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Characteristics attributed to individuals with dental fluorosis

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Background: Previous investigations of the public perception of dental fluorosis have focused mainly on aesthetics. Other characteristics which could potentially be ascribed to fluorosis, such as perceived personality traits, have not been examined. ***Objectives:*** This study aimed to identify personal characteristics (descriptors) attributed to people with fluorosis of varying degrees of severity, as depicted in standardised photographs viewed from different perspectives. ***Method:*** Extra-oral (full face) and intra-oral images of male and female subjects were digitally manipulated to represent normal dental enamel, mild, moderate, and severe fluorosis. The images were then scored by 90 members of the public (45M, 45F), under different experimental conditions, which varied the level of cueing to the teeth. Participants were asked (i) to record their spontaneous descriptors, (ii) select relevant descriptors from a predefined list of 50 descriptors and traits. ***Results:*** 170 different word or phrase descriptors were spontaneously attributed to the images. Characteristics used to describe fluorosis varied with the degree of severity. However, endorsements were significantly influenced by whether participants viewed extra or intra-oral images and the degree of cueing. Conditions which most accurately mirrored everyday social interactions, that is viewing extraoral images without cueing to pay particular attention to the mouth, were least likely to result in the attribution of characteristics that varied with levels of fluorosis. ***Conclusions:*** While characteristics varying with severity of dental fluorosis were ascribed, more sophisticated attitudinal measures are required to ascertain the wider social impact of fluorosis beyond the aesthetic.

Key words: Dental Caries, fluoride, fluorosis, perception, psychology, public, risk-benefit.

Introduction

That fluoride is an effective caries-preventive agent is beyond doubt (McDonagh et al., 2000; Murray, 2003). However, in debating the risk-benefits of fluoride use, the impact of dental fluorosis must be considered. Fluorosis results from inappropriate exposure to fluoride during tooth development, and those opposed to the use of fluoride frequently cite fluorosis as an adverse outcome.

Fluorosis may be viewed from a number of perspectives; that of the affected patient, the parents of affected children, dental professionals, and the general public. To date, studies on the potential disadvantages of fluorosis have been considered mainly in terms of aesthetics. While it is generally agreed that perceptions of unattractiveness increase with increasing severity of dental fluorosis, (Alkhatib et al., 2004; Clark, 1995; Clark et al., 1993; Ellwood and O'Mullane, 1995; Sigurjons et al., 2004; van Palenstein Helderman and Mkasabuni, 1993), the degree to which milder levels of fluorosis cause concern, or might even be preferred, amongst members of the public is uncertain (Riordan, 1993; Hawley et al., 1996; McKnight et al,1998). There is also evidence of disagreement about what is an acceptable level of fluorosis from an aesthetic perspective between the public and dental professionals (Clark, 1995; Ellwood and O'Mullane, 1995; Milsom et al., 2000). Studies by McKnight et al., (1999) and Levy and co-workers (2002), using standardised computer generated intra-oral images, suggested that dental students changed their opinion over time, raising the possibility that dental training may influence professionals' opinion of fluorosis.

There is therefore a large body of literature on the aesthetic impact of fluorosis. However, it is possible that defects of dental enamel may impact in ways other than the aesthetic and there is as yet, little evidence regarding the wider impact of fluorosis (Lalumandier and Rozier, 1998; Pendrys, 1991). The psychological literature recognises that attributes linked to appearance and disfigurements go beyond the aesthetic. Rumsey (Rumsey, 1997) noted that individuals whose appearance deviates from the norm are at greater risk of rejection and negative stereotyping, and even minor disfigurement may lead to negative personal appraisals and ridicule (Macgregor, 1970). People who are physically attractive are typically considered to have more positive personality traits than unattractive individuals (Miller, 1970). Attractive individuals are rated more highly on measures of social competence, adjustment, potency, and intellectual competence than less attractive people (Eagly et al., 1991). Physical attractiveness has been shown to influence teachers' expectations of children (Clifford and Walster, 1973) and jurors' attitudes to defendants in a mock trial (Efran, 1974).

Although fluorosis may be considered relatively insignificant when compared to disfigurements such as cleft lip or palate, serious burns, or even port wine stains, it may have a considerable bearing on the affected individual.

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Indeed, people with relatively mild disfigurements may suffer significant psychological distress because they are more likely than the severely disfigured to be subjected to social comment and ridicule (Macgregor, 1970). In addition, those with a mild disfigurement may be uncertain whether this would be noticed by others, this uncertainty potentially resulting in social distress.

The mouth is an important feature in determining overall facial appearance (Terry, 1977; Terry and Davis, 1976). Feng, and colleagues (2001) and Newton et al., (2003), for example, found that dental appearance affected judgements about some personal characteristics. Decayed or discoloured teeth were associated with perceived lower levels of adjustment and intellectual competence. It is possible that an oral condition such as dental fluorosis might influence how affected individuals are socially evaluated by others. It was concluded therefore that there was a need to investigate the public's perception of dental fluorosis in terms beyond aesthetics.

Utilising standardised intra and extra-oral images displaying different levels of fluorosis within a single face, the aims of this study were:

- firstly, to identify descriptions spontaneously attributed by members of the public to different levels of fluorosis
- secondly, to ascertain which features participants endorsed from a predefined list of characteristics to describe the images
- and finally, to investigate how these descriptions were influenced by viewing either intra or extra-oral images and when viewing the latter to determine the effect of cueing the participants by asking them to pay particular attention to the mouth.

Materials and Methods

Production of standardised images

The initial stage of the investigation involved the production of a series of standardised images. Extra and intra-oral photographs were taken of student volunteers using a Fujifilm Finepix S1 Pro camera, a Nikon Macro Speedlight SB-29, and an AF Micro Nikkor 105mm lens. Two of these images (one male, one female) were digitally altered using Adobe PhotoShop version 6. Both extra and intra-oral images were created and in addition to normal enamel, the teeth were manipulated to simulate normal enamel, mild, moderate, and severe fluorosis based on Dean's Index (Dean, 1934). As the images were derived from a single male and female image, alignment and spacing of the teeth were constant, as was the appearance of the gingivae, and other extra-oral features such as hairstyle, etcetera. These photographs were produced as life size (extra-oral full face showing the teeth, with the upper canines and incisors exposed) and 4 x 6-inch (intra-oral) colour photographs.

As a result, standardised extra- and intra-oral photographs (of the same individuals) displaying a range of severity of dental fluorosis were available for assessment as described below.

Production of a list of traits and descriptors

To determine participants' assessment of traits and descriptors associated with the standardised images, a tick-list was developed by selecting 40 traits identified from the psychological literature (Anderson, 1968) as being meaningful to the public. A further 10 words related to aesthetics derived from Eli and co-workers (2001) and Shaw (1981) were also included. A list of the traits and descriptors used is given in Table 1.

Table 1. The descriptors and traits used in Stage 2 of the study and how they were collapsed into characteristics

Descriptors/traits on the tick list	*Characteristics*
Beautiful; Good looking	Attractive
Not good looking; Ugly	Unattractive
Clean	Clean
Dirty	Dirty
Systematic; Prompt; Efficient; Orderly	Careful
Careless; Unpunctual	Careless
Unhealthy	Unhealthy
Intelligent; Observant	Intelligent
Gullible; Unobservant	Unintelligent
Humorous; Relaxed	Happy
Unhappy	Unhappy
Sentimental; Understanding; Helpful; Kind; Thoughtful; Forgiving	Kind
Egotistical; Rude; Malicious; Phoney; Unkind; Cruel	Unkind
Co-operative; Exciting; Tolerant; Sociable; Gossipy; Witty	Sociable
Stubborn; Hostile	Unsociable
Frank	Honest
Cowardly	Dishonest
Independent	Independent
Reliable	Reliable
Excited	Positive miscellaneous characteristics
Greedy	Negative miscellaneous characteristics
Overcritical; Unemotional; Oversensitive; Unconventional	Neutral or ambiguous miscellaneous characteristics

Participants

The participants who assessed the photographs were recruited from a Sports and Leisure Centre, and comprised a convenience sample of 90 volunteers (45 male, 45 female). They ranged in age from 18-66 years old with a median age of 38 years.

As illustrated in Figure 1, the study was conducted in two stages. The 90 participants were theoretically sampled to one of three study conditions, i.e. they were allocated to ensure a relative balance in terms of age and gender between the study conditions. One group viewed extra-oral photographs only; the second viewed the same photographs but were asked to pay particular attention to the mouth, whilst the final group viewed only the intra-oral images. In total, each participant viewed four photographs (one at each level of fluorosis plus normal enamel). As these were based on standardised manipulated images, and each participant viewed images of just one subject, the only variable across images viewed by an individual was the level of fluorosis.

Participants viewed all photographs in order of increasing fluorosis severity, although the point in the sequence at which they began viewing was systematically varied, that is approximately a quarter viewed the photograph with no fluorosis first, a quarter began with mild fluorosis, and so on. Participants were allocated to ensure that 45 viewed male images and 45 female images.

Description of photographs

In Stage 1 of the study, participants were asked to write down traits or descriptors that they spontaneously thought described each photograph. Participants viewed each photograph one at a time and described it in their own words.

In Stage 2, participants were asked to view the photographs for a second time and on this occasion endorse adjectives (from the 50-item descriptor list) that they felt described the individual in each photograph (Table 1).

Condensing traits and descriptors into characteristics

On completion of the study, as a separate exercise, the descriptions spontaneously generated by participants were combined into characteristics. This was done because many of the descriptions generated were very similar in meaning, but were used too infrequently to be analysed separately. Allocation of these words into their general characteristics was undertaken by eight volunteer judges unassociated with the main study. Judges were shown the complete list of descriptions spontaneously generated by the participants during Stage 1. The judges grouped these descriptions into characteristics based on similarity of meaning.

Likewise, the 50 descriptors used in the tick-list were collapsed into characteristics by the same eight judges using the same method (Table 1).

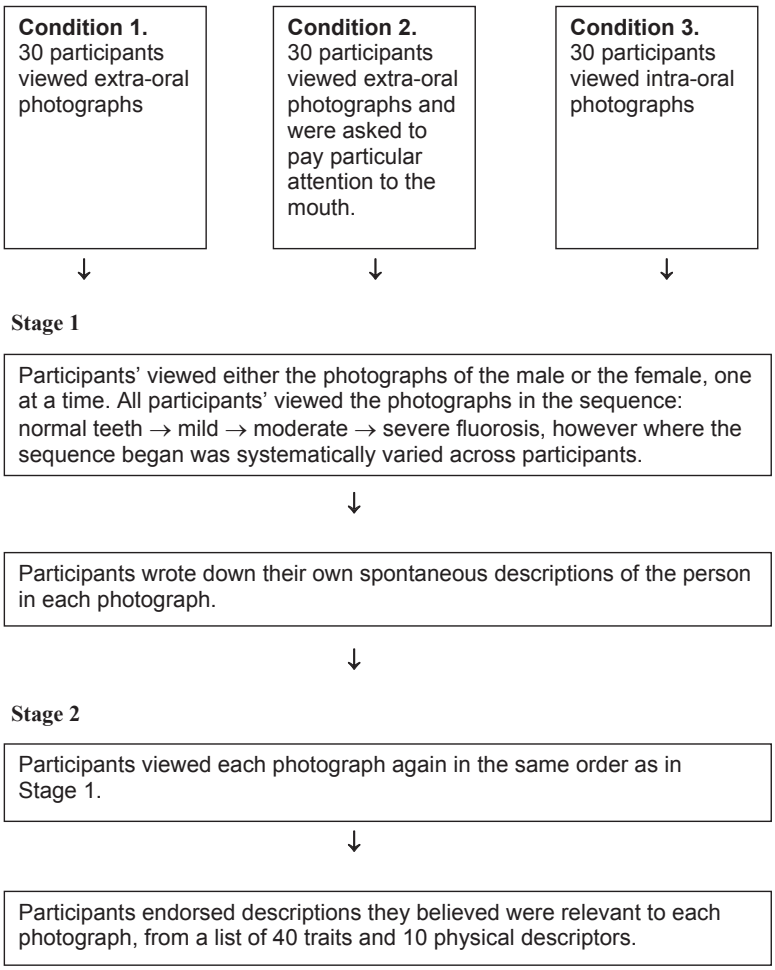

Figure 1. *The study procedure*

Analysis

A frequency count was taken of the number of participants who used at least one of the descriptions/traits within each characteristic, at each level of fluorosis. The characteristics generated/endorsed from Stage 1 and 2 were analysed separately. Comparisons between the frequency of endorsement of each characteristic according to level of fluorosis were performed, using the chi-square statistic, on those characteristics that had at least 20 endorsements. Probability adjustments for multiple comparisons were not made.

Ethical approval

The study was approved by the South East Wales local research and ethics committee.

Results

Stage 1

In all, the 90 participants spontaneously generated 170 words or phrases when describing the photographs in the first stage of the study. These were subsequently collapsed into 32 characteristics. For the participants who viewed the extra-oral photographs without being asked to pay particular attention to the mouth (condition 1), four characteristics received at least 20 endorsements: confident, happy, intelligent, and sociable (Table 2). However, none of these characteristics showed significant variation across the levels of fluorosis. For the participants who viewed the extra-oral photographs and were asked to pay particular attention to the mouth, the characteristics endorsed on at least 20 occasions were: confident, happy, intelligent, kind, and sociable (Table 3). As in condition 1, none of these characteristics showed significant variation across the levels of fluorosis. When participants viewed the intra-oral photographs (condition 3) they did not use any characteristics with sufficient frequency to allow a chi-square analysis.

Stage 2

In the second stage of the study participants were asked to look at the photographs again, but this time endorse descriptors from the 50 item tick-list, the list being subsequently collapsed into 22 characteristics as described above (Table 1).

At least 20 endorsements were made for 10 characteristics in study conditions 1 and 2 (extra-oral photographs, without and with cueing to teeth, respectively), and 13 characteristics were endorsed for study condition 3 (intra-oral photographs). These are shown in Tables 4-6. These tables show the total number of endorsements each characteristic received across the levels of fluorosis out of a possible 120 (30 participants per condition x four levels of fluorosis), the chi-square, significance level and the percentage of participants who endorsed each characteristic at each level of fluorosis.

As can be seen from Table 4, only two characteristics significantly varied across the levels of fluorosis when participants viewed extra-oral photographs without being cued to look at the mouth, namely attractive and clean.

Table 2. Characteristics spontaneously generated when describing extra-oral photographs of fluorosis of varying severity, without being asked to pay particular attention to the mouth

Characteristics from study condition 1	*Total number of responses across levels of fluorosis*	*Chi-square*	*p value*	*Percentage of participants who endorsed characteristic for each level of fluorosis*			
				No fluorosis	*Mild fluorosis*	*Moderate fluorosis*	*Severe fluorosis*
Confident	23	1.0	N.S.	20.0	23.3	20.0	13.3
Happy	49	2.6	N.S.	50.0	43.3	40.0	30.0
Intelligent	24	0.4	N.S.	23.3	20.0	16.7	20.0
Sociable	49	0.4	N.S.	43.3	40.0	43.3	36.7

Table 3. Characteristics spontaneously generated describing extra-oral photographs of fluorosis of varying severity, when asked to pay particular attention to the mouth

Characteristics from study condition 2	*Total number of responses across levels of fluorosis*	*Chi-square*	*p value*	*Percentage of participants who endorsed characteristic for each level of fluorosis*			
				No fluorosis	*Mild fluorosis*	*Moderate fluorosis*	*Severe fluorosis*
Confident	28	5.6	N.S.	33.3	20.0	30.0	10.0
Happy	43	1.8	N.S.	36.7	43.3	36.7	26.7
Kind	32	1.0	N.S.	33.3	26.7	23.3	23.3
Intelligent	24	0.4	N.S.	23.3	20.0	20.0	16.7
Sociable	48	2.8	N.S.	50.0	36.7	43.3	30.0

Table 4. Characteristics endorsed from the tick-list when describing extra-oral photographs of fluorosis of varying severity, without being asked to pay particular attention to the mouth

Characteristics	*Total number of responses across levels of fluorosis*	*Chi-square*	*p value*	*Percentage of participants who endorsed characteristic for each level of fluorosis*			
				No fluorosis	*Mild fluorosis*	*Moderate fluorosis*	*Severe fluorosis*
Attractive	44	15.5	$p < 0.001$	46.7	46.7	46.7	6.7
Careful	30	3.0	N.S.	30.0	30.0	26.7	13.3
Clean	58	21.5	$p < 0.001$	70.0	56.7	53.3	13.3
Happy	65	0.6	N.S.	60.0	53.3	50.0	53.3
Honest	28	2.6	N.S.	23.3	30.0	26.7	13.3
Independent	22	2.0	N.S.	23.3	20.0	20.0	10.0
Intelligent	45	3.2	N.S.	46.7	33.0	43.3	26.7
Kind	82	5.1	N.S.	80.0	70.0	70.0	53.3
Reliable	41	1.3	N.S.	40.0	33.3	36.7	26.7
Sociable	87	5.5	N.S.	80.0	80.0	73.3	56.7

Table 5. Characteristics endorsed from the tick-list when describing extra-oral photographs of fluorosis of varying severity, when asked to pay particular attention to the mouth

Characteristics	*Total number of responses across levels of fluorosis*	*Chi-square*	*p value*	*Percentage of participants who endorsed characteristic for each level of fluorosis*			
				No fluorosis	*Mild fluorosis*	*Moderate fluorosis*	*Severe fluorosis*
Attractive	53	13.3	$p < 0.005$	66.7	43.3	46.7	20.0
Careful	36	7.9	$p < 0.005$	36.7	33.3	40.0	10.0
Clean	60	18.4	$p < 0.001$	66.7	60.0	56.7	16.7
Happy	74	5.9	N.S.	76.7	63.3	70.0	36.7
Independent	28	4.5	N.S.	30.0	23.3	30.0	10.0
Intelligent	69	13.5	$p < 0.005$	73.3	66.7	60.0	30.0
Kind	99	15.9	$p < 0.001$	96.7	83.3	90.0	60.0
Reliable	62	20.4	$p < 0.001$	66.7	56.7	66.7	16.7
Sociable	92	25.0	$p < 0.001$	90.0	86.7	86.7	43.3
Unattractive	26	34.8	$p < 0.001$	10.0	6.7	10.0	60.0

Table 6. Characteristics endorsed from the tick-list when describing intra-oral photographs of fluorosis of varying severity

Characteristics	*Total number of responses across levels of fluorosis*	*Chi-square*	*p value*	*Percentage of participants who endorsed characteristic for each level of fluorosis*			
				No fluorosis	*Mild fluorosis*	*Moderate fluorosis*	*Severe fluorosis*
Attractive	29	21.6	$p < 0.001$	43.3	13.3	40.0	0.0
Careful	37	29.5	$p < 0.001$	56.7	13.3	50.0	3.3
Careless	22	19.8	$p < 0.001$	6.7	20.0	3.3	43.3
Clean	36	29.5	$p < 0.001$	46.7	16.7	56.7	0.0
Dirty	21	43.6	$p < 0.001$	3.3	10.0	0.0	56.7
Happy	30	13.0	$p < 0.005$	33.3	16.7	43.3	6.7
Intelligent	26	10.0	$p < 0.005$	33.3	13.3	33.3	6.7
Kind	43	8.2	$p < 0.005$	50.0	33.3	43.3	16.7
Reliable	23	6.6	N.S.	26.7	10.0	30.0	10.0
Sociable	52	25.2	$p < 0.001$	60.0	30.0	70.0	13.3
Unattractive	27	45.6	$p < 0.001$	6.7	13.3	3.3	66.7
Unhealthy	27	69.3	$p < 0.001$	0.0	13.3	0.0	76.7
Unkind	23	7.5	N.S.	3.3	23.3	20.0	30.0

However, when participants viewed extra-oral photographs and were asked to pay particular attention to the mouth, the number of characteristics that showed significant variation increased to eight (Table 5). As before attractive and clean varied significantly, as did careful, intelligent, kind, reliable, sociable, and unattractive. The majority of the characteristics received fewer endorsements for severe fluorosis than for the other levels, but this trend was reversed for unattractive. Ten percent of participants rated the photographs as unattractive when they had normal enamel or moderate fluorosis, and just 6.7% rated them as unattractive when they had mild fluorosis, with endorsements for severe fluorosis then showing a steep climb to 60%. As might be expected, this pattern was reversed when the participants were endorsing the photographs as attractive. When rating photographs with normal enamel 66.7% of participants regarded them as attractive, 43.3% endorsed them as attractive with mild fluorosis, 46.7% with moderate fluorosis, and 20% with severe fluorosis.

When viewing intra-oral photographs, 11 characteristics varied significantly (Table 6). As in the previous experimental conditions, there was a tendency for characteristics that might generally be considered to be positive to show fewer endorsements for severe fluorosis compared to the other levels, and for the converse to be true of negative characteristics. However, when viewing these intra-oral photographs, endorsements for mild fluorosis were closer to severe fluorosis than to moderate fluorosis and normal enamel for several of the characteristics, a trend not evident when viewing the full-face extra-oral photographs. For example, endorsements for intelligent were 33.3% for no and moderate fluorosis and 13.3% and 6.7% for mild and severe fluorosis respectively.

In summary, when endorsing characteristics, participants made more attributions based on fluorosis in an extra-oral photograph when they were cued to look at the mouth than when they were not. Moreover, they made further attributions still when shown intra-oral photographs, which could be regarded as a further level of cueing to the mouth. In other words, there is a trend that indicates the greater the level of cueing to the mouth, the more attributions are made on the basis of dental fluorosis.

Discussion

This investigation is, to our knowledge, the first attempt to investigate the public's attitudes towards those with dental fluorosis, in contexts other than the purely aesthetic. Previous work investigating the aesthetic impact of fluorosis has used a number of different methods. These include questionnaire surveys of children's and parent's perceptions of fluorosis (Martínez-Mier et al., 2004), asking lay people to rate the teeth of patients with fluorosis (Ellwood and O'Mullane, 1995; Riordan, 1993), asking lay people to rate intra-oral slides or photographs of fluorosis (Clark, 1995; Hawley et al., 1996; McKnight et al., 1998), and asking participants to compare computer generated intra-oral images of fluorosis and other dental conditions (Levy et al., 2002; McKnight et al., 1999).

While these techniques may be appropriate for consideration of aesthetics, they are inappropriate for consideration of wider social and psychological factors. Social interactions, in which judgements are made about others, involve consideration of a variety of cues, of which teeth form only one aspect. Any judgement made about an individual that relies solely on intra-oral photographs of teeth necessarily removes these additional cues from consideration. The use of standardised photographs in the present study facilitated investigation of the perceptions of varying degrees of fluorosis in the context of a full face, in which any variation in the attitudes expressed towards the images would be solely attributable to fluorosis. The fact that each participant viewed images of only one subject meant that tooth size, shape, colour and the influence of other extra-oral features such as hairstyle were kept constant.

Although the images were viewed in order of increasing severity, the point at which each participant viewed the images varied, with a quarter viewing normal enamel first, a quarter viewing mild enamel and so forth. The was done in an attempt to eliminate the effects of participants being unduly influenced by the first image that they observed, although it is accepted that in any future study there would be merit in also having images viewed in decreasing order of severity.

That normal enamel (no fluorosis) and mild and moderate fluorosis were generally associated with positive characteristics and severe fluorosis was generally associated with negative traits relates to previous work on the aesthetics of dental fluorosis. There is little dispute that severe fluorosis is a cause for aesthetic concern (Clark, 1995; Clark et al., 1993; Ellwood and O'Mullane, 1995; van Palenstein Helderman and Mkasabuni, 1993). However, as was noted in the introduction, of greater clinical significance is the debate on whether or not mild and moderate levels of fluorosis are a problem (Ellwood and O'Mullane, 1995; Hawley et al., 1996; McKnight et al., 1998; Riordan, 1993). In this study, when viewing intra-oral photographs of mild fluorosis, participants' endorsements of a number of characteristics were more similar to their ratings of severe fluorosis than to their ratings of moderate fluorosis or non-fluorosed enamel. This may reflect a preference for the more uniform whitening associated with moderate fluorosis (where the whole tooth appears white), than the diffuse striations that represented mild fluorosis (where the degree of whiteness varies across the tooth).

While these findings suggest that characteristics are ascribed to dental fluorosis that go beyond the aesthetic, their significance in the context of day to day social interaction requires consideration. It may be that the altered tooth appearance resulting from fluorosis has the potential to impact on perceived characteristics and traits of the affected individual. However, this study has shown that perceptions were markedly influenced by the conditions under which participants are asked to rate the fluorosis. A greater variation in attributions is observable when viewing intra-oral (close-up) views of the teeth, than when viewing life-size extra-oral images. Furthermore, when viewing extra-oral images, cueing the raters to pay particular attention to the mouth, significantly affects the

attributions made. We believe that this has considerable implications for previous investigations of the aesthetic impact of fluorosis, where teeth were viewed in close-up, with undue attention drawn to dental appearance.

It could be argued that in the conditions which most naturally simulated normal social interactions, i.e. where the members of the public were asked to spontaneously generate descriptions when looking uncued at the full face image (Table 2), no significant differences in the characteristics attributed to individuals with varying degrees of fluorosis were observable.

It is accepted that the number of participants involved was relatively small. Although covering a wide age range, they were all attending a sports and leisure centre and are therefore a sample of convenience rather than a true population sample.

A further consideration relates to the fact that study participants found it much easier to attribute descriptors and traits from the tick-list than when left to spontaneously describe the images. The fact that participants' responses showed far greater variation when they were endorsing descriptions, rather than generating their own, raises several possibilities. It may be that it is the participant's spontaneously generated thoughts and opinions that are most salient to them, and that they endorsed opinions which are less salient when simply having to choose from a tick list. In other words, descriptions endorsed from the tick-list were weaker opinions than those generated spontaneously. As none of the spontaneously generated descriptions varied significantly across levels of fluorosis, it could be argued that participants in this study did not hold strong views about dental fluorosis. On the other hand, it could be argued that the list of traits prompted the participants to give the matter more thought. More sophisticated psychological measures are required to determine the strength of views held.

It is also possible that participants' were reluctant to make judgements about others unless prompted, due to concerns over seeming impolite. The techniques used in this study have relied on explicit measures of attitude. In other words, the participants were aware that they were being asked to make social judgements about others. Ellwood and O'Mullane have suggested that the gold standard for studies of dental fluorosis should be to assess the appearance of the teeth under conditions of normal social interaction (Ellwood and O'Mullane, 1995). Implicit measures of attitude have been used in psychological studies where the respondent may be unwilling (or unable) to answer explicitly, but have not been applied to a study of dental appearance.

Conclusions

In conclusion, this study highlights that explicitly derived evaluations toward those with fluorosis may be unduly influenced by the study method used and hence not properly capture participants actual attitude toward the condition. To answer this question, a more sophisticated approach, using psychological measures of implicit attitude, may reveal more subtle differences in attributions made on the basis of dental fluorosis, while controlling for the influence of other facial features affecting aesthetics and social judgements.

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