Beauty and the Teeth: Perception of Tooth Color and Its Influence on the Overall Judgment of Facial Attractiveness

*Lea Höfel, Dipl Psych**
*Matthias Lange, DDS***
*Thomas Jacobsen, Dipl Psych, PhD****

This study investigated the influence of changes in tooth color on judgments of facial attractiveness. Standardized photographs were presented, and teeth were digitally manipulated (main categories: original, whitened, colored; filler category: impaired). Participants were instructed to evaluate the faces for attractiveness. Additionally, they were asked to name facial features they found either positive or negative with regard to attractiveness. Whitened teeth were mentioned more often in a positive way but did not improve participants' assessment of attractiveness. A colored tooth did not attract attention, and the attractiveness judgment did not worsen. Tooth color is thus not necessarily perceived and does not have a major impact on facial attractiveness. (Int J Periodontics Restorative Dent 2007;27:349–357.)

*Student and Researcher, Institute of Psychology I, University of Leipzig, Germany.
**Private Practice, Berlin, Germany.
***Associate Professor, Institute of Psychology I, University of Leipzig, Germany.

Correspondence to: Lea Höfel, Institute of Psychology I, Cognitive and Biological Psychology, Seeburgstrasse 14-20, D-04103 Leipzig, Germany; fax: +49-341-973-59-69; e-mail: hoefel@uni-leipzig.de.

Physical attractiveness plays an important role in everyday life. Judgments of esthetics, beauty, and attractiveness are influenced by a host of factors.[1–5] Self-esteem, body image, and psychologic welfare, for example,[6,7] as well as effects on social interaction[8] and associations connected with an attractive or unattractive appearance,[9] reflect a small portion of a variety of aspects connected with the outward appearance of a person (for an overview of esthetics and attractiveness, see Höfel[10] and Rhodes and Zebrowitz[11]). It is known that the smile plays an important role in the evaluation of facial attractiveness and in the overall assessment of a smiling person.[12] Furthermore, an improved dentofacial appearance is believed to positively influence attractiveness.[13,14] Studies of eye movement have shown that the perception of a face involves a triangular scanning pattern, with the main emphasis on the eyes, nose, and mouth.[15,16] Therefore, it could be inferred that the mouth and thus the teeth would be important in the evaluation of attractiveness, which was investigated in the present study.

Human attractiveness has been studied in many experiments. Mechanisms that lead to perceived beauty and attractiveness judgments are most often explained by evolutionary theories.[17–19] Balanced and harmonious facial features with a straight profile for men and a slightly convex profile for females are preferred in the assessment of the face.[20] Langlois and Roggman stated that an average-looking face is most beautiful.[21] Perrett and coworkers showed that an average face is even more attractive if some facial characteristics are slightly exaggerated, for example, larger eyes, higher cheekbones, or a thinner chin for women.[22] The influence of separate facial features on the perception of attractiveness has been analyzed, for example, symmetry, size of the eyes, and interocular distance.[23,24] Of the studies of facial attractiveness, most have used faces with a neutral, closed-mouth expression and thus could not assess the influence of a smile and teeth. Beauty of the smile alone has been studied with regard to different types of smiles and factors such as the degree of exhibition of teeth, curvature of the lips, and visibility of the gums.[12,25–28]

The attractiveness of teeth has also been investigated in detail. This can involve obvious deviations from the norm—decayed teeth[14] and open bites,[29] for example—or minor changes in maxillary anterior tooth position, angulation, occlusion, and proportion.[30–33] Half of the participants in the study of Alkhatib and coworkers were concerned about their own tooth discoloration,[34] and younger people placed greater importance on white teeth than did older people.[35,36] A study by Dunn and coworkers[27] suggested that a light tooth shade had the greatest impact on the positive perception of a smile. Grosofsky et al[37] doubted that white teeth had a positive influence on attractiveness, leaving open the question of whether white teeth were consciously noticed or not. Esthetic perception of dental fluorosis with the help of computer-generated images has been investigated by Levy and colleagues[38] and McKnight et al[39] in two follow-up studies, showing that digital alteration of images is a helpful method to investigate tooth perception.

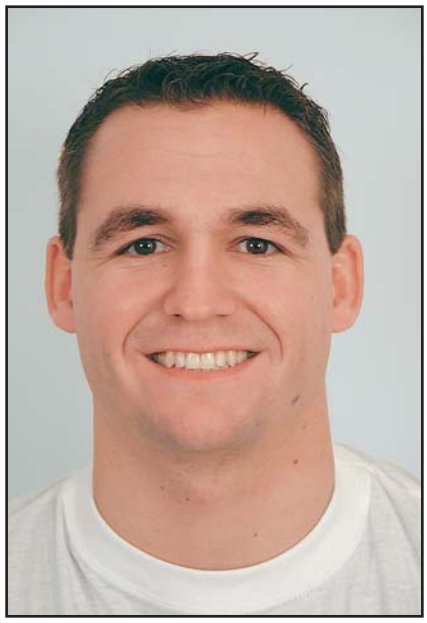
In addition to these rather descriptive aspects of studies on facial attractiveness, smiles, and teeth, the psychologic influence of an appealing appearance on the self-esteem of a person must be mentioned. Physical attractiveness and a beautiful dentofacial appearance might not just please the beholder; they also improve self-esteem.[40] It is known that attractive people are perceived as more intelligent, kinder, and happier than less attractive people.[9,41,42] As a self-fulfilling prophecy, these people are often more self-confident and serene.[43,44] Dentofacial appearance influences perceived friendliness, social class, and popularity.[45] Effects such as these are more pronounced in the evaluation of the opposite sex.[14] Thus, it is understandable that individuals want to be attractive rather than unattractive, and this may involve esthetic or cosmetic dentistry.

The present study, consequently, combined research on aspects of facial attractiveness with aspects of the smile and dentition. A study conducted by al Yami et al[46] implied that dental and facial esthetics might be influenced by different factors and do not necessarily interact. Minor exaggerations of certain facial features heighten attractiveness[22]; here, it was investigated whether this also applies to the condition of the teeth, especially color. Whitening procedures and the treatment of discolored nonvital teeth are conducted in many dental practices.[47,48] Whitening and discoloration were thus chosen as positive and negative color deviations, respectively, from the original teeth in this study. The authors investigated whether realistic changes in tooth color as they are treated in a dental practice are noticed by young, Western lay people, and whether changes in tooth color consequently influenced the overall judgment of facial attractiveness. It was hypothesized that *(1)* whitened teeth would be named more often in a positive way and less often in a negative way than teeth in the original or colored condition and that faces with whitened teeth would be judged as more attractive, *(2)* teeth with a colored maxillary lateral incisor would be named less often in a positive and more often in a negative way than teeth in the original or whitened condition, and *(3)* faces with a colored maxillary lateral incisor would be judged as less attractive.

Method and materials

Participants

Ninety young adults (11 men and 79 women) who were psychology stu-



Figs 1a and 1b *Stimulus examples of a female face and a male face (original teeth) as they were presented in the experiment.*

dents at the University of Leipzig voluntarily participated in the experiment for partial fulfillment of course requirements. Their mean age was 23.2 years (range, 19 to 38). None had a professional dental or cosmetics background or had participated in a similar experiment before. One additional participant was excluded from further analysis because of data loss.

Material

Photographs of the face, neck, and upper shoulder region of 10 female (mean age 22.3) and 10 male (mean age 23.8) white-skinned European students showing a smile were used in this study (Fig 1). The faces were chosen such that the smiles looked natural and the maxillary teeth were clearly visible. Teeth did not show extreme abnormalities. Subjects were photographed with an Olympus Camedia C-2100 camera from a standard distance in a frontal view. Background and lighting were identical across subjects. Glasses, earrings, and piercings were removed if possible or were digitally retouched later. Subjects wore identical white shirts, and the hair was tied back if necessary. Photographs of the faces were then adjusted by matching the horizontal positions of the eyes and mouth and the vertically centered position of the nose. The overall attractiveness level was varied to prevent homogenous answers.

All 20 faces were then digitally manipulated by one author (ML) with regard to tooth color and an additional filler category. This resulted in four manipulations of the factor "tooth" (factor levels: original, whitening, color, form). "Original" showed the face with the natural, original tooth display. "Whitening" showed the face with realistically whitened teeth, and "color" showed one of the maxillary lateral incisors in a realistically darkened or yellowed state, with the darkened tooth representing a nonvital tooth and the yellow tooth reflecting discoloration caused by smoking. Color type, tooth side, and sex were fully crossed. To divert the main emphasis from color changes, an additional filler category ("form") showed the teeth in an either form-corrected or form-impaired status, counterbalanced across faces. After manipulation, the photographs were examined by five dental experts (three dentists and staff) with regard to correctness and viability of the changes in a dental practice. Figure 2 provides examples of the manipulated images.

Figs 2a to 2j *Manipulation examples. On the left side, the original teeth are shown. On the right side, the corresponding tooth manipulations are shown (*top to bottom*: whitening, maxillary left lateral incisor tooth nonvital, maxillary right lateral incisor yellow, form improved, and form impaired).*

Study design and procedure

Participants in the study were seated in front of a 17-inch computer monitor at a normal viewing distance. They were divided into four groups and instructed to evaluate the 20 faces on a five-point scale from "not attractive at all" to "very attractive." They were asked to evaluate the esthetics of the faces and were not informed about the dental manipulation. Each participant saw each face just once in one of the four manipulations. Thus, five faces of each manipulation were to be evaluated by one participant. Male and female faces were alternated to eliminate anchor effects caused by direct sequential comparison, as had been noticed in pilot tests. Manipulations and faces were counterbalanced within and across participants. Additionally, participants were asked to name facial features they found either positive or negative with regard to the overall attractiveness of the face.

The presentation started with instructions. Then, the face was shown for 3 seconds. After that, the photograph of the face appeared centered on a dark gray background, with the photograph itself being surrounded by a thin black frame (23.5 × 17 cm). The picture was shown for 40 seconds; after this, the dark gray background remained while the participant took notes. Participants continued the presentation at their own pace by pressing the computer mouse button.

Data analysis

Statistical analysis consisted of several steps and was subdivided into the analysis of the naming of facial features and the analysis of overall attractiveness ratings. For the analysis of positive and negative naming of features, the number of positive and negative tooth statements was counted. Each participant saw five faces with one manipulation. The frequency data was put into a four-by-two repeated-measures analysis of variance (ANOVA) design with the factors "tooth" (levels "original," "whitening," "color," and "form") and the factor "valence" (levels "positive" and "negative"). Results were analyzed for the original data and square root–transformed data. For the overall attractiveness ratings, the mean attractiveness score was entered into an ANOVA in separate subject and item analyses, with the four factor levels "original," "whitening," "color," and "form" of the factor "tooth." Results were analyzed for the original and z-transformed data. If applicable, error percentages reflecting Greenhouse-Geisser (G-G) corrected degrees of freedom and G-G epsilon (ϵ) values are reported. Only significant results are reported. (Detailed assignment of tooth manipulation and participants and the complete list of statistical results are available online at http://www.uni-leipzig.de/jacobsen.)

Results

Naming of positive and negative features

All features

The eyes were mentioned more often than all other features for the evaluation of overall facial attractiveness. This was followed by teeth, head shape, lips, skin, nose, chin, hair, smile, impression, ears, forehead, beard, cheeks, and personality (the participants were not instructed to evaluate hair and personality, so it is unlikely that the rank ratings of these two characteristics accurately reflect their impact). The influence of teeth seems to be more important in the evaluation of male attractiveness; it ranked second for men and fourth in the evaluation of female attractiveness. All features except the eyes and smile were named more often in a negative way than in a positive way.

Teeth

Teeth were mentioned more often in a negative way, as revealed by the general ANOVA with the factors "tooth" and "valence" (main effect for "valence" [$F(1,89) = 113.29$, mean square error [MSE] = .98, $P = .000$]). Furthermore, an interaction for "valence" × "tooth" [$F(3,267) = 10.88$, MSE = .97, $\epsilon = .88$, $P = .000$] was revealed, which allowed for the analyses based on the study hypotheses; *(1)* "whitening" and "original," *(2)* "color" and "original," and *(3)* "color" and "whitening" were entered into separate further analyses with "valence" ("positive"/"negative").

- Whitened teeth were mentioned in a more positive way than the original teeth [$t(89) = 2.46$, MSE = .1, $P = .02$] and in a less negative way than the original teeth [$t(89) = –2$, MSE = .14, $P = .048$] (follow-up analysis of a main effect for "valence" [$F(1,89) = 65.6$, MSE = .85, $P = .000$] and an interaction for

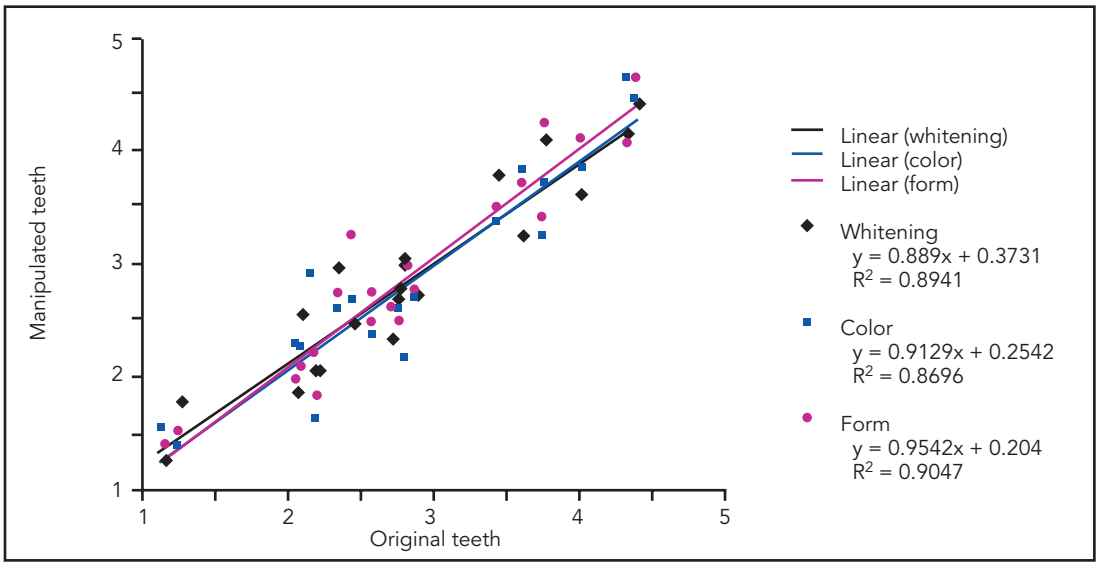


Fig 3 *Attractiveness ratings for the manipulations "whitening," "color," and "form" in comparison to original teeth. The horizontal axis represents the score for faces with original teeth, and the vertical axis shows the corresponding scores for the manipulations. Linear trend lines and R^2 represent the explained variance of the original attractiveness score on the scores for the manipulations.*

"tooth" × "valence" [F(1,89) = 7.06 , MSE = .83, *P* = .01]).

- Teeth were mentioned more often in a negative than in a positive way (main effect for "valence" [F(1,89) = 167.65, MSE = .72, *P* = .000; no interaction]).
- Colored teeth were mentioned in a more negative way than the whitened teeth [t(89) = 2.91, MSE = .13, *P* = .005] and in a less positive way than the whitened teeth [t(89) = 3.85, MSE = .1, *P* = .00] (follow-up analysis of a main effect for "valence" [F(1,89) = 78.7, MSE = .94, *P* = .000] and an interaction for "tooth" × "valence" [F(1,89) = 18.6, MSE = .67, *P* = .000]).

Analysis of the square root–transformed data showed the same tendency; therefore only differing results are mentioned here. The overall analysis of "tooth" and "valence" revealed an additional main effect for tooth [F(3,267) = 3.02, MSE = .23, ϵ = .917, *P* = .03]. Whitened teeth were mentioned in a more positive way than the original teeth [t(89) = 2.39, MSE = .07, *P* = .02] but not in a less negative way.

Attractiveness ratings

Subject ANOVA for the 90 participants and the factor levels "original," "whitening," "color," and "form" revealed no effect for the original or for the z-transformed data (F < 1). Because of the naming differences in the hypothesized factor level comparisons, the levels "whitening" and "original" as well as "color" and "whitening" were analyzed further. No comparisons showed significance, indicating that tooth manipulation did not influence overall facial attractiveness across participants.

Item ANOVA for the 20 faces and the factor levels "original," "whitening," "color," and "form" revealed no effect for the original or for the z-transformed data (*F* < 1). The initial overall attractiveness score of the face with original teeth explained approximately 80% of variance of the corresponding attractiveness judgments of the manipulations (whitening 80%, color 76%, form 82%; see R^2 in Fig 3).

Because of the naming differences in the hypothesized factor level comparisons, the levels "whitening" and "original" as well as "color" and "whitening" were further analyzed separately (comparable to the subject analysis). No comparison revealed significance, indicating that tooth manipulation did not influence the overall facial attractiveness across faces.

Discussion

Perception and evaluation of tooth color and their influence on overall facial attractiveness were investigated in the present study. Participants judged 10 male and 10 female faces and named positive and negative features with regard to overall attractiveness. Tooth color was realistically manipulated to assess its perceptibility and its influence on the judgment task. Influences of an improved dental appearance on the self-esteem of a person were not taken into account using this approach. Results generally indicated that teeth are noticed as a facial feature when assessing beauty. Only the eyes were mentioned more often, indicating that teeth play a rather important role in the assessment of a smiling face, especially in the assessment of male attractiveness.

Similar to most of the features, teeth were noticed more often as a negative facial feature, independent of tooth condition and manipulation. This agrees with studies that investigated the negativity bias, which have shown that negative aspects have a strong impact on judgment and evaluation processes and that they have the tendency to be more stable than positive aspects.[49–51]

Regarding the separate tooth manipulations, it was evident that whitened teeth were mentioned more often in a positive way than the original teeth. Versus the negative manipulation of colored teeth, they were additionally mentioned in a less negative way. Participants became aware of the whitened status. In contrast, however, participants did not consciously notice and name the discolored state of a maxillary lateral incisor. One may conclude that a positive or negative evaluation of tooth color goes along with a more positive or negative judgment of overall facial attractiveness. This statement is not sustainable given the present data. Attractiveness judgments were not influenced by tooth color. Neither the positive manipulation of whitened teeth nor the negative manipulation of a colored tooth resulted in differences in the overall judgments of attractiveness. For example, even though whitened teeth were noticed in a positive way, the overall attractiveness judgment did not improve in comparison to the original tooth condition. Furthermore, the overall attractiveness judgment of faces with whitened teeth was not better than that of faces with a colored tooth. Mechanisms of detailed dental tooth perception and of overall facial attractiveness evaluation are thus not necessarily dependent on one another. The naming of teeth as the second most important factor for evaluating the overall attractiveness of a smiling face implies that aspects of teeth other than color are important. Proportion and form improvement or impairment of the teeth might thus be valuable alternatives for further research.

Furthermore, participants in the study were mostly women. The contemplation of male and female faces focuses on different features, eg, the chin for male faces and the eyes and mouth for female faces.[3] Although it is not known whether female and male spectators look at different facial features for the assessment of attractiveness, this might have influenced the subjects' perceptions of the faces. Additionally, the results reflect the opinions of young people, who were judging faces of their peers. Because tooth color seems to play a more important role for young people than for older subjects,[35] whiter teeth will probably not have a great influence on attractiveness ratings for older people. Nonetheless, future studies may want to control for possible gender, culture, or age differences.

Interpreting the results in a broader sense, the growing public interest in whiter teeth and the expanding market of whitening products[52] represent a fashion trend and do not seem to relate strongly to perceived attractiveness. Social comparison is known to influence self-perception and might thus have led to the increasing demand for whitening procedures.[53–55] People compare themselves to illustrations in magazines, advertisements, or the dental status of celebrities, for example, all of which suggest that white teeth are important for happiness and success. The question of whether dentistry should support the trend toward whiter teeth cannot be answered here. From a psychologic point of view, unrealistic promises should be kept to a minimum to prevent disappointment in patients who might otherwise expect major changes in their attractiveness.

In general, the results of the present study contribute to a more objective understanding of the influence of tooth color on overall facial attractiveness. Changes in the color of normal teeth without extreme abnormalities do not improve or worsen overall facial attractiveness, as judged by young lay people.

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