

Contributions of dental colour to the *physical attractiveness stereotype*

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SUMMARY Dental appearance may play a key role on the way we develop a first impression of another person. To test whether relatively minor changes in the lightness of tooth colour would influence the perceived social appeal (social, intellectual, psychological and relational abilities) of an unknown male and unknown female, this cross-sectional study was performed on 555 Spanish adults. The two major independent variables related to the photograph were tooth lightness (computer-derived), divided into three levels that included lightened teeth, natural teeth and darkened teeth, and the gender of the observed face. Moreover, six independent variables related to the observer were assessed (age, gender, educational level, place of residence, frequency of brushing and self-reported health status). The dependent variables were scored on five-point Likert scales designed to quantify four domains (social, intellectual, psychological and relationship competences) of the Social Appeal Scale (SAS). Tooth lightness influences the perception of social

appeal in all dimensions, as darkened smiles received significantly poorer scores than natural-colour smiles, but these were also worse than lightened smiles. A logistic regression analysis revealed that the major predictor of social appeal was tooth lightness, and for each increment in lightness (from darkened to lightened smiles), the odds ratio (OR) of positive values being perceived increased significantly in all items (from 2.3 in *Popularity* to 6.9 in *Happiness*). A perceptible change in dental lightness is the strongest factor associated with the *dental attractiveness stereotype*, affecting significantly the 12 traits assessed, but mainly the *Happiness*, *Social Relations* and *Academic Performance*.

KEYWORDS: social perceptions, dental appearance, tooth colour, self-assessment, physical attractiveness stereotype

Accepted for publication 11 May 2014

Introduction

Physical appearance has traditionally been recognised as playing a key role in human social interactions. The role of several bodily and facial features in judgements of attractiveness has been used widely since the early 1970s, confirming that a person's overall appearance and face are the two major characteristics for assessing the physical attractiveness of both sexes, beyond other bodily and facial features such as the eyes, nose, hair and ears (1). In this sense, some authors (2, 3) have found that attractive people are

perceived as more popular, sociable, extraverted, clever, as well as more sexually assertive and happier than counterparts rated as less attractive. This was highlighted by Dion *et al.* (3) more than 40 years ago, revealing the existence of a *physical attractiveness stereotype*, based on the rationale that an attractive stereotype immediately evokes positive qualities, such as likeability, modesty, competence, friendliness, sensitivity and flexibility, as well as intelligence, leadership and success in social and professional life.

Except for severe bodily disfigurement, the face is usually the part of the body most exposed to, and

identifiable by, others, acting as a 'social card of presentation'. Furthermore, regarding the face, it is probably the eyes and mouth that would be the most important elements of facial attractiveness, because both these organs are moving parts and are the major components involved in social and emotional expression (4, 5). People's smiles are assumed to be one of the major components determining the attractiveness of facial appearance (6). There is evidence to support the notion that the aesthetics of the mouth has a significant effect on the way we develop a first impression of another person (7), thus modulating social interactions (8, 9) and even impinging on occupational performance (10, 11). Thus, harmony in faces and smiles has an impact on self-esteem and self-confidence, as we are often judged by our outward appearance (7, 12). Social attractiveness is influenced by a variety of different smile-related factors and should reflect a harmonious interplay between the teeth and gums, including tooth colour and the size and the shape of the teeth, as well as the visibility of the teeth and gums (13). These circumstances could underlie the current pattern of people's motivation to seek dental assistance. In dentistry, patient motivation for dental treatment has gradually shifted from functional or pain-related reasons to focusing on aesthetic-related requirements (14–16), probably due to a decrease in the prevalence and severity of caries, but also because of the emerging predominance of cosmetics within the mostly healthy populations of developed countries. Currently, people not only desire to be healthy but also to attain beauty ratings in accordance with the standards of beauty of the culture they belong to, probably in an attempt to gain personal benefit from the *physical attractiveness stereotype* and its presumed effects on personal success (17).

Three decades ago, Tedesco *et al.* (18, 19) found a basic consensus as regards factors of facial and dental attractiveness among adolescents of different races and sexes, suggesting the existence of relative standards of facial beauty, which start in childhood and last throughout life (20). However, there is no strong evidence to suggest that preferences for facial traits are inheritable instead of being influenced by the sociocultural environment (21). Despite this, there is increasing evidence, suggesting that attitudes towards the importance of general appearance have varied considerably, not only over time but also among

groups of individuals from different sociodemographic backgrounds (age, gender, educational level) and with different self-assessed health statuses (22). Strikingly, even in the case of professionals working in the dental health field, it has been shown that the significance of dental appearance varies widely among dentists, dental technicians and people with other professional profiles (14, 23). In addition, recent work has demonstrated lack of a correlation between dentists and patients regarding dental appearance (23).

Over the years, several studies have deployed simple methods based on computer-aided image manipulation to investigate the significance of dental appearance on social judgements (6, 7, 24). Thus, they have employed photographs showing different dental appearances, but holding all other facial features constant, to analyse the impact of such changes. These studies have demonstrated that over a range of judgements, including numerous personality traits, people are perceived more favourably when they have healthy dentition as opposed to abnormal tooth colour (caused by caries or severe dental fluorosis) or tooth arrangement (9, 18, 19, 25, 26). The presence of apparently healthy (7, 24), straight teeth (27), – but also the colour, size and visibility of the teeth and gums as well as the position of the upper lip – are considered critical factors in the self-perception of smile attractiveness (17).

However, to date, none of the studies has addressed the impact of dental appearance on social judgements (*dental attractiveness stereotype*) when an apparently sound and straight smile is computer manipulated only to increase or reduce the lightness of natural tooth colour. Furthermore, the confounding effect of some potential covariables such as age, sex, educational status or self-rated health remains unclear (7, 24). The null hypothesis of the present study is that a perceptible change in dental lightness would not impinge on the *dental attractiveness stereotype*.

Objectives

The present work aims to test the hypothesis that relatively minor changes in the lightness of tooth colour would influence the perceived social appeal (social, intellectual, psychological and relational abilities) of an unknown male and unknown female by means of computer-manipulated photographs.

Methods

This study was revised and approved by the Bioethics Committee of the University of Salamanca. For the purposes of this study, a cross-sectional design was used in which participants viewed a single image from a possible choice of six. The two major independent variables related to the photograph were tooth lightness, divided into three levels that included lightened teeth, natural teeth and darkened teeth, and the gender of the observed face. Moreover, there were six independent variables related to the observer, that is age, gender, educational level, place of residence, frequency of brushing and self-reported health status. The dependent variables were scored on five-point Likert scales designed to quantify four domains of social appeal (social, intellectual, psychological and relationship competences). This scale has been used previously by other authors with similar objectives (7, 24).

A full-face colour digital photograph (14 Mb) was taken of two subjects (male and female and henceforth referred to as 'models'), unknown to the observers smiling in a way that exposed their apparently healthy smile, with straight anterior maxillary teeth, using a tripod-supported Canon EOS-400 digital camera without flash in a naturally lit environment. The models were young Caucasians of no apparent ethnic origin (Fig. 1). No jewellery, glasses or make-up were worn, and their monochromatic clothes and the background were unremarkable. These original photographs were considered to be the pattern of naturally lit smiles for both subjects. Using the *quick selection* and the *polygonal lasso* functions of the PHOTOSHOP CS6 SOFTWARE*, the natural appearance of both smiles was changed by increasing and decreasing the exposure of the teeth by 0.1 unit using an overlapped layer created with the *layer via copy* function. Then, the colour difference (ΔE_{ab}) was transformed from the RGB to the CIELab system using the colour calculator application (<http://www.easyrgb.com/>) to verify that all the colour increments (from darkened to natural and then to lightened) were above 6 units, based on the assumption that differences in colour (ΔE_{ab}) > 5.5 units are clinically very evident to the human eye (28). Apart from the lightness of the teeth, all facial features were standardised. Thus, we finally obtained

six photographs, three for each model: the natural and the two computer-derived photographs resulting from changing tooth lightness in both directions by 7.3 units on average (the lightened and the darkened photographs).

Seven copies of each of these photographs were laser-printed onto photographic paper using a 21 cm × 30 cm portrait format. The 42 photographs were distributed in sealed envelopes among 42 undergraduate students from the fourth course of the dentistry degree at the University of Salamanca in the last lecture before the Christmas holidays. The students were previously informed about the purpose and methodology of the study and were randomly given a single photograph with 15 questionnaires for distribution among their family members, friends or companions during the holidays. Participants were initially told that the purpose of the study was to explore 'how we make judgements about people by means of photographs'. The questionnaire comprised an observer-related section in which data on sociodemographic, behavioural and self-rated dental health status of the participant were gathered, and a photograph-related section in which the participating subjects recorded their perception about the social appeal of the model in the photograph. This so-called Social Appeal Scale (SAS), which was originally used for the same purposes by Newton *et al.* (7) and was later expanded by Kershaw *et al.* (24), comprises 12 items distributed in four domains (three each): social competence (SC), intellectual ability (IA), psychological adjustment (PA) and relationship satisfaction (RS), as depicted in Fig. 2. All respondents were asked to record their answers on a five-point Likert scale: the extent to which they perceived the model in the photograph as having certain appealing social characteristics. The total summary scores of the scale and the dimensions were calculated by adding the number of items with positive responses (two of the other three which were neutral or negative) to generate a quantitative variable for subsequent analysis.

Statistical analysis

Nonparametric (chi-square and Kruskal-Wallis tests) and parametric tests (Student's *T*-test and ANOVA with *post hoc* Bonferroni corrections) were used to analyse the modulating factors of the Social Appeal Scale. Furthermore, a forward stepwise regression analysis

*Adobe system; San José, CA, USA.



Fig. 1. The lightened, natural and darkened photographs used in this study.

including all the potentially related sociodemographic, behavioural and subjective variables was carried out to predict social appeal based on the observer-related factors and those related to the model observed in the photograph. Pearson correlation coefficients were calculated to test the linear relationship of the total summary score of the scale with each subscale. All analyses were performed with the SPSS v.21.[†]

Results

As shown in Table 1, the study sample comprised 555 subjects, 53% being females, living mostly in urban areas (78.7%). Mean age was 39.3 ± 17.3 years. The educational status of the subjects was mainly university level (57.8%), and in terms of behaviour, 76.2%

of the sample brushed their teeth at least twice a day; 70.5% did not smoke and 55.1% were problem-based dental attendees. The participants assessing photographs of the male target (model) were comparable in sociodemographic and behavioural terms to those assessing photographs of the female model, except for the educational level and place of residence, that is high school level and urban residence were more common in the subjects assessing photographs of the male model (Table 1).

Regarding the distribution of self-rated health status and satisfaction, Table 2 shows that the study sample mostly rated their health as good (33.5%) or fair (28.8%). In general, participants were satisfied with both the appearance (64.1%) and the colour (54.6%) of their central incisors, and they did not conceal their teeth when smiling (81.1%). This distribution was comparable among subjects assessing the photographs of the male or female models.

[†]Statistical Package for the Social Sciences, Chicago, IL, USA.

Appendix A Items used to measure personality traits				
Social competence (SC)				
SC1: The subject works for a big organisation. Rate how popular you think the individual is with other colleagues				
0 Very unpopular	1 Quite unpopular	2 Indifferent	3 Quite popular	4 Very popular
SC2: How friendly does the individual appear?				
0 Very unfriendly	1 Quite unfriendly	2 Indifferent	3 Quite friendly	4 Very friendly
SC3: How trustworthy does the individual appear?				
0 Very untrustworthy	1 Quite untrustworthy	2 Indifferent	3 Quite trustworthy	4 Very trustworthy
Intellectual ability (IA)				
IA1: Rate how successful the individual was at school				
0 Very unsuccessful	1 Quite unsuccessful	2 Indifferent	3 Quite successful	4 Very successful
IA2: How intelligent does the individual appear to be?				
0 Very unintelligent	1 Quite unintelligent	2 Indifferent	3 Quite intelligent	4 Very intelligent
IA3: How possible was it for the individual to be successful at university?				
0 Very impossible	1 Quite impossible	2 Indifferent	3 Quite possible	4 Very possible
Psychological adjustment (PA)				
PA1: How introverted or extroverted does the individual seem?				
0 Very introverted	1 Quite introverted	2 Indifferent	3 Quite extroverted	4 Very extroverted
PA2: How happy does the individual appear to be?				
0 Very unhappy	1 Quite unhappy	2 Indifferent	3 Quite happy	4 Very happy
PA3: How self-confident is the individual?				
0 Not at all self-confident	1 Not very self-confident	2 Indifferent	3 Quite self-confident	4 Very self-confident
Relationship satisfaction (RS)				
RS1: How attractive is the individual?				
0 Very unattractive	1 Quite unattractive	2 Indifferent	3 Quite attractive	4 Very attractive
RS2: How sexually fulfilled is the individual?				
0 Very unfulfilled	1 Quite unfulfilled	2 Indifferent	3 Quite fulfilled	4 Very fulfilled
RS3: How likely is the individual to be in a relationship?				
0 Very unlikely	1 Quite unlikely	2 Indifferent	3 Quite likely	4 Very likely

Fig. 2. The Social Appeal Scale. Taken from Kershaw *et al.* (24).

The colour change (ΔE_{ab}) from darkened to natural tooth colour was 8.5 for the females and 6.4 for the males, and between the natural and the lightened photographs, the values were 9.9 and 8.6, respectively. Table 3 shows that tooth lightness influences the perception of social appeal in all dimensions, as darkened smiles received significantly poorer scores than natural-colour smiles, but these were also worse than lightened smiles.

Table 4 shows that tooth lightness influences the perception of appeal in all dimensions, as darkened smiles were awarded significantly lower scores. In general, however, the gender of the model was not a significant factor, except for the 'relationship competences' in which females showed higher positive scores than males when tooth lightness was natural. This trend was also observed within the total score, but it did not reach the level of significance. It is

Table 1. Description of the sociodemographic and behavioural variables among the study sample ($n = 555$)

	All subjects ($n = 555$)	Assessing males ($n = 248$)	Assessing females ($n = 307$)
Age (mean $\pm$ SD)	39.3 $\pm$ 17.3	39.0 $\pm$ 17.5	39.5 $\pm$ 17.1
<30 years (n ; %)	222; 40.0%	102; 41.1%	120; 39.1%
30–59 years (n ; %)	260; 46.8%	111; 44.8%	149; 48.5%
≥ 60 years (n ; %)	73; 13.2%	35; 14.1%	38; 12.4%
Gender			
Female (n ; %)	294; 53%	135; 54.4%	159; 51.8%
Male (n ; %)	261; 47%	113; 45.6%	148; 48.2%
Education level*			
Primary School (n ; %)	83; 15%	28; 11.3%	55; 17.9%
High School (n ; %)	151; 27.2%	86; 34.7%	65; 21.2%
University (n ; %)	321; 57.8%	134; 54%	187; 60.9%
Residence*			
Urban (n ; %)	437; 78.7%	219; 88.3%	218; 71%
Rural (n ; %)	118; 21.3%	29; 11.7%	89; 29%
Smoking (n ; %)			
No	391; 70.5%	165; 66.5%	226; 73.6%
Yes	164; 29.5%	83; 33.5%	81; 26.4%
Dental attendance			
Check-up visits	249; 44.9%	109; 44%	140; 45.6%
Problem-based brushing habits	306; 55.1%	139; 56%	167; 44.4%
<twice/day	132; 23.8%	60; 24.2%	72; 23.5%
$\geq$ twice/day	423; 76.2%	188; 75.8%	235; 76.5%

*Significant differences in the data distribution between groups after chi-square tests.

noteworthy that for the darkened smiles, males mostly scored higher than females, although this was not significant. The total summary score of the Social Appeal Scale was more correlated with psychological competences ($r = 0.87$; $P < 0.01$) than with 'relationship satisfaction' ($r = 0.84$, $P < 0.01$), and intellectual and social abilities ($r = 0.83$, $P < 0.01$).

The results obtained from the logistic regression analysis for modelling the number of items recorded as positive across the Social Appeal items (Table 5) revealed a parsimonious set of independent observer- and target-related variables included in these significant regression models, with a moderate prediction capacity (R^2 Nagelkerke) ranging from 0.19 in *Popularity* to 0.44 in *Happiness* and *Social Relations*. The major factor associated with social appeal was tooth lightness, and for each increment in lightness (from darkened to lightened smiles), the odds ratio (OR) of positive values being perceived increased significantly in all items (from 2.3 in *Popularity* to 6.9 in *Happiness*). The other photograph-related independent variable (sex of the model) influenced the *Personality*, *Attrac-*

tiveness and *Partner Relations* items, but in the opposite way, that is when the photograph was of male, the OR of being considered extraverted was increased, while the OR of being perceived as attractive or having successful partner relations was reduced. Regarding the observer-related independent variables, the most powerful associated factors were sociodemographic (mainly gender, but also age, educational level and place of residence). When the observer was female, the OR of perceiving positive values increased significantly in terms of *Trustworthiness*, *School Performance*, *Academic Performance*, *Happiness*, *Self-confidence*, *Social* and *Partner Relations*. Also, the older the observer, the greater the OR concerning *Popularity*, *Self-Confidence*, *Attractiveness* and *Partner relations*. Moreover, the higher the education level, the lower the OR of positive values being attributed in *Intelligence* and *Attractiveness*. The place of residence only influenced perceived *Intelligence*, being higher for rural than for urban residents. The only significant factor related to self-reported health was the hiding of the teeth when smiling. Observers reporting this behaviour had

Table 2. Description of the self-rated oral health status among the study sample ($n = 555$)

	All subjects ($n = 555$)	Assessing males ($n = 248$)	Assessing females ($n = 307$)
Oral health			
Very good	58; 10.5%	21; 8.5%	37; 12.1%
Good	186; 33.5%	96; 38.7%	90; 29.3%
Fair	160; 28.8%	68; 27.4%	92; 30.0%
Bad	118; 21.3%	46; 18.5%	72; 23.5%
Very bad	33; 5.9%	17; 6.9%	16; 5.2%
Dental appearance			
Very satisfied	55; 9.9%	21; 8.5%	34; 11.1%
Satisfied	301; 54.2%	131; 52.8%	170; 55.4%
Indifferent	86; 15.5%	38; 15.3%	48; 15.6%
Dissatisfied	96; 17.3%	48; 19.4%	48; 15.6%
Very dissatisfied	17; 3.1%	10; 4.0%	7; 2.3%
Dental colour			
Very satisfied	30; 5.4%	14; 5.6%	16; 5.2%
Satisfied	273; 49.2%	123; 49.6%	150; 48.9%
Indifferent	120; 21.6%	53; 21.4%	67; 21.8%
Dissatisfied	118; 21.3%	53; 21.4%	65; 21.2%
Very dissatisfied	14; 2.5%	5; 2.0%	9; 2.9%
Hiding smile			
No	450; 81.1%	200; 80.6%	250; 81.4%
Yes	101; 18.2%	47; 19.0%	54; 17.6%
Missing data	4; 0.7%	1; 0.4%	3; 1.0%

greater probability of perceiving positive values in *Popularity*, *Trustworthiness* and *Academic Performance*. In sum, the main significant factor for all the items was that introduced experimentally by computer-aided manipulation (lightness), although the gender and the age of the observer also partially modulated the probability of positive perceptions being perceived. It is noteworthy that for *Partner Relations*, both the gender of the observer and the gender of the target (photograph, model) significantly modulated the probability of positive responses to a similar extent. Women, as both observers and as observed persons, were those who showed an increased probability of perceiving or being perceived as a successful partner and vice versa, whereas in men (observers or target), this probability was significantly reduced.

Discussion

The present study aimed to recreate Kershaw's study published in 2008 (24), which was based on work published in 2003 by Newton (7). However, here we introduced some methodological changes in an attempt to examine the impact of a single dental attri-

bute (lightness) on social judgements in greater depth.

The main differences with respect to the reference studies should be reviewed to better understand our contributions to the field of the *dental attractiveness stereotype*. First, in the Newton study (7), the Social Appeal Scale only comprised the first three domains (*Social Competences*, *Intellectual ability* and *Psychological adjustments*) shown in Fig. 2, whereas we used the full four-domain scale used by Kershaw (24), designating it the Social Appeal Scale. This has been validated previously among the Spanish population, revealing the good psychometric properties and high reliability of the scale (0.93) and subscales (ranging from 0.83 to 0.87) (Gómez-Polo C, Santos J, Vicente MP, Galindo MP, Montero J., Validation of the Social Appeal Scale among Spanish population. under review).

Moreover, to restrict the variables that might influence judgements, Newton (7) used photographs of adult white males only, thus being unable to measure the effect that gender or ethnicity might exert on such judgements. In contrast, Kershaw (24) used photographs of Indian males and females, in spite of being aware that the social judgements recorded within a mostly white responding sample could be

Table 3. Distribution of Social Appeal Scale responses according to photograph lightness ($n = 555$)

	Darkened ($n = 166$)	Natural ($n = 191$)	Lightened ($n = 198$)
Popularity**			
Very unpopular	5; 3.0%	1; 0.5%	3; 1.5%
Quite unpopular	53; 31.9%	13; 6.8%	8; 4.0%
Indifferent	73; 44.0%	57; 29.8%	62; 31.3%
Quite popular	31; 18.7%	97; 50.8%	107; 54.0%
Very popular	4; 2.4%	23; 12.0%	18; 9.1%
Friendliness**			
Very unfriendly	7; 4.2%	0; 0.0%	1; 0.5%
Quite unfriendly	61; 36.7%	7; 3.7%	3; 1.5%
Indifferent	49; 29.5%	23; 12.0%	21; 10.6%
Quite friendly	43; 25.9%	131; 68.6%	135; 68.2%
Very friendly	6; 3.6%	30; 15.7%	38; 19.2%
Trustworthiness**			
Very untrustworthy	11; 6.6%	3; 1.6%	1; 0.5%
Quite untrustworthy	65; 39.2%	11; 5.8%	4; 2.0%
Indifferent	54; 32.5%	52; 27.2%	40; 20.2%
Quite trustworthy	32; 19.3%	111; 58.1%	118; 59.6%
Very trustworthy	4; 2.4%	14; 7.3%	35; 17.7%
School performance**			
Very unsuccessful	15; 9.0%	2; 1.0%	0; 0.0%
Quite unsuccessful	67; 40.4%	22; 11.5%	17; 8.6%
Indifferent	57; 34.3%	78; 40.8%	53; 26.8%
Quite successful	26; 15.7%	73; 38.2%	84; 42.4%
Very successful	1; 0.6%	16; 8.4%	44; 22.2%
Intelligence**			
Very unintelligence	22; 13.3%	2; 1.0%	0; 0.0%
Quite unintelligence	59; 35.5%	9; 4.7%	9; 4.5%
Indifferent	49; 29.5%	78; 40.8%	32; 16.2%
Quite intelligence	34; 20.5%	85; 44.5%	110; 55.6%
Very intelligence	2; 1.2%	17; 8.9%	47; 23.7%
Academic performance**			
Very unsuccessful	21; 12.7%	3; 1.6%	0; 0.0%
Quite unsuccessful	53; 31.9%	11; 5.8%	4; 2.0%
Indifferent	65; 39.2%	66; 34.6%	25; 12.6%
Quite successful	25; 15.1%	85; 44.5%	115; 58.1%
Very successful	2; 1.2%	26; 13.6%	54; 27.3%
Personality**			
Very introverted	24; 14.5%	0; 0.0%	0; 0.0%
Quite introverted	72; 43.4%	13; 6.8%	13; 6.6%
Indifferent	39; 23.5%	36; 18.8%	22; 11.1%
Quite extroverted	26; 15.7%	112; 58.6%	92; 46.5%
Very extroverted	5; 3.0%	30; 15.7%	71; 35.9%
Happiness**			
Very unhappy	33; 19.9%	1; 0.5%	1; 0.5%
Quite unhappy	63; 38.0%	8; 4.2%	1; 0.5%
Indifferent	39; 23.5%	28; 14.7%	21; 10.6%
Quite happy	26; 15.7%	115; 60.2%	89; 44.9%
Very happy	5; 3.0%	39; 20.4%	86; 43.4%
Self-confidence**			
Not at all	30; 18.1%	2; 1.0%	2; 1.0%
Not very self-confident	55; 33.1%	11; 5.8%	6; 3.0%

(continued)

Table 3. (continued)

	Darkened (<i>n</i> = 166)	Natural (<i>n</i> = 191)	Lightened (<i>n</i> = 198)
Indifferent	51; 30.7%	52; 27.2%	24; 12.1%
Quite self-confident	28; 16.9%	96; 50.3%	91; 46.0%
Very self-confident	2; 1.2%	30; 15.7%	75; 37.9%
Attractiveness**			
Very unattractive	35; 21.1%	15; 7.9%	6; 3.0%
Quite unattractive	68; 41.0%	32; 16.8%	19; 9.6%
Indifferent	47; 28.3%	72; 37.7%	32; 16.2%
Quite attractive	15; 9.0%	65; 34.0%	76; 38.4%
Very attractive	1; 0.6%	7; 3.7%	65; 32.8%
Partner relations**			
Very unsuccessful	40; 24.1%	4; 2.1%	2; 1.0%
Quite unsuccessful	52; 31.3%	14; 7.3%	9; 4.5%
Indifferent	53; 31.9%	90; 47.1%	38; 19.2%
Quite successful	19; 11.4%	74; 38.7%	82; 41.4%
Very successful	2; 1.2%	9; 4.7%	67; 33.8%
Social relations**			
Very unsatisfactory	41; 24.7%	1; 0.5%	0; 0.0%
Quite unsatisfactory	59; 35.5%	10; 5.2%	2; 1.0%
Indifferent	42; 25.3%	69; 36.1%	23; 11.6%
Quite satisfactory	23; 13.9%	90; 47.1%	99; 50.0%
Very satisfactory	1; 0.6%	21; 11.0%	74; 37.4%

**Very high significant ordinal distribution after Kruskal–Wallis nonparametric tests ($P < 0.001$).

partially explained in terms of this ethnic origin, thus confounding the interpretation of their conclusions. This is why we used young Caucasians (male and female) with no apparent ethnic origin, being aware that the effect of the ethnicity of the target could not be explored with this method. However, at least by standardising this factor (ethnicity), the effect of the other potential factors could be explored within the most common ethnicities among the Spanish population.

In both studies, sample size and the sociodemographic spectrum of the sample were not sufficient to properly explore the main confounding and modifying variables, except the dental appearance, which was identified as the major predictor. In Newton's study (7), complete data were only available from 164 British undergraduate students belonging to 11 different ethnicities, assessing eight types of photographs of four men. This provided a broad range of potentially related variables for a relatively small cell size, which would reduce the power of the analysis. Kershaw's conclusions are based on those reported by 180 female dental patients from South London with a mean age of 24.3 ± 3.9 years (24), limiting the exploration of the effect of the gender of the observer. In

both studies, the effect of observer age could not be assessed properly, as the samples comprised undergraduate students (7) and young females (24). However, our sample contained a broad age range, including youths, adults and elderly people (Table 1) from different regions of Spain, because our students collected all data from their family members, friends and/or acquaintances during the Christmas holidays, such that the sociodemographic spectrum of the sample was enriched.

In both studies (7, 24), the scale and subscale summary scores were derived from summing the item responses, which were coded arbitrarily on an ordinal scale (e.g. from 1 to 5, or from 0 to 4), and the resulting variable was treated as quantitative (by means of analysis of variance or linear regression), when in fact the equidistance between the category values, which all quantitative variables possess, should not have been assumed. A better methodological approach could be that applied in the present study, in which we counted the items recorded as positive (the last two categories) to obtain a pure quantitative variable, as used in other Likert scale-based questionnaires. This is known as the simple-count method (29). In the same sense, we performed a logistic regression

Table 4. Comparisons of the number of items positively recorded across the Social Appeal dimensions, depending on the lightness and gender of the model photograph. ANOVA with *post hoc* Bonferroni correction

Total score	Lightness		
	High	Natural	Low
Male photograph	9.5 ± 2.6 ^A	6.9 ± 3.2 ^B	2.4 ± 3.4 ^C
Female photograph	9.5 ± 2.5 ^A	7.7 ± 2.5 ^B	2.0 ± 2.9 ^C
<i>F</i> = 118.77, d.f.: 5; <i>P</i> < 0.001			
Social competence			
Male photograph	2.3 ± 0.9 ^A	2.0 ± 1.0 ^A	0.9 ± 1.2 ^B
Female photograph	2.2 ± 1.0 ^A	2.2 ± 0.9 ^A	0.6 ± 1.0 ^B
<i>F</i> = 54.11, d.f.: 5; <i>P</i> < 0.001			
Intellectual competence			
Male photograph	2.3 ± 1.0 ^A	1.5 ± 1.2 ^B	0.6 ± 1.0 ^C
Female photograph	2.3 ± 0.9 ^A	1.7 ± 1.2 ^B	0.5 ± 0.9 ^C
<i>F</i> = 52.83, d.f.: 5; <i>P</i> < 0.001			
Psychological competence			
Male photograph	2.6 ± 0.8 ^A	2.2 ± 0.9 ^A	0.6 ± 1.1 ^B
Female photograph	2.5 ± 0.8 ^A	2.2 ± 0.9 ^A	0.5 ± 1.0 ^B
<i>F</i> = 96.22, d.f.: 5; <i>P</i> < 0.001			
Relationship competence			
Male photograph	2.3 ± 0.9 ^A	1.2 ± 1.1 ^B	0.3 ± 0.8 ^D
Female photograph	2.4 ± 0.9 ^A	1.6 ± 1.1 ^C	0.4 ± 0.8 ^D
<i>F</i> = 78.16, d.f.: 5; <i>P</i> < 0.001			

Significant two-by-two comparisons after Bonferroni *post hoc* analyses are depicted by different superscript letters.

analysis to predict positive social values instead of a linear regression analysis to predict the summary values. This was because we wished to analyse the odds ratio of positive responses by each item, and using the so-called simple-count method each item could only score 0 or 1. Thus, a logistic probabilistic model was generated.

In an attempt to assess the impact of visible dental disease on social judgements, both reference studies (7, 24) arbitrarily manipulated the appearance of visible teeth (by discolouration and/or cavitated decay), introducing such factors jointly and hence jeopardising the estimation of the independent effect of each of these restorable conditions. In our study, we focused only on the impact of lightness in an apparently sound smile by increasing or decreasing it by an over- or underexposure of 0.1, resulting in an evident colour change ($\Delta E_{ab} \approx 7$ units) whose magnitude would be similar to that obtained with whitening treatments (30), assuming that tooth colour is a strong factor in dental aesthetic satisfaction (31).

The main limitations to our study are that according to the CIELab color system, the natural tooth

lightness of both models was not similar and neither was the magnitude of change in colour after the symmetric manipulation of exposure by 0.1 units using Photoshop Software. Thus, the baseline conditions were not comparable, although in any case, the effect of increasing or decreasing lightness to the same extent was measured adequately. Furthermore, we have no evidence regarding the consistency of the appraisals made by participants, as they were constrained to make arbitrary judgements about people unknown to them and no test-retest analysis was performed to confirm the consistency of such ratings. Nevertheless, the trends of the responses do not seem to be spurious and are apparently coherent with the underlying theory about the *physical attractiveness stereotype* suggested by Dion decades ago (3).

The main findings of the current study revealed that participants responded to changes in tooth lightness as expected, perceiving poorer social appeal from darkened smiles across the 12 items of the scale. This is in agreement with previous research demonstrating that visible dental disease or tooth discolouration impinges negatively on the perceptions of the social appeal of targets (6, 7, 24, 32). Conversely, other authors consider that lightened teeth (33, 34) are not clearly associated with facial attractiveness.

Our results expand the evidence of the existence of a *dental attractiveness stereotype*, which may be partially responsible for the emergence of aesthetic reasons for requesting dental treatment (15) and the concomitant increase in the demand of commercial bleaching products and techniques (35). By contrast, a certain degree of social exclusion could be presumed in the case of subjects with darkened smiles living in today's cosmetically driven populations. Dental appearance and visible dental disease are significantly correlated with satisfaction and oral health-related quality of life (36), with self-esteem (12), and may even impair the occupational performance of workers (11) or personal success (17).

In our study, we observed that tooth lightness was the strongest factor of social appeal (Table 4), significantly affecting the 12 traits assessed, but mainly as regards happiness, social relations and academic performance (Table 5). Given this, an increasing number of subjects seeking tooth whitening and other cosmetic procedures to improve their dental appearance would be expected. In fact, in our series, 46.1% of the sample would be prepared to seek dental bleach-

Table 5. Stepwise forward logistic regression models of reporting positive responses (versus indifferent or negative) across the Social Appeal Scale domains after including all the potentially related sociodemographic behavioural and subjective variables depicted in Tables 1 and 2

Models/parameters	Wald hypothesis contrast				OR 95% CI	
	B	Error	Odds ratio	P-value	Lower	Upper
Popularity*						
Intersection	-1.85	0.27	0.16	0.000		
Age (years)	0.02	0.01	1.02	0.000	1.01	1.03
Dental lightness	0.85	0.12	2.34	0.000	1.86	2.95
Dissimulation (no/yes)	0.55	0.25	1.73	0.026	1.07	2.79
Friendliness†						
Intersection	-0.57	0.15	0.57	0.000		
Dental lightness	1.56	0.15	4.74	0.000	3.53	6.36
Trustworthiness‡						
Intersection	-1.34	0.20	0.26	0.000		
Gender (female as reference)	-0.42	0.20	0.66	0.032	0.45	0.97
Dental lightness	1.24	0.13	3.47	0.000	2.70	4.47
Dissimulation (no/yes)	0.71	0.27	2.02	0.008	1.20	3.42
School performance§						
Intersection	-1.67	0.20	0.19	0.000		
Gender (female as reference)	-0.43	0.19	0.65	0.024	0.45	0.95
Dental lightness	1.08	0.12	2.94	0.000	2.31	3.74
Intelligence¶						
Intersection	-0.15	0.32		0.630		
Dental lightness	1.36	0.13	3.90	0.000	3.00	5.06
Education (School vs High school)	-0.66	0.33	0.52	0.044	0.27	0.98
Education (School vs University)	-0.90	0.30	0.41	0.003	0.22	0.74
Residence (Rural vs Urban)	-0.55	0.26	0.58	0.032	0.35	0.96
Academic performance**						
Intersection	-1.85	0.22	0.16	0.000		
Gender (female as reference)	-0.43	0.21	0.65	0.039	0.43	0.98
Dental lightness	1.71	0.15	5.51	0.000	4.12	7.36
Dissimulation (no/yes)	0.60	0.28	1.83	0.034	1.05	3.19
Personality††						
Intersection	-1.24	0.19	0.29	0.000		
Sex of the model (female vs male)	0.40	0.21	1.50	0.049	1.00	2.24
Dental lightness	1.54	0.14	4.67	0.000	3.55	6.18
Happiness‡‡						
Intersection	-1.46	0.22	0.23	0.000		
Gender (female as reference)	-0.66	0.23	0.52	0.003	0.33	0.80
Dental lightness	1.94	0.17	6.94	0.000	5.01	9.61
Self-confidence§§						
Intersection	-2.16	0.33	0.12	0.000		
Age (years)	0.01	0.01	1.01	0.046	1.00	1.02
Gender (female as reference)	-0.76	0.21	0.47	0.000	0.31	0.71
Dental lightness	1.62	0.15	5.07	0.000	3.82	6.74
Attractiveness¶¶						
Intersection	-2.43	0.57	0.10	0.000		
Age (years)	0.02	0.01	1.02	0.02	1.00	1.03
Sex of the model (female vs male)	-0.56	0.22	0.57	0.01	0.38	0.88
Dental lightness	1.64	0.15	5.15	0.000	3.828	6.938
Education (School vs High school)	-0.98	0.38	0.38	0.009	0.18	0.79
Education (School vs University)	-0.64	0.36	0.53	0.07	0.26	1.06

(continued)

Table 5. (continued)

Models/parameters	Wald hypothesis contrast				OR 95% CI	
	B	Error	Odds ratio	P-value	Lower	Upper
Partner relations***						
Intersection	-2.51	0.34	0.08	0.000		
Age (years)	0.02	0.01	1.02	0.008	1.00	1.03
Gender (female as reference)	-0.43	0.20	0.65	0.036	0.44	0.97
Sex of the model (female vs male)	-0.42	0.20	0.66	0.038	0.44	0.98
Dental lightness	1.52	0.14	4.56	0.000	3.47	6.01
Social relations***						
Intersection	-1.91	0.23	0.15	0.000		
Gender (female as reference)	-0.45	0.22	0.64	0.034	0.42	0.98
Dental lightness	1.87	0.16	6.48	0.000	4.78	8.80

* $\chi^2 = 84.427$, gl = 3; $P < 0.001$; Nagelkerke $R^2 = 0.19$.

* $\chi^2 = 142.825$, gl = 1; $P < 0.001$; Nagelkerke $R^2 = 0.32$.

* $\chi^2 = 126.688$, gl = 3; $P < 0.001$; Nagelkerke $R^2 = 0.28$.

* $\chi^2 = 92.67$, gl = 2; $P < 0.001$; Nagelkerke $R^2 = 0.21$.

* $\chi^2 = 144.17$, gl = 4; $P < 0.001$; Nagelkerke $R^2 = 0.31$.

** $\chi^2 = 196.65$, gl = 3; $P < 0.001$; Nagelkerke $R^2 = 0.40$.

** $\chi^2 = 160.17$, gl = 2; $P < 0.001$; Nagelkerke $R^2 = 0.34$.

** $\chi^2 = 211.42$, gl = 2; $P < 0.001$; Nagelkerke $R^2 = 0.44$.

** $\chi^2 = 184.65$, gl = 3; $P < 0.001$; Nagelkerke $R^2 = 0.38$.

** $\chi^2 = 199.01$, gl = 6; $P < 0.001$; Nagelkerke $R^2 = 0.41$.

*** $\chi^2 = 169.03$, gl = 4; $P < 0.001$; Nagelkerke $R^2 = 0.35$.

*** $\chi^2 = 216.56$, gl = 2; $P < 0.001$; Nagelkerke $R^2 = 0.44$.

ing procedures (results not shown), even though the distribution of satisfaction with dental appearance (64.1%) and tooth colour (54.6%) was only slightly lower than that reported for British adults in an epidemiological study (37).

The gender of the model also significantly modulates certain traits such as *Personality*, *Attractiveness* and *Partner Relations*, although with a lower weight in the regression model and mainly related to the *Relationship Satisfaction* domain. Kershaw failed to find any significant influence of the gender of the model in social appeal (24). There is no clear explanation for this factor (model-related gender) apart from the fact that there are multiple physical traits between the targets that might have influenced this trend. In this sense, Newton (7) found that some face profiles were interpreted as reflecting high intellectual, social and psychological ability regardless of dental appearance or the gender of the target (all were white males). It is necessary to take into account that tooth colour is only one of the major parameters determining the facial attractiveness (33, 38).

Nevertheless, it is assumed that in any given population, most of the gender-due differences in personal-

ity may result from the adoption of gender roles that define appropriate conduct for males and females (gender stereotypes) (2). In addition, if Dion's postulate 'what is beautiful is good' (3) is adopted, we should assume that some personality traits may be more desirable or tolerable by males or females and that the *dental physical stereotype* is able to project what is considered good for one gender or the other onto what is considered beautiful. This complex issue would need further research from a psycho-social point of view in different cultural backgrounds as there is increasing evidence that gender personality differences are surprisingly more pronounced in European and American cultures, in which traditional sex roles are minimised (39).

In disagreement with the reference studies (7, 24), whose authors found that none of the sociodemographic characteristics (age, gender, education), or behavioural variables (dental pattern) or subjective variables (self-rated oral health), had any effect on the ratings given by participants to the photographs shown, our results demonstrate that the participants' sociodemographic characteristics (gender, age, education and place of residence) are involved as significant

factors in several social judgements (Table 5). Women seem to be more sensitive to the *dental attractiveness stereotype*, awarding higher social ratings to similar dental conditions in *Trustworthiness*, *School Performance*, *Academic Performance*, *Happiness*, *Self-confidence*, *Social* and *Partner Relations*. Perhaps this could be because females are also more sensitive to appearance (14, 40).

In contrast to Eli *et al.* (6), who stated that the effect of dental appearance on the evaluation of the target was most prominent when respondents of both sexes rated targets of the opposite sex, we found that only for *Partner Relations* was the gender of both the observer and target (photograph) involved in the set of significant predictors, although the probability a successful partner relationship being perceived was increased when women assessed female targets, whereas the opposite was seen in the case of men assessing men. Again, we believe that this result could be due to the global beauty profile of the specific targets used here. If the facial configuration of the female target used here is more attractive in our context, and women are more sensitive to beauty (as we have stated here), then it would be more likely that better scores would be obtained when women perceive the women, and vice versa in the case of men. In any case, it seems evident that gender is consistently important in determining the impact of dental appearance on social judgements.

Regarding age, as most dental disease is cumulative, leading to impaired oral function, older subjects are well aware of the social implications of a youthful smile and also tend to give higher ratings in *Popularity*, *Self-Confidence*, *Attractiveness* and *Partner relations*. This positive effect of age has already been reported elsewhere (33, 34). The educational level and place of residence may modulate the likelihood of a positive social appraisal being given. The explanation of such variables could rely on the fact that higher educational levels do not attribute positive values in *Intelligence* and *Attractiveness* based only on a full-face photograph, however light the smile, as they may have accumulated experience of the variability in this trait from their own educational experience. People residing in rural areas are more likely to perceive higher values of intelligence in people they are not acquainted with than urbanites. Because cosmetic smiles are more common in rich individuals, people from rural settings may associate this trait with intelli-

gence, which is not the case of urbanites. It is not surprising that subjects who hide teeth when smiling are more sensitive to the dental attractiveness stereotype, because they may be assumed to have visible dental disease and this would affect their normal functioning as they are aware of the social consequences of a pleasant smile. This is in disagreement with what was reported by Newton, who found that the effect of participants' self-rated oral health on social judgements was low, although this effect tended to be higher in rating intellectual competence when the observers believed that they had a good or excellent level of oral health (7). We suspect that it is precisely people with a poorer dental condition who will be more likely to be aware of the social consequences of the *dental attractiveness stereotype*.

The assessment of dentofacial aesthetics and appearance is challenging because these constructs are neither directly observable nor measurable, and several factors (e.g. culture, gender, age...) affect the subjects' perceptions. Van der Geld *et al.* (17) found that when patients were asked, they stated that an aesthetically attractive smile depended not only on tooth factors, such as position, size, shape and colour, but also on gum display and the framing of the lips. It is possible that certain other facial features (such as the male baldness, the distance between the eyes, nose and skin colour) would underlie the social attractiveness of such people (8), and these features should be addressed in future studies. Facial attractiveness is usually associated positively with widely spaced eyes, a small nose and a wide mouth (8) with apparently sound (6, 24) and straight teeth (27). However, the colour, size and visibility of the teeth and gums, and the position of the upper lip are also considered critical factors in self-perception of smile attractiveness (17).

The profiles of facial attractiveness should be further investigated in both sexes from a specific socio-cultural background, taking into account that female preferences for male faces are more variable than male preferences for female faces (41). We believe that the lightness of a smile could act as a neutral factor in dental attractiveness, although other facial attributes could be gender polarise, that is that being perceived as physically attractive creates positive impressions of achievement-related traits for men, but negative impressions for women, such as a marked gonial angle in the mandible.

The scientific rationale for this study was based on the conception that clinicians and researchers should be interested in quantifying the effect of dental colour on the physical attractiveness, as several dental interventions are focused on change in dental aesthetics. According to our results, both clinicians and patients would be well aware about the social implications of the tooth colour.

Conclusions

A perceptible change in dental lightness is the strongest factor associated with the *dental attractiveness stereotype*, affecting significantly the 12 traits assessed, but mainly the *Happiness, Social Relations* and *Academic Performance*.

Disclosure/Acknowledgments

The study received the approval of the Bioethics Committee of the University of Salamanca. This study has been funded by the Department of Surgery of the University of Salamanca. Authors declared they have no conflict of interest.

References

1. Lerner RM, Karabenick SA, Stuart JL. Relations among physical attractiveness, body attitudes, and self-concept in male and female college students. *J Psychol*. 1973;85:119–129.
2. Eagly A H, Makhijani MG, Ashmore RD, Longo LC. What is beautiful is good, but...: a meta-analytic review of research on the physical attractiveness stereotype. *Psychol Bull*. 1991;110:109–128.
3. Dion K, Berscheid E, Walster E. What is beautiful is good. *J Pers Soc Psychol*. 1972;24:285–290.
4. Secord PF, Dukes WF, Bevan W. Personalities in faces. I. An experiment in social perceiving. *Genet Psychol Monogr*. 1954;49:231–279.
5. Russell JA. Is there universal recognition of emotion from facial expression? A review of the cross-cultural studies. *Psychol Bull*. 1994;115:102–141.
6. Eli I, Bar-Tal Y, Kostovetzki I. At first glance: social meanings of dental appearance. *J Public Health Dent*. 2001;61:150–154.
7. Newton JT, Prabhu N, Robinson PG. The impact of dental appearance on the appraisal of personal characteristics. *Int J Prosthodont*. 2003;16:429–434.
8. McKelvie SJ. Effects of feature variations on attributions for schematic faces. *Psychol Rep*. 1993;73:275–288.
9. Cunningham SJ. The psychology of facial appearance. *Dent Update*. 1999;26:438–443.
10. Stevenage SV, McKay Y. Model applicants: the effect of facial appearance on recruitment decisions. *Br J Psychol*. 1999;90:221–234.
11. Montero J, López-Valverde A, Clemot Y, Bravo M. The occupational role of dental conditions among a consecutive sample of Spanish workers. *Med Oral Patol Oral Cir Bucal*. 2011;16:e966–e972.
12. Davis LG, Ashworth PD, Spriggs LS. Psychological effects of aesthetic dental treatment. *J Dent*. 1998;26:547–554.
13. Duarte S Jr, Schnider P, Lorezon AP. The importance of width/length ratios of maxillary anterior permanent teeth in esthetic rehabilitation. *Eur J Esthet Dent*. 2008;3:224–234.
14. Carlsson GE, Wagner IV, Odman P, Ekstrand K, MacEntee M, Marinello C *et al*. An international comparative multicenter study of assessment of dental appearance using computer-aided image manipulation. *Int J Prosthodont*. 1998;11:246–254.
15. Samorodnitsky-Naveh GR, Geiger SB, Levin L. Patients' satisfaction with dental esthetics. *J Am Dent Assoc*. 2007;138:805–808.
16. Lajnert V, Pavičić DK, Grzić R, Kovač Z, Pahor D, Kuis D *et al*. Influences of age and maxillary anterior teeth status on patient's satisfaction with dental appearance and tooth colour. *Gerodontology*. 2012;29:e674–e679.
17. Van der Geld P, Oosterveld P, Van Heck G, Kuijpers-Jagtman AM. Smile attractiveness. Self-perception and influence on personality. *Angle Orthod*. 2007;77:759–765.
18. Tedesco LA, Albino JE, Cunat JJ, Slakter MJ, Waltz KJ. A dental-facial attractiveness scale. Part II. Consistency of perception. *Am J Orthod*. 1983;83:44–46.
19. Tedesco LA, Albino JE, Cunat JJ, Green LJ, Lewis EA, Slakter MJ. A dental-facial attractiveness scale. Part I. Reliability and validity. *Am J Orthod*. 1983;83:38–43.
20. Cross JF, Cross J. Age, sex, race and the perception of facial beauty. *Dev Psychol*. 1971;5:433–439.
21. Rhodes G. The evolutionary psychology of facial beauty. *Annu Rev Psychol*. 2006;57:199–226.
22. Carlsson GE, Johansson A, Johansson AK, Ordell S, Ekbäck G, Unell L. Attitudes toward dental appearance in 50- and 60-Year-old subjects living in Sweden. *J Esthet Restor Dent*. 2008;20:46–55.
23. Mehl CJ, Harder S, Kern M, Wolfart S. Patients' and dentists' perception of dental appearance. *Clin Oral Investig*. 2011;15:193–199.
24. Kershaw S, Newton JT, Williams DM. The influence of tooth colour on the perceptions of personal characteristics among female dental patients: comparisons of unmodified, decayed and "whitened" teeth. *Br Dent J*. 2008;204:256–257.
25. Riordan PJ. Perceptions of dental fluorosis. *J Dent Res*. 1993;72:1268–1274.
26. Locher P, Unger R, Sociedade P, Wahl J. At first glance: accessibility of the physical attractiveness stereotype. *Sex Roles*. 1993;28:729–743.
27. Shaw WC, Rees G, Dawe M, Charles CR. The influence of dentofacial appearance on the social attractiveness of young adults. *Am J Orthod*. 1985;87:21–26.