL TIME RELAPSED BETWEEN INITIAL (T1) TO POST-SURGERY (T2) IN ORTHODONTISTS AND LAYPERSONS BY PAIRED SAMPLES T-TEST

Descriptive Statistics / Paired Variables	Mean Difference	Std. Deviation	95% Confidence Interval of the Mean Difference		t	df	P-value (2-tailed)
			Lower	Upper			
Orthodontists							
Ortho1 (Perceived - Actual)	-9.81059	8.69403	-14.2806	-5.34053	-4.653	16	0.000
Ortho2 (Perceived - Actual)	-2.18118	19.33654	-12.1231	7.76075	-0.465	16	0.648
Ortho3 (Perceived - Actual)	-3.51353	6.6415	-6.92827	-0.09879	-2.181	16	0.044
Ortho4 (Perceived - Actual)	-0.24	9.62035	-5.18633	4.70633	-0.103	16	0.919
Ortho5 (Perceived - Actual)	-6.65471	8.42344	-10.9856	-2.32377	-3.257	16	0.005
Ortho6 (Perceived - Actual)	-7.40176	6.12849	-10.5528	-4.25078	-4.98	16	0.000
Ortho7 (Perceived - Actual)	-4.04706	15.81778	-12.1798	4.08569	-1.055	16	0.307
Ortho8 (Perceived - Actual)	-0.17529	8.59048	-4.59211	4.24152	-0.084	16	0.934
Ortho9 (Perceived - Actual)	-0.81941	10.56583	-6.25186	4.61304	-0.32	16	0.753
Ortho10 (Perceived - Actual)	-8.74294	12.12206	-14.9755	-2.51036	-2.974	16	0.009
Laypersons							
Lay1 (Perceived; Actual)	-4.95176	10.22883	-10.2109	0.30741	-1.996	16	0.063
Lay2 (Perceived - Actual)	-6.17529	9.01545	-10.8106	-1.53998	-2.824	16	0.012
Lay3 (Perceived - Actual)	1.89824	12.98935	-4.78027	8.57674	0.603	16	0.555
Lay4 (Perceived - Actual)	3.85412	16.31972	-4.53671	12.24494	0.974	16	0.345
Lay5 (Perceived - Actual)	4.83176	16.97485	-3.8959	13.55942	1.174	16	0.258
Lay6 (Perceived - Actual)	0.60706	15.00751	-7.10909	8.32321	0.167	16	0.870
Lay7 (Perceived - Actual)	-5.31647	9.32072	-10.1087	-0.5242	-2.352	16	0.032
Lay8 (Perceived - Actual)	-2.95765	14.57868	-10.4533	4.53802	-0.836	16	0.415
Lay9 (Perceived - Actual)	-7.03412	7.92122	-11.1068	-2.9614	-3.661	16	0.002
Lay10 (Perceived - Actual)	-5.40471	9.3898	-10.2325	-0.57692	-2.373	16	0.030

4.5 Mean Perceived Age Change vs. Actual Time Elapsed between T1 and T2

For orthodontists, the mean perceived age difference between T1 and T2 was 6.17mm, equivalent to 1.85 years. For laypersons, the mean perceived age difference between T1 and T2 was 8.47mm, equivalent to 2.54 years. The mean actual age difference between T1 and T2 was 10.54mm, equivalent to 3.16 years.

Both orthodontists and laypersons showed negative values for mean age difference, meaning that perceived age difference between T1 and T2 in both of these groups was *less* than the actual age change. However, only orthodontists (p=0.022), and not laypersons (p=0.306), showed a statistically significant difference between mean perceived age difference and actual age difference. (Table X)

TABLE X

MEAN PERCEIVED AGE CHANGE VERSUS MEAN ACTUAL TIME RELAPSED BETWEEN INITIAL (T1) TO POST-SURGERY (T2) IN ORTHODONTISTS AND LAYPERSONS BY PAIRED SAMPLES T-TEST

Descriptive Statistics / Paired Variables	Mean Difference	Std. Deviation	95% Confidence Interval of the Mean Difference		t	df	P-value (2-tailed)
			Lower	Upper			
Orthodontists (Ortho1, … Ortho10)							
Mean Perceived Age Change - Actual Age Change	-4.35865	7.0667	-7.99201	-0.72529	-2.543	16	0.022
Laypersons (Lay1, … Lay10)							
Mean Perceived Age Change - Actual Age Change	-2.06488	8.04295	-6.20019	2.07042	-1.059	16	0.306

4.6 Mean Facial Attractiveness Rating change between T1 and T2

TABLE XI

DESCRIPTION OF MEAN FACIAL ATTRACTIVENESS CHANGE BETWEEN T1 AND T2 BROKEN DOWN BY EVALUATOR SUBGROUP

	Mean FA Rating at T1	Mean FA Rating at T2	Mean Change T2-T1	Mean % Change
Orthodontists	32.86	50.19	17.33	52.7%
Laypersons	33.25	42.34	9.09	27.3%

4.7 Total Orthodontist Ratings vs. Total Laypersons Ratings

Taking into aggregate all data values for Facial Attractiveness Rating, orthodontists gave a mean value of 41.52, compared with 37.77 for laypersons. Pairwise comparisons were made, resulting in a mean FAR difference between orthodontists and laypersons of +3.75, which was statistically significant (p=0.003).

Taking into aggregate all data values for Perceived Age Rating, orthodontists gave a mean value of 33.08, compared with 32.60 for laypersons. Pairwise comparisons were made, resulting in a mean PAR difference between orthodontists and laypersons of +0.047, which was *not* statistically significant (p=0.546). (Table XII)

TABLE XII

COMPARATIVE ANALYSIS OF FACIAL ATTRACTIVENESS RATINGS AND PERCEIVED AGE RATINGS GIVEN BY ORTHODONTISTS VERSUS LAYPERSONS BY PAIRED SAMPLES T-TEST

Descriptive Statistics / Paired Variables	Mean Difference	Std. Deviation	95% Confidence Interval of the Mean Difference		t	df	P-value (2-tailed)
			Lower	Upper			
Facial Attractiveness							
Orthodontists - Laypersons	3.74686	6.83067	1.40044	6.09327	3.245	34	0.003
Perceived Age							
Orthodontists - Laypersons	0.47417	4.60477	-1.10762	2.05597	0.609	34	0.546

5. DISCUSSION

5.1 Evaluators

Each of the 20 evaluators examined all 34 composite photographs twice, with one week between each viewing, to assess for intra-evaluator reliability. Consistency amongst Week 1 and Week 2 ratings was high, with 16 out of 20 evaluators displaying no statistically significant differences between timepoints for both assessed variables (facial attractiveness rating and perceived age). Between the evaluator subgroups, laypersons actually displayed greater consistency than orthodontists in both Facial Attractiveness and Perceived Age evaluations; only 1 out of 20 laypersons evaluations (Layperson 6; facial attractiveness score) exhibited statistically significant differences between weeks, compared with 7 out of 20 evaluations in the orthodontist group.

5.2 Testing Hypotheses

Null hypothesis #1: *There is no difference in facial attractiveness in patients before and after orthodontic surgical orthodontic treatment.*

Comparing data between T1 and T2, we can observe a very strong positive increase in FA ratings after surgery (Table VII). 10 out of 10 orthodontists displayed statistically significant differences between initial and post-surgical timepoints. Mean values for T1 – T2 for all orthodontists were negative, indicating that average FA ratings for all patients significantly improved after orthognathic surgery (T2). On the other hand, 6 out of 10 laypersons showed statistically significant differences between T1 and T2. Even for the 4 laypersons with non-significant differences, however, the mean difference values were (similar to the orthodontists) all negative values for T1-T2. This demonstrates that average FA ratings for all laypersons improved after orthognathic surgery. We can *reject* this null hypothesis and conclude that there is a significant difference (positive change) in facial attractiveness in patients before and after surgical orthodontics (for both orthodontists and laypersons).

__Null hypothesis #2__: *There is no difference between perceived age change and actual age change in patients before and after surgical orthodontic treatment.*

Comparing perceived age between T1 and T2, we can see that 5 out of 10 orthodontists and 10 out of 10 laypersons showed statistically significant differences between T1 and T2 ($p<0.05$) (Table VIII). This suggests that for our sample of evaluators, the laypersons group not only gave more consistent ratings between Week 1 and Week 2 (refer to above section on evaluator reliability), they were also more accurate in differentiating patient ages at two different timepoints. Even though 5 orthodontists showed insignificant differences in age rating between T1 and T2, all average values for T1 – T2 for these five evaluators were negative, meaning that these evaluators were still correct in assessing patients as being older in their post-surgical photos than their pre-treatment photos. Comparing the above perceived age values with actual elapsed time between T1 and T2 photos (Table IX), orthodontists displayed a significant difference between mean perceived age change and mean actual age change ($p=0.022$), while laypersons did not ($p=0.306$). We can thus *reject* our null hypothesis for orthodontists, but *accept* it for laypersons. In addition, the mean perceived age change for both orthodontists and laypersons was *less* than the actual time elapsed between T1 and T2. This suggests that in general, orthognathic surgery caused the evaluator groups to perceive the patients as appearing more youthful than through natural aging. These results substantiate the fact that perception of age is a very complex and intricate variable, and it is a much less consistent measure for evaluators than facial attractiveness.

5.3 Limitations and Future Directions

This investigation, along with the majority of related studies on quantifying facial attractiveness, are retrospective in nature. Compared with prospective studies, retrospective studies have disadvantages including inferior experimental designs and the lack of explicit control groups. Prospective studies with adequate sample sizes with clearly differentiated patient groups (1-jaw, 2-jaw, genioplasty performed or not) are needed in the future.

One source of experimental error that we propose lies in the variations in hair styles, length, and color amongst all of the composite photographs, even within the same individual. According to Meskó and Bereczkei (2005), hair is an extremely important component of facial attractiveness. Evolutionary psychologists have theorized that having long, healthy, shiny hair can communicate the health and vigor of an individual. A person who is malnourished may have thin, brittle, weak or missing hair compared to one who has shiny, thick hair who might be perceived as healthy (Cunningham & Hunt, 2001). We have not standardized or selected for hair quality in this study, since altering this could significantly alter evaluators' perceptions of the patient's natural facial proportions. This is one advantage that silhouette studies or studies involving computer-altered images would have, as the confounding effects of hair appearance can be eliminated.

In a similar vein, differences in eye makeup in composite comparison studies, or simply differences in makeup application amongst the patients within this study, could have potentially caused another confounding factor in judging treatment effects. This was not an issue in this study, however, as the de-identification of patient identity through black boxes effectively eliminated the eyes and periorbital region from impacting evaluator ratings.

All of the patients used for this study were presented to evaluators as static colored photographs in three common views: frontal at rest, frontal on smiling, and profile. While Howells et al. (1985) have demonstrated a strong correlation between assessments made on live subjects and those made from standardized photographic records, other studies suggest otherwise. A problem with live photographs that Phillips et al. (1992) found in a visual analog scale study of 18 orthodontic patients was that perception of attractiveness can be considerably affected by the view presented, even among the same patient, and that ratings differed significantly among the three views in 80% of patients. Furthermore, Cochrane et al. (1997) have suggested that non-dental professionals rarely notice the profile view of an individual unless they view it in a photograph. Laypersons may also focus more on other facial features including hairstyles, skin complexion, or makeup. An alternative method to explore could be to use 3D imaging systems such as 3dMD, which recent studies by Bassel et al. (2015) and Wittig et al. (2015) have shown to be well-correlated with viewing patients in real life in terms of accuracy and reproducibility. Evaluating patients through 3D imaging systems would also eliminate a systematic error of different patient postures and head positions in static images and its effects on evaluator ratings (Hong et al., 2017).

A comparison of means between pre-surgical (T1) and post-surgical (T2) data showed a statistically significant improvement in facial attractiveness ($p<0.05$) (Table XI). On average, facial attractiveness ratings given by orthodontists improved by 17.33, or 52.7% between T1 and T2. For laypersons, facial attractiveness ratings improved by a lesser extent on average, by 9.09mm, or 27.3%. This difference in average facial attractiveness rating between orthodontists and laypersons was statistically significant ($p=0.003$). This suggests that orthodontists may be more discerning on noticing significant changes in the dentofacial skeleton as a result of treatment. This can be a cumulative result from years of education focused on the minute details of hard and soft tissue parameters involving the lips, chin, and midface.

With regards to perceived age, we found that on average both orthodontists and laypersons perceived the time elapsed between pre-surgical (T1) and post-surgical (T2) photographs as less than the actual elapsed time (Table X). Orthodontists on average perceived the time elapsed as 41.4% less than the actual time elapsed between pre-surgical and postsurgical photos, a difference that was statistically significant ($p=0.022$). Laypersons on average perceived the time elapsed as only 19.6% less than the actual time elapsed between T1 and T2. Contrary to the orthodontists, this difference was not statistically significant ($p=0.546$), suggesting that laypersons are actually quite adept at evaluating the age of patients in the photographs presented. This is in agreement with others studies that orthodontists may not actually be better at discerning age differences in photographs (Dindaroğlu, Ertan Erdinç, & Doğan, 2016). Through evolution, humans as a whole have developed an amazing ability to be able to recognize, remember, evaluate and distinguish between other human faces. It is an evolutionary adaptation to be able to evaluate faces in an objective manner, not a skill specific to dental professionals alone.

Another potential source of error in measurements is the difference in lighting and resolution of composite photos. Since both photographs between different patients and within the same patient at the two timepoints may have been taken with a different camera with varying camera settings and different lighting conditions, this could have a significant impact on the observer judgments. An evaluator looking at a well-lit, high resolution photograph without any distracting shadows may potentially be inclined to give a higher attractiveness score. With regards to image resolution, while the majority of photographs were taken with modern DSLR (digital single lens reflex) cameras, several of the photographs were taken with point-and-shoot cameras. Photographs taken with lower resolutions could be distracting for the evaluators and possibly result in inadvertent lowering of scores. Investigators in this study, however, believe that the effects of this discrepancy in image resolution was negated because the photographs were all condensed and printed onto a 8.5x11" paper, which diminished the pixel-per-inch (ppi) difference among high-quality and low-quality photographs. A suggestion for controlling for this confounding factor in future studies, aside from using the same camera and settings for all images, would be to standardize the dpi for all images to the lowest-quality image available.

It should be noted that while both orthodontists and laypersons were consistently correct in their assessment of post-surgical images as being older than their pre-surgical equivalents, we cannot infer any causal relationship with the effects orthognathic treatment versus the patients simply aging normally. Future studies should introduce a control group of non-treated patients to be assessed in order to better analyze the direct effects of surgical orthodontics on the measured parameters. In addition, all surgeries were performed by the same oral surgeon, which may have resulted in a systematic misrepresentation of typical orthognathic surgery results. Followup studies should investigate patients treated by a larger number of surgeons with diverse training backgrounds and varied years of surgical experience.

In a similar manner, we could not by the current design isolate the effects of orthognathic surgery alone on the patient's esthetics. Since pre-surgical (T1) photos were taken before any patients had orthodontic appliances initially placed, it is hard to quantity how much of the observed facial attractiveness improvement between T1 and T2 was from orthognathic surgery or simply from correcting dental misalignment. An alternative study design was proposed to use immediate pre-surgical photographs as the T1 image. Since these patients would have their teeth leveled and aligned, however investigators ultimately decided against this method due to the fact that all immediate pre-surgical photographs would display patients while having orthodontic appliances visible, which could significant skew facial attractiveness ratings. Furthermore, using immediate pre-surgical photographs would present patients in a dentally decompensated situation, often with worsened underbites, which would not be representative of what they would look like if they simply avoided treatment to begin with.

Often individuals with dentofacial deformities also exhibit a significant degree of facial asymmetry, which alone is a significant factor in determining facial attractiveness. The degree of pre-surgical asymmetry in each patient was not controlled for in this study. Since orthognathic surgery typically corrects or drastically improves facial symmetry, we must accept that the lack of control on the pre-existing facial asymmetry of each patient could have been a confounding factor to pre-surgical versus post-surgical results.

It could be expected that male and female evaluators might give different ratings from one another (Garza, Heredia, & Cieslicka, 2016). Although this study did not investigate the relationship between gender of the evaluators on their given ratings due to a relatively small sample size to each group, we did attempt to minimize effects of gender differences by studying an equal number of male (5 male orthodontists, 5 male laypersons) and females (5 female orthodontists, 5 female laypersons) evaluators.

6. CONCLUSION

This study explored the effects of surgical orthodontics on the perception of facial attractiveness and perceived age of 17 surgical patients with concave profiles. A 100mm visual analog scale was used to quantify evaluations from 10 orthodontists and 10 laypersons in two separate sittings.

The results of this study confirm that while minute variations are present between individuals on what is considered to be attractive, a general acceptance of what comprises an attractive face does exist. Ratings from orthodontists and laypersons showed average post-surgical attractiveness improvements of 52.7% and 27.3%, respectively. Significant changes in skeletal form, such as those produced from orthognathic correction of dentofacial deformities, were shown to produce consistently better attractiveness ratings from evaluators. Perceived patient age, on the other hand, is a variable that is inconsistently rated, hard to predict, and had a high variance among assessments. No significant changes in the perception of age were found to occur as a result of treatment. Isolating the effects of surgical treatment on perceived age from the natural aging process is a challenging endeavor.

In contemporary biological models, variation should be expected, and the “facial ideal” that Angle strived for is much more so the exception than the rule. The continual shift in focus to achieve esthetic ideals has placed enhanced emphasis on clinical examination of soft tissue conditions than ever before. Orthodontists should always plan treatment within the patient's unique soft tissue contours, as they define the functional, stability-related and esthetic limitations of orthodontic treatment. Furthermore, dental professionals need to look beyond objective measurements of treatment success and consider how the patient perceives his/her own appearance. Only by managing the psychosocial component of the patient along with achieving traditional treatment objectives can orthodontic treatment be deemed a success.

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APPENDICES

Appendix A

This study was approved by the Office for the Protection of Research Subjects of the University of Illinois at Chicago as having met the criteria for exemption as defined in the U.S. Department of Health and Human Services Regulations for the Protection of Human Subjects (Research Protocol #2018-0885).

UIC

Exemption Granted

July 30, 2018

Harrison Siu
Orthodontics
Phone: (585) 200-9351

RE: Research Protocol # 2018-0885
"Impact of Orthognathic Surgery on Facial Attractiveness and Perceived Age"

Dear Dr. Siu:

Your Claim of Exemption was reviewed on July 30, 2018 and it was determined that your research protocol meets the criteria for exemption as defined in the U. S. Department of Health and Human Services Regulations for the Protection of Human Subjects [(45 CFR 46.101(b)]. You may now begin your research.

Exemption Period:	**July 30, 2018 – July 29, 2021**
Subject Enrollment #:	50 (retrospective review)
Performance Sites:	UIC
Sponsor:	None

Appendix B

TABLE XIII

RAW DATA. ORTHODONTISTS FACIAL ATTRACTIVENESS RATINGS OUT OF 100 (WEEK 1)

Composite #	Ortho1	Ortho2	Ortho3	Ortho4	Ortho5	Ortho6	Ortho7	Ortho8	Ortho9	Ortho10
1	44.5	30	29.7	24.1	40.9	32	32.7	43.6	22.1	66.3
2	24.9	23.5	25.6	24.5	28.4	22.4	27.9	13.2	22.5	43.2
3	12	33.6	49	47.5	33.9	31.1	33.6	11.1	43.3	54.7
4	35.8	56.2	48.9	29.3	20.2	58.8	49.2	20.6	19.4	38.7
5	64.9	62.21	60.8	46.4	61.6	60.9	66.4	38.3	30.3	84.2
6	34.5	32.6	24.4	24.5	11.5	28.6	35	13.9	17.7	34.6
7	23.5	39.6	29.1	14	16.2	41.3	8.1	17.1	13	56.4
8	33.5	39.3	43.3	18.9	45.8	40.4	34.9	16.1	16.5	56.7
9	58.5	58	47.3	36.4	71.4	57	62.4	52	29.4	93.1
10	36.7	61.6	34.7	38.2	59.3	60.8	53.3	43	30.2	56.9
11	32.1	64.1	58.4	46.4	79.8	65.5	61.2	57.9	31.5	57.3
12	25.2	41.3	27.4	26.4	19.7	41.6	26.1	23.8	27.4	49.6
13	70.2	61.5	60.9	40.1	76.1	62.4	68.8	57.9	30.7	63.6
14	54.3	44.5	50.8	32	62.8	44.5	68.3	47.9	28	50.9
15	45.1	34.1	32.5	31.2	57.8	36.1	63.9	42.5	28.2	62
16	49.8	32.3	44.3	21.5	51.2	26.1	45.8	54.5	20.5	48.1
17	43.1	52.9	41.1	36.8	41.6	52.9	40	42.2	32.8	63.3
18	30.7	39.8	28.7	26.4	15.9	40.4	29.8	46.5	12.5	35.6
19	40.4	22	29.2	15.6	52.6	23	16.6	49.4	10.6	59.3
20	59.8	55.7	61.1	55.7	78.1	56.4	68.9	52.1	55.7	93.2
21	24.6	37	28.6	26	36.3	36.6	37.6	16.1	22	58
22	53.5	52.2	42.9	33.7	79.6	52.2	52.4	48.5	23.7	87.3
23	51.4	49.8	26.2	17.2	62.1	50.2	49.8	48.7	15.4	49.1
24	31.5	59.7	63	21	21.4	58	27.6	45.8	21	68.9
25	47.5	61.2	66.8	29.7	82	60.5	49.3	48.6	29.7	76.4
26	24.6	30	39.2	31.2	52.6	29.6	24.3	29.3	26.7	58.6
27	15.9	17.2	38.3	30.7	34.8	17.4	19.3	12.6	30.7	43.7
28	49.1	55.5	52.1	35.1	73.1	55.8	54.4	34.2	29.2	50.8
29	37.9	67.8	38.6	36	22.5	66.9	20.9	12.3	38	48.8
30	51.1	69.6	56.3	41.5	70.3	70.5	68.6	42.5	40.6	80.4
31	52.6	46	52	38.7	46.2	47	72.8	39.1	38.7	68.1
32	31.2	37.9	36.4	29	22.9	38.1	31.1	12.2	28	51.3
33	47.4	58.2	46.2	27.2	68.6	60.7	61.2	46.5	28.2	64.5
34	42	49.1	35.8	38.5	27.6	52.2	44.2	37.7	37.5	47

TABLE XIV

RAW DATA. ORTHODONTISTS FACIAL ATTRACTIVENESS RATINGS OUT OF 100 (WEEK 2)

Composite #	Ortho1	Ortho2	Ortho3	Ortho4	Ortho5	Ortho6	Ortho7	Ortho8	Ortho9	Ortho10
1	39.1	52.8	26.6	22.9	45	57.9	40.1	44.6	21.9	55
2	25.5	28.8	22.5	12.5	28.5	30.7	14.2	7.2	10.5	27.3
3	0.2	44	53	38.2	34.9	44.1	35.8	14	34.2	45.7
4	33.6	48.1	51.5	28.1	21.6	49.3	31.9	24.4	27.3	40
5	79	51.8	60.5	32.2	61.7	49.8	74.3	51.4	24.2	85.8
6	23.1	30.8	21.5	16.6	10.7	30.7	31.8	19.8	15.6	31.4
7	12.3	38.2	19.6	16.9	18.4	38.2	29.1	6.4	17	51.3
8	26.4	32.1	46.7	16.4	57.7	44.7	20.8	34.5	16.4	60.1
9	65.9	55.2	45.1	21.6	80.3	55.2	57.5	48.7	17.4	83.2
10	36.9	52.5	32.5	26	63.8	49.4	51.6	34.1	25	57.1
11	28.7	62.3	55.9	37.8	80.1	53.8	56.9	49.3	37.8	56.9
12	18.1	42.4	25.4	14.6	24.8	42.8	30.1	19.8	14.7	55.3
13	70.5	67.5	58.4	32.9	68	68.4	77	61.3	33.9	65.2
14	42.3	50	48.8	37.5	63.7	51.3	71.9	44.4	37.5	53.2
15	19.8	41.2	35	22.2	60.9	43.5	57.4	47.6	13.1	74.6
16	26.5	34.3	46.4	20.8	55.6	36.5	56.7	34.5	20.9	51.8
17	31	53	39	21.4	37.1	52.5	50	39.2	18.4	56
18	29	33.5	26.6	17.5	12.6	32.4	27.7	23.9	15.9	24.3
19	30	43.6	31.7	17.1	42.2	48.6	31.6	48	17.1	56
20	65	44.2	64.3	53.2	77.7	42.2	65.8	52.8	57.1	85.3
21	16.6	43.1	31.2	31.1	42.3	44.2	51.6	37.7	32.3	54.9
22	51.5	62.3	48.1	22	77.6	64	55.1	54.1	28	87
23	28.4	53.2	28.4	14.1	58.7	54.3	57.3	44	13.4	55.7
24	27.1	56.4	52	25.7	21	56.9	25.3	29.1	25.8	58.1
25	61.5	56.2	52.3	38.9	83.5	54.2	41.3	54.6	36.9	80.5
26	19.5	28	46.4	15.5	55.8	27.5	22.3	12.4	14.5	41.7
27	9.8	27.1	33.3	35.5	38.3	28.2	21.5	6.9	33.5	31.6
28	45	47.6	49.6	44.1	71.6	46.4	53.5	42.6	44	51.4
29	22.7	56.3	33.9	33.3	23.1	55.7	26.9	14.5	33.3	38.9
30	44.1	58.2	52.9	40.1	68.2	57	61.4	43.6	40.6	78.3
31	33.8	46.2	49.9	42.2	54.3	46.2	59.7	47.1	40.2	75.5
32	26.4	42.1	26	17.9	24.6	44.2	35.2	10.8	17.6	47.9
33	37.9	58.6	40.2	25.5	62.1	58.6	60.7	43.3	24.5	59.6
34	34.2	51.8	38.6	35.2	29.4	52.8	64.9	14.4	36.2	55.1

TABLE XV

RAW DATA. LAYPERSONS FACIAL ATTRACTIVENESS RATINGS OUT OF 100 (WEEK 1)

Composite #	Layperson1	Layperson2	Layperson3	Layperson4	Layperson5	Layperson6	Layperson7	Layperson8	Layperson9	Layperson10
1	21.6	43.8	31.1	63.3	34.4	31.3	46.4	31.7	42.9	33.4
2	14.2	35.7	6.6	64.1	33.4	27.7	7.4	25.2	57.4	32.6
3	30.1	41	16.1	66.5	38.2	29.9	2.8	28.1	62.5	41.2
4	18.7	30.8	27.7	70.5	19.9	26.6	7.6	27.2	38.2	19.4
5	47.4	50	43.2	77.1	53	40.4	43.6	65.7	52.7	52.1
6	20.5	27	32.8	61.7	36	20	13.7	28.9	35.6	37
7	16.8	31.2	7.6	54.9	13.9	25.9	12.9	22.8	39	12.6
8	30	35.8	22	53.5	42.5	29.3	10.5	30	31.3	41.3
9	37.3	35.4	47.6	50.2	21.6	36	19.7	23.3	29.2	20.7
10	26.8	23.4	8	62.8	54.7	16.2	36.4	41	35	53.8
11	66.6	41	58.7	57.7	33.2	29.2	36	24.6	43	35.1
12	18.2	44.4	11.2	57.4	34.5	31.6	11.7	27.6	66.9	35.7
13	67.6	40.9	61.8	61.8	58.6	30.4	40.8	24	58.7	59.5
14	46.5	42.2	46	50.9	19.7	23	11.3	26.8	56	20.5
15	34	43	35.3	61.6	33.9	36	23.8	53.5	40	35.6
16	47.3	40.3	68.5	67.1	43.1	29.6	32.9	25.9	55.9	41.6
17	19.5	44	29.5	53	51.3	35.1	7.2	31.8	36.3	51.6
18	25	29.3	7.5	63.2	24.7	14.7	5.6	22	32.5	23.5
19	30.4	40.5	58	56.1	37.8	25.8	6.5	21.9	30.9	37.1
20	53.1	41.3	65.9	70.3	51.1	37.4	55.5	47.7	62.7	49.8
21	19.9	30.8	21.5	46	26.9	12.4	13.7	27.5	54.2	26.9
22	56.2	47.4	61.1	58.4	35	44.2	37.2	27.8	54.9	34.7
23	54.6	27.3	57.1	49.3	42.4	37.2	14.2	24.2	39.5	43.4
24	39.9	26	9.6	56	48.3	32.6	15.1	29.2	70.1	48.4
25	60.3	47.2	69	63.8	49	26.6	41.8	37.6	42	48.3
26	55.3	39.8	17.3	58.4	44.5	38.4	8.7	20.3	46.1	44.2
27	38.7	29.6	10.9	66.6	29	17.1	6.3	23.5	44.2	28.7
28	22.3	48.8	31.9	62	31.6	42.8	37.1	36.9	47.6	31.5
29	46.3	43.8	58.3	60.1	37.9	25.8	44.1	27.8	40.1	37.4
30	20.1	46.8	51.7	65.2	44.5	35	21.1	29.1	36.5	42.5
31	21.3	40	65.6	66.3	42.5	29.3	28.6	36	61.5	42.4
32	38	42	32.6	59.2	26.1	21.9	13.5	28.1	40.4	26.4
33	16.8	46.8	59.1	64.5	33.4	25.1	36.4	45.3	41.3	34.3
34	21.4	42	47.8	59.8	35.9	14.8	48.5	31.4	37.1	34.9

TABLE XVI

RAW DATA. LAYPERSONS FACIAL ATTRACTIVENESS RATINGS OUT OF 100 (WEEK 2)

Composite #	Layperson1	Layperson2	Layperson3	Layperson4	Layperson5	Layperson6	Layperson7	Layperson8	Layperson9	Layperson10
1	14.9	38.5	17.5	66.9	33.1	49.4	26.6	20.9	55.9	34.1
2	13.5	34.2	6.3	58.9	34.5	29.9	16.4	21.1	40.5	34.6
3	43.5	49.5	16.9	66.7	39.8	30.4	7	28.3	58.3	42.8
4	14	40.1	16.1	58.6	18.1	34.6	33.5	26.7	33.5	17.9
5	54.6	33.5	72.3	73.3	47	57.8	47.2	42.9	66.1	48.5
6	28.7	42.7	13.4	55.7	34	28.3	11.8	27.3	39.1	35
7	23.7	24.4	12.4	61	14	28.5	18.8	15.6	58	13.4
8	29.3	30.9	41.6	61.5	44.6	38.2	18.8	26	56.8	43.2
9	22.5	40.1	38	67.6	14	33	38	24.7	36.3	16.2
10	27	41.1	1.4	54.5	57.8	22.3	31.6	38	46.4	56.2
11	70.7	39.4	46.6	59.4	36	38.7	38	44.1	64.7	34
12	25.3	40.3	26.2	65.2	35.9	39.9	28.6	18	45.9	36.4
13	58.1	41.3	66.9	66.8	60.4	50.3	41.4	37.7	62.6	62.4
14	41.7	39.5	46.7	66.8	18.3	32	17.4	38.2	57.8	18.1
15	58.5	40	55.6	58.7	38.8	38.5	40	39.8	53.2	38.2
16	23.6	40.4	50.3	62.11	39.6	29.7	33.3	34.2	37.6	38.2
17	14	39.8	37.4	65.5	55.1	25.2	18.3	19.3	40.3	54.9
18	10.5	29	2.2	57.5	22.1	17	25.4	22.6	24.6	22.1
19	35	28.9	46.3	66.7	39.4	29.8	13.1	26	25.1	39.3
20	35.7	42.2	40.1	62	47	30.9	39.9	44.2	43.1	52
21	15.6	42.1	11.5	73.2	27.1	31.7	25.3	30.9	48.3	27.3
22	38.2	46.5	63.6	64.3	36.4	39.6	36.5	33.7	79.3	36.3
23	19.5	41.2	15.6	58	41.5	28.2	36.6	43	34	42.4
24	14.2	41.2	38.8	59.3	51	53.6	41.4	24.1	58.9	51.2
25	61.7	42.2	70.7	73	45.7	54.4	42.2	41.2	51.4	45.9
26	14.9	39.6	33.1	64.5	44.4	31.9	12.6	20.5	54	44.1
27	18	38.6	4.1	68	25.7	19.3	9.4	26.2	23.9	24.9
28	44	28	61.5	61.4	27	45.5	43.6	37.9	41.9	28.1
29	21.6	39.6	58.1	61.2	38.5	54.3	21.6	19.9	35	38.2
30	22.4	43.2	16.9	57.4	45.7	50.7	25.1	37.8	48.5	44.7
31	44.1	36.2	54.4	62.7	39.9	43.9	32.7	31.8	67.8	38.8
32	33.3	27.4	39.5	58.9	28	25.6	7	29	28.9	28.3
33	15.3	30.8	40.1	61.3	36.4	22.7	14.5	34.3	35.7	37.2
34	29.7	32.9	27	53.9	44.6	34.8	38.1	26.7	35.7	41.6

TABLE XVII

RAW DATA. ORTHODONTISTS PERCEIVED AGE RATINGS OUT OF 100 (WEEK 1)

Composite #	Ortho1	Ortho2	Ortho3	Ortho4	Ortho5	Ortho6	Ortho7	Ortho8	Ortho9	Ortho10
1	16.8	12.9	16.7	10.3	14.6	25.1	11.4	11	28.4	5.2
2	33.5	49.9	20.6	16.4	23.7	33.4	30.6	21.6	36.5	19.6
3	33.6	27.5	19.9	14.4	15.1	17.2	24.5	13.1	35.2	13.4
4	35.7	16.8	26.4	12.2	23	28.9	15.9	16.6	29.3	23
5	31	30	31.9	16.5	26.1	23.1	25	26.3	53.8	28.8
6	30.9	15.4	14.1	16.3	17.3	19.3	16.8	12.1	29.8	24.8
7	40.8	19.5	23.3	16.4	29.2	22.5	64	24.9	39.6	30.8
8	50.2	50.6	35.4	25.3	29.7	31.7	79.5	44.6	29.4	33.8
9	40.9	74	12.3	49.6	42.9	47.1	58.4	35.9	42.7	36.7
10	29.7	27.7	33.5	15.5	29.6	22.3	31.76	23.2	29.7	16.7
11	49.7	36.3	36.4	33.2	32.2	23.6	38.5	33.1	55.6	22.5
12	44.2	40.4	21.1	20.6	19.4	30.8	32.5	25.6	38.4	19.3
13	52	39.6	31.5	33.4	29.5	33.7	44	31	59.2	24
14	50.3	67.2	28.1	49.9	33.5	38.6	36.2	39.7	45.1	28.7
15	46.6	34.2	25.1	37.5	37.6	30	27.5	49	35	27.6
16	53.7	58	40.9	44.7	31.1	30.7	47.5	57.7	51.9	32.4
17	45.9	36.2	26.5	17.3	26.4	30.1	31.9	30.3	30.3	23.4
18	46	60.2	23.1	14.6	30.4	36.7	44.9	32.8	62.9	53.4
19	49.8	50.9	26.4	24.3	30.5	33.3	45.4	29.7	30.7	32.9
20	53.3	40.6	30.1	33.8	26.1	23.3	48.3	31.4	39.1	34.2
21	45.9	23.9	26.8	18.2	22.2	13.1	17.5	11.6	28.6	19.2
22	52.7	39.5	31.5	28.5	37.8	33.5	34.1	30.3	37.5	42.1
23	44.8	31.4	35.5	20.5	32.7	38.2	31.7	33.5	61.2	30.1
24	41.2	31.2	29.5	30.1	27.5	25.3	25.4	27.3	29.1	23.4
25	49.4	57.6	40.9	11.6	33.6	31.4	51.2	35.3	39.4	28.7
26	53.3	31.6	24.9	29.7	29.5	35.7	39.6	32.6	53.8	38.3
27	46.6	14.3	25	14.4	28.7	17.5	30	19	30.1	31.4
28	30.6	11.3	49.4	50.8	29.8	21.4	12.5	28.5	53	16.8
29	52	70.7	16.6	49.3	33.1	29.7	56.2	30.6	53.2	37.6
30	46.8	57.8	47.6	31.6	34.6	26.3	45	35.3	35.5	30.9
31	46.5	31.3	31.7	23.1	18.6	25.5	52.7	33.4	44	33.6
32	33.6	14.4	28.2	30	14.1	28.7	14.7	18.9	29	21.4
33	29.5	16.5	23.9	26.1	24.7	17	18.6	28.4	27.7	20.9
34	47.2	30.4	36.2	19.2	21.3	28	30.9	32.4	38	17.7

TABLE XVIII

RAW DATA. ORTHODONTISTS PERCEIVED AGE RATINGS OUT OF 100 (WEEK 2)

Composite #	Ortho1	Ortho2	Ortho3	Ortho4	Ortho5	Ortho6	Ortho7	Ortho8	Ortho9	Ortho10
1	28.6	5.4	18.7	5.4	14.8	21.8	9.5	16.8	31.5	9.7
2	53.7	49.6	20.5	18.8	37.3	33.3	36.8	29.3	55	22.1
3	32.8	13.4	22.3	12	14.3	13.3	30.5	28.3	33	18.6
4	49.4	16.7	29.4	15.7	28	19.2	25.2	28.4	30.7	16.7
5	33.1	18.9	27.2	24.1	25.6	25.7	37.1	33.2	59.1	26.8
6	46.8	23.4	13.1	17.6	22.8	15.6	12.4	16.8	33.2	26.3
7	53.8	15.8	21.1	27.8	39.8	22.2	56.1	29.8	29	30.2
8	52.3	65.4	27.4	19.5	52.5	25.1	62	37.5	36.6	34.1
9	45.4	50.3	13.6	66.6	37.5	31.1	51.8	44.5	66.2	33.5
10	52.2	22.7	24.9	16.7	19.5	18.1	31.6	32.6	61.1	15.4
11	52.7	30.4	34.7	17	28.2	25	39.1	37.7	37.8	29.9
12	49.8	33	22.7	24.5	20.5	28.5	25.8	26.6	69.5	21.2
13	54.4	47.2	35.8	29.7	33.2	25.5	42.8	39.5	68.3	28.7
14	44.9	66.3	30.7	25.3	50	29.1	43.1	33.6	56.9	28.9
15	40.3	37.8	26.6	35.2	26.9	25.8	32	38.1	52	29.5
16	49.5	30	37	55.4	30	33.3	53.2	42.6	65.6	27.2
17	46.9	57.5	27	21.1	47.6	26.1	46.1	49.6	36	32.8
18	57.8	73.1	24.5	16.6	57.7	28.8	38.9	26	69.8	49.4
19	47.2	33.6	18.7	20.1	30.1	30.8	55.1	36.4	63.5	23
20	45.2	50	29.6	20.4	32.2	21.6	36.9	40.3	39	32.2
21	28.2	2.9	21.5	7.7	16.8	18.9	14.3	19.8	48.7	18
22	49.5	56.4	28.5	32.8	50.4	25.8	41.7	46.2	38.8	36.4
23	35.7	42.7	25.3	26.3	41.8	29.2	47.7	37	74.3	21.4
24	54.2	17	28.4	10.5	39.8	21.4	20.1	16.6	36.5	21.9
25	45.6	56.3	37.4	25.7	44.7	28.5	52.4	47.4	44.8	36.8
26	54	49.5	31.3	28.2	35.4	30.2	43.4	27.5	54.2	34.6
27	52.9	9.5	25.7	14.8	17.2	17	45.9	17	26.9	31.4
28	53.3	6.6	53.4	49.7	24.2	17.3	28.2	30.3	71.1	21.6
29	51.6	59.6	14.5	50.6	49.7	29	50.2	33.5	37.8	33.2
30	49.8	63.8	31.6	31.7	33.4	25.6	44.5	32.7	37.2	21.8
31	35.5	22.5	29.6	24.8	18.1	29.5	55.8	30.3	54.6	34.1
32	41.6	3.6	24	30.2	15.8	15.2	21.7	18.8	29.6	29.1
33	29.5	17.2	22	17.6	20.6	25.7	25.8	28.6	38.6	16.3
34	44.5	31.2	38.1	23.9	30.1	20.7	41.3	33.1	60	25.1

TABLE XIX

RAW DATA. LAYPERSONS PERCEIVED AGE RATINGS OUT OF 100 (WEEK 1)

Composite #	Layperson1	Layperson2	Layperson3	Layperson4	Layperson5	Layperson6	Layperson7	Layperson8	Layperson9	Layperson10
1	7.3	4.9	5.6	13.6	12.4	18.2	7.3	22.8	23.4	8.2
2	25.5	19.8	23	33.2	33.2	29.2	28.1	40.4	24	24.5
3	13.8	23.6	33.5	13.7	13.5	20	5.6	28.8	38.9	14.8
4	20.3	16.5	19.3	32.4	33.3	23.9	20.8	41.8	24.6	20.6
5	23.3	26.4	19.5	46.1	45	36.1	25.8	53.6	23.8	21.3
6	20.1	10.8	30.3	19.3	22.3	22.6	25.4	41.6	26.3	19.9
7	26.6	13.5	20.5	42.3	52.3	24.4	21.9	42.6	25.2	27.2
8	36.8	23.6	55.5	61.5	66.3	38	21.9	56.3	20.3	36.9
9	45.4	34.8	53.6	72.5	82.5	66.5	57	75.7	38	45.1
10	28	10	50.6	39.6	42	33.8	13	40.4	24.8	27
11	31.1	15.9	44.2	49.8	50.2	33.4	10.4	57.1	24.6	30.5
12	25.9	21.3	22.1	33.6	33.3	38.6	22.2	40.1	36.8	25.8
13	35.9	32.8	50	49.8	50.7	66.4	25.6	55	35.7	36.5
14	26.4	35	56.8	81.6	82.7	57.9	25.9	71.5	25.9	27.2
15	41.9	29.5	43	47.1	49.9	55	22.8	39.6	35.3	42.1
16	37.2	28.1	46.3	55.6	59.7	41.4	39	59.6	35.7	38.1
17	27.8	16	33.2	40.3	39.3	55.6	39.4	56.9	26.2	28.6
18	38.3	23.5	20.7	29.6	29.5	26.9	37.1	45.6	36.5	36.1
19	30.3	29.5	25.8	35.5	33.4	44.9	38.6	25.9	31	31.2
20	19.5	25.7	24	51.5	59.7	71	27.9	39.5	32.5	20.2
21	9.2	21.8	14.5	13.4	13.2	19.2	12.5	28.2	28.4	9.3
22	36	24.6	35.1	49.6	51.6	48.7	21.4	28.3	35.1	35.5
23	31.3	16.3	33.4	31.5	30.7	66.3	25.4	37.7	19.7	30.8
24	20.6	18.8	19.3	41.2	50.2	45.7	14	27.8	35.5	20.7
25	30.1	27.3	49.9	51.2	66.9	50	38.7	29.1	30.9	30.5
26	35.7	26.2	34.4	59.8	66.2	75.7	22.5	38.7	32.6	36.2
27	7.7	13.1	8.4	8.2	7.8	14.1	12.9	39.5	24.7	7.5
28	21.7	15.3	37	32.2	33.2	30	13.7	29.1	29.1	21.5
29	51.8	32.9	55.5	61.5	62.9	42	58.2	38.8	33.4	52.2
30	21.6	16.2	47.9	49.6	50.4	49.3	26.1	39.2	35.7	21.8
31	9.4	17	45.1	39.8	41.6	44.6	25.4	24.6	34	10.5
32	23.8	15.8	13.3	21.5	22.9	68.2	12.4	41.3	34	22.7
33	13.2	8.6	20.3	18.2	17.1	32.6	20.3	24.8	29.9	12.9
34	8.5	18.6	28.6	45.5	50.1	60.1	20.6	27.6	33.2	9.8

TABLE XX

RAW DATA. LAYPERSONS PERCEIVED AGE RATINGS OUT OF 100 (WEEK 2)

Composite #	Layperson1	Layperson2	Layperson3	Layperson4	Layperson5	Layperson6	Layperson7	Layperson8	Layperson9	Layperson10
1	19	5.2	16.9	10.1	9.3	19.7	12.7	20.9	13.6	17
2	25	19.1	20.5	32.2	33	49.7	26.8	30.1	20.4	26.2
3	20.3	24	26.7	12.6	12.6	40.1	13.1	26	24.8	21.2
4	23	16.9	24.4	29.4	28.4	53.1	22.2	29.7	23.6	22.5
5	27.3	26	27.7	34.2	33.3	46.2	20.9	38.7	30.7	26.9
6	17	11.9	16.6	12.3	11.4	17.1	21.3	22.9	17.8	17.5
7	20.5	13.7	17.4	39.6	38.5	26.2	25.4	38.3	27	21.2
8	19.3	24.8	51.7	74.2	73.8	50.2	12.4	61.6	32.7	20.2
9	41.2	32.9	37.5	72.5	72.44	64	39.4	73	48.9	41.3
10	14.8	9.9	41.5	41.2	82.6	54.1	24.7	30.7	24.6	15.2
11	31.1	16.7	29.1	43.3	42.6	30.9	25.9	38.8	37.6	31.2
12	21.9	21.4	33.4	49.2	54.3	68.9	22.2	24.3	40.2	22.2
13	35.4	33.8	41.5	64.2	66.3	73.7	29.9	57.3	40.2	36.1
14	30.6	28.1	39.4	76.2	71	71.1	39.9	57.2	33.5	30.8
15	35.8	25.5	29.5	36.1	32.9	58.3	23.6	44.4	40.8	36.2
16	25.6	28.5	37.4	59.8	62.7	63	27.7	58.1	38.6	26
17	30.4	16.9	33.7	42.4	42.4	32.7	40.3	27.1	25.1	30.2
18	24.4	25	21.5	35.5	57.1	50.4	22.7	24.3	33.8	25.5
19	25.7	31.2	31.2	34.2	33.8	53.7	40.7	29	23.3	26.3
20	23.3	24.2	39.3	49.3	49.3	63.8	23.4	56.9	37.1	22.7
21	9.1	23.1	20.7	12.4	12.4	60.8	11.3	27.6	7.2	9.2
22	32.1	23.1	37.9	51.6	48.9	66.7	25.2	38.5	32.4	33.5
23	20.6	15.4	28.5	42.7	46.6	60.2	25.4	31.2	24.6	22.5
24	6.5	16.7	14.1	31.2	27.1	33.3	13.6	29.4	40.1	9.9
25	36.9	25.9	49.3	59.9	61.9	70.2	39.7	58	25.2	35.8
26	38.1	21.7	24.7	34.2	33.5	69.3	28	40.4	26.8	37.7
27	2.7	13.8	12.9	14.4	17.2	39	13.2	26.2	16.6	5.5
28	19.1	16.2	50.4	36.9	37.5	40.1	23.3	38.1	23.4	19.5
29	29.6	33.7	50.5	57.8	49.7	59.2	43.9	72.6	30	32.2
30	21.6	17.5	23.3	39.2	39.1	22.1	25	39.9	20.1	21.5
31	39.5	16	50.3	27.6	26.6	43.9	25.6	43.7	32.8	22.5
32	39.1	15.2	14.9	17	16.1	36.7	24.4	25.8	22.6	31.5
33	19.9	6.6	21.4	16.6	16.5	16.8	23.7	29.6	18	18.5
34	35.2	16.4	50.5	25.5	23.9	45.9	24.9	40.2	22.4	29.5

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