HOW OTHERS PERCEIVE ORTHOGNATHIC PATIENTS: AN EYE-TRACKING STUDY

**Aim:** To test the hypothesis that the faces of patients with a severe Class III are contemplated differently from and assessed more negatively than skeletal Class I patients in direct face-to-face interaction.

**Method:** The eye movements of 24 randomly recruited evaluators were analyzed with a noninvasive, infrared high-speed camera while looking at 18 standardized frontal photographs of adult orthognathic Class III patients and 18 photographs of adults with skeletal Class I relationships as controls. Additionally, all images were assessed for appearance, symmetry, and facial expression.

**Results:** The Class III patients were rated significantly more negatively in terms of appearance, symmetry, and facial expression than the Class I individuals. The eye movement data revealed that orthognathic patients were appraised differently from the Class I individuals, with fewer fixations in the face center, especially around the mouth. **Conclusion:** Skeletal Class III patients were characterized as less attractive than Class I individuals. Faces of Class III patients were visually perceived with different eye movements. These differences in visual perception are described for the first time in the present study. Although they were small, they are an indication of an objectively different perception of faces that are rated subjectively as less attractive and more asymmetric and exhibiting a more negative expression. World J Orthod 2010;11:153–159.

**Key words:** orthognathic patients, skeletal Class III occlusion, asymmetry, face perception, eye tracking

The face is the principal source of communication in human interactions. Facial perception and rating of facial attractiveness are controlled by factors such as averageness, youthfulness, and symmetry. A harmonious and symmetric body shape is a central cue for attractiveness. Evolutionary theories explain this with the assumption that symmetry may be a signal of health and genetic fitness. Because only healthy individuals can maintain symmetric development under environmental stress, symmetry may serve as an indicator of superior phenotypic, as well as genotypic, quality.

Patients with severe facial deformities have been reported to be judged more negatively than controls. In particular, Philipps et al reported that subjects with Class I profiles are rated as more attractive than those with a Class II or Class III profile by patients, laypersons, orthodontists, and oral surgeons. Furthermore, it has been shown that malocclusions might cause social deprivation. It was also pointed out that children with open and deep bites, Class III relationships, and crowding are commonly teased. Therefore, dentofacial deviations have been reported to be associated with an increased risk for psychologic disturbances. Patients who need orthognathic surgery are often stigmatized in social situations (including lack of popularity, decreased opportunities for marriage, and frequent targets of insults). Thus, the primary reason for undergoing surgery is often the patients’ desire to improve their facial and dental appearance.

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The face plays a particularly important role in social cognition. The visual processing of faces is unique because faces are processed rapidly and holistically along a specialized subcortical route. Symmetric faces are judged to be more attractive. Thus, facial disharmony in patients with a skeletal Class III relationship might be a source of social and emotional distress. However, to date, no study has examined how others perceive the faces of orthognathic patients with severe skeletal Class III malocclusions and whether they are contemplated differently from faces of Class I patients.

A recent approach to study how faces are envisioned is to analyze the eye movements of the observer. Eyes move continuously as they inspect objects. Therefore, analysis of their movement provides valuable information about the perception process. Visual perception during natural viewing is characterized by a gaze-controlled sampling strategy. The eyes alternate between fixations and saccades, rapid-eye movements that lead to a new fixation in an area of interest (AOI). Noton and Stark demonstrated that the distribution of fixations and saccades is not random. When individuals look at an object, their eyes wander from feature to feature in a regular sequence, referred to as the scan path. Based on this principle, Mertens et al analyzed how faces are scrutinized by monitoring the perceiver’s scan path with an eye-tracking camera. Although it is generally agreed that severe skeletal Class III individuals are associated with inferior facial attractiveness, there have been no studies that objectively analyzed the perception.

Therefore, the aims of this study were to determine how faces of adult patients with severe skeletal Class III relationships are rated for appearance, symmetry, and expression and whether adults with a severe Class III occlusion are scanned differently (for example, with an aberrant eye-movement pattern compared to a control group with a Class I occlusion).

METHODS AND MATERIALS

Evaluators

Twenty-four evaluators (13 women and 11 men) with a mean age of 25.4 ± 4.2 years were recruited via a newspaper classified ad. They were paid €10 for their participation. Inclusion criteria were (1) normal vision, (2) not members of the medical/dental community, (3) no current medical or dental treatment, and (4) no congenital facial deformity or other distinctive facial feature.

Visual material

Black-and-white preoperative photographs of 18 adult patients presenting with a severe skeletal Class III relationship (8 women and 10 men, mean age 24.5 ± 6.8 years) and 18 individuals with a skeletal Class I, age- and sex-matched to the Class III group, who served as controls were shown to the evaluators. All patients and controls had consented to the use of their photographs. The Class III patients were designated for combined orthodontic-surgical treatment in the Department of Orthodontics, Medical Faculty of the University of Wuerzburg. Inclusion criteria for the Class III patients was a Wits appraisal < −3 mm; for the control individuals, it had to be in the range of 0 ± 2 mm.

All faces were photographed in front of a dark background with a neutral expression and the eyes looking straight ahead (Fig 1). None of the faces exhibited a distinctive feature such as a piercing or tattoo. Every face was covered beneath the chin and around the head so that ears, hair, and other peripheral features were screened out. The picture size was set to 412 × 581 pixels at a resolution of 96 pixels per inch.

Tracking device

The surveyors were seated comfortably 50 cm in front of a 17-inch monitor (with a resolution of 1,024 × 768). The head was stabilized by a chin and a forehead
support to eliminate any head movement (Fig 2). Picture presentation was controlled by Presentation 0.90 (www.neurobs.com).

Eye movements were recorded with a video-based iView X Hi-Speed infrared camera (SensoMotoric Instruments). Images of the eye’s position were sampled at 238 Hz and a spatial resolution of approximately 0.5 to 1.0 degree. The eye tracker was calibrated for each evaluator’s right eye using an 11-point calibration procedure.

Procedure

**Photo rating.** In the first part of the study, all surveyors were instructed to rate every photograph on a 9-point interval scale for three conditions: appearance (1 = very poor, 9 = very good), symmetry (1 = very asymmetric, 9 = very symmetric), and facial expression (1 = very negative, 9 = very positive). These three aspects had to be dealt with separately in random order to avoid serial dependence of the different ratings. By doing so, each picture was rated three times. This resulted in a total of 108 trials (3 × 36 pictures). The length of inspection was evaluator-defined.

**Eye tracking.** In the second part of the study, the eye movements of the evaluators were recorded continuously while they viewed the individual facial photographs. The surveyors were introduced to this procedure by on-screen instructions and four practical trials. They were told that they would see a series of photographs of faces at which they could look in any way they wished.

Before each picture was displayed, a fixation cross was presented in the center of the screen. After the cross was continuously fixated for 1.5 seconds, photographs were presented in random order. They appeared on either the left or right side of the screen to attain a first saccade toward the face. Each picture was presented for 5.0 seconds. The intertrial interval was 250 milliseconds (ms). The experiment was interrupted by a short break after half the photographs were inspected. The study was conducted in accordance with the ethical standards established by the Institutional Board of the Department of Orthodontics, Medical Faculty of the University of Wuerzburg, and with the Helsinki Declaration of 1983. All evaluators took part voluntarily and were interviewed individually.
Fixations were defined as scan path data limited to a maximum visual angle of 2.02 degrees for at least 80 ms (BEGAZE Software, SensoMotoric Instruments). For the analysis of the eye movement, data-distinctive morphologic areas of the face were marked as AOIs. The eyes, nose, and mouth were defined as the central AOI, whereas the forehead, cheeks, and chin were subsumed as the peripheral AOI. The cumulative duration of all fixations was analyzed for each AOI as an index of sustained attention span. Furthermore, the first three fixations in the AOI eyes, nose, and mouth (1–3) were recorded as the index of initial attention capture.

SPSS 14.0 (SPSS) was used for statistical analysis. The t test (two-tailed) for paired groups was used to analyze both the eye-tracking data and the data of the photo rating. For all analyses, the α-level was set at $P = .05$. 

**Data analysis**

Fig 3  Mean and standard error of the rating for appearance, symmetry, and facial expression on an arbitrary nine-point interval scale.

Fig 4  Mean and standard error of the percentage of the first six fixations in the central and the peripheral AOI in both picture categories.

Fig 5  Scan path of one randomly chosen evaluator looking at a picture of a skeletal Class III patient. Each circle represents a fixation and the circle’s size the duration of the fixation; most fixations are in the central AOI.
RESULTS

Photo rating

The results of the photo rating show a significant difference between the two groups in every aspect (Fig 3). The photos of the Class III patients were rated significantly more negatively in terms of appearance, symmetry, and facial expression than those of the Class I individuals. The highest mean difference was found in appearance (Class III: mean = 3.32, SD = 1.11; Class I: mean = 5.32, SD = 1.13; \( P < .001 \)), followed by symmetry (Class III: mean = 4.42, SD = 1.04; Class I: mean = 6.05, SD = 0.95; \( P < .001 \)), and facial expression (Class III: mean = 3.99, SD = 0.73; Class I: mean = 5.56, SD = 0.81; \( P < .001 \)).

Eye tracking

Areas of interest. Initially, the first six fixations in the central and peripheral AOI of the evaluator’s gaze were analyzed. There was a significant difference between the central and the peripheral AOI: \( t (23) = 31.71, P < .001 \) (Fig 4). Overall, 88.7% (SD = 5.98) of the first six fixations were on the central AOI, whereas only 11.3% on the peripheral AOI (SD = 5.98). In Fig 5, one surveyor’s scan path is shown exemplarily while scanning a photo of a skeletal Class III patient.

Sustained attention span. The duration of all fixations in the central AOI were registered and compared for the Class III and I individuals. The mean fixation time while scanning pictures of both groups is presented in Fig 6. In Class III patients, the mean fixation duration on the central AOI was significantly shorter than in the Class I individuals (Class III: mean = 34,145.86 ms, SD = 6,733.83 ms; Class I: mean = 35,148.37 ms, SD = 6,510.71 ms; \( P = .043 \)).

Initial attention capture. To examine the initial attention capture in facial scanning of the two groups, the mean (%) of the first three fixations was calculated. For a more sophisticated analysis, the central AOI of the two groups was subdivided into the three AOIs: eyes, nose, and mouth. The photos of the Class III patients were significantly less fixated in the mouth region than those of the Class I individuals (Class III: mean = 5.29%, SD = 3.77; Class I: mean = 6.36%, SD = 3.96; \( t (23) = 2.12, P = .046 \)), but no significant difference was found between the two groups for the eyes and nose AOIs (Fig 7).
DISCUSSION

This study is the first of its kind. The underlying hypothesis was that severe Class III patients are perceived differently from and judged more negatively than skeletal Class I individuals. The fact that Class III individuals are rated as less attractive than matched ones with a skeletal Class I is consistent with previous data.\(^2\)\(^{12}\)\(^{13}\)

Other studies analyzed attractiveness of facial profiles,\(^14\)\(^{15}\) but there is evidence that individuals primarily scan the full faces (frontal view) of other people.\(^16\) Therefore, frontal views of the sample were selected and they were shown to evaluators from outside the medical community to most closely approximate real-life situations.

The rating of the photographs by the evaluators revealed that symmetry is a decisive feature of attractiveness. Eventually, this was one reason why the surveyors defined orthognathic Class III patients as being less attractive overall. Within this context, it should be mentioned that patients with mandibular prognathism objectively exhibit a higher degree of mandibular deviation from the midline.\(^17\) The more negative rating of the facial expression in Class III patients could be explained by the functional organization of facial expressions across the upper-lower facial axis. Both face parts express emotions, but the lower one prevails for happy-pleasant kinds of expressions.\(^18\) The fact that a prominent and dominant mandible or a noticeable asymmetry are in a decoding area for normally happy-pleasant type of expressions could explain the more negative rating observed in this study.

It is somewhat surprising that the focus of the facial perception was on the central AOI while the peripheral ones comprised approximately 70% of the total face. This finding is consistent with previous eye-movement studies.\(^10\) For the benefit of clinical practitioners, it has to be emphasized that a harmonic morphology in the central AOI should have the greatest impact on treatment decisions.

CONCLUSION

The faces of Class III orthognathic patients were perceived as less attractive than those of a control group. In direct face-to-face inspection, these patients were contemplated differently. The eye movements during visual perception of patients with a severe Class III occlusion were characterized by fewer fixations in the central face area, especially around the mouth. Although the differences between the two groups were small, this finding is an indication that faces of severe Class III patients are rated subjectively as less attractive and more asymmetric and as exhibiting a more negative facial expression.

REFERENCES