Perception of dentofacial esthetics

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Abbreviations

Abbreviations	Description
CP	Chin prominence
GS	Gingival smile
IOP	Occlusal plane inclination
LCLI	Length of canines and lateral incisors
LFIP	Length of frontal interdental papillae
MS	Midline shift
NC	Nose length and chin prominence
NL	Nose length
PC	Position of the commissures
RVA	Relative visibility of the arches
SA	Smile arc
SPM	Sagittal position of the maxillary arch
VPCC	Vertical position of the canine cusps
VPM	Vertical position of the maxillary arch
WBC	Width of buccal corridor
ZFT	Zenith of the front teeth

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Introduction

Definition and history of esthetics

The idea of beauty has always been of great interest to mankind. [1] The first evidence of self-care is 40000 years old from Murcia, Spain, where seashells containing shiny pigments were supposedly used for make-up. The ancient Egyptians regarded beauty as holy and divine; thus, they applied various methods to enhance it. They used make-up to highlight certain facial features or draping to make the posterior portion of the head longer. [2] In ancient Greece, beauty was considered supernatural, and it played a very important role in everyday life. They admired nature and weather, and they were trying to reproduce what they considered divine. It was Pythagoras who made the first attempts at measuring facial esthetics using the armamentarium of mathematics. His works inspired the so-called *divine proportion* or *golden ratio*. [3] The works of the Roman engineer Marcus Vitruvius Pollio contained the first description of the harmony of the human body; thus, providing the basis for the so-called *Vitruvian man*. In the Middle Ages, catholic theology showed an immensely ambivalent attitude towards beauty. It was feared of, regarded as dangerous and demonic, but was considered a blessing at the same time. [1] Baumgarten and Wolff played a substantial role in laying the scientific basis of beauty and esthetics. St. Thomas Aquinas' observations were of high significance as well, considering beauty as good, and all good things beautiful. The idea of beauty in the Renaissance was based on ancient Greek observations. Leonardo da Vinci used the Vitruvian principles to formulate his rules for the proportions of body and face. Ten nose types and eleven face types were observed in his works. These observations were so lasting that the 19th century pioneer of modern rhinoplasty and plastic surgery, Prof. Dr. Jacques Joseph (*Nasenjoseph*) based his definition of the naso-facial angle on Leonardo's drawings. While according to Leonardo's idea, beauty is based on symmetry, the later works of Francis Bacon saw harmony as the substance of it. [4] The works of renaissance painters Michelangelo and Albrecht Dürer were based on careful observation of harmonies and proportions as well. Neoclassicist painter von Schadow should be noted too, as he performed meticulous nasal measurements on paintings and sculptures. [2] Despite being distinct concepts, esthetics and beauty complement each other. Esthetics is

closely related to the definition of beauty, with subjective components playing a major role in it. [1] Naini's contemporary work defines beauty as the combination of such features that evokes good feeling and delight in the viewer's mind. [5] While it is female beauty that has always been in the forefront of art and culture, Western civilization sees an emerging importance of male attractiveness in the last couple of decades. [6]

Dentofacial esthetics and the esthetics of smile

It is evident that there is a great interest in beauty. [2] There are several factors of esthetic perception. The face has a crucial role in it, thus, dentofacial esthetics are of utmost importance. [7] An esthetic facial profile is based on the relative harmony between morphology and contour of different facial structures. Hard tissues determine the outline and the dimensions of the face; however, soft tissues play an equally important role. [8] Every facial anthropometric parameter has a mean and a normal range, specific to age, sex, and ethnicity. [9] Eyes and lips play an even more important role, as humans tend to concentrate on these, and spend substantially less time observing other structures during interpersonal communication. [10] Therefore, smile has a major role in facial expression and appearance. Facial and smile esthetics show a major connection. [6] The pleasant feeling caused by an esthetic smile derives from the harmonic integration of dental, dentofacial, and facial elements. [11] Facial height, facial outline, facial profile, and interpupillary line are particularly important; however, most studies regarding the perception of smile esthetics concentrate on the attractiveness of a smile, without defining the possible factors of it. [12] Defining factors can be divided into macro-, mini- and microesthetic ones. Macroesthetics include the connection between dental and soft tissue, miniesthetics are defined by the relationship between lips, teeth, and gingiva, while microesthetics are based on fine structures of the teeth and the gingiva. [13] Lips define the "borders" of a smile. Evaluation of the lips should include morphology, position, harmony between upper incisors and lower lips, parallelism of incisive plane and that of the lower lip, as well as the number of visible teeth. [14] Gingival factors include shape, contour, level, symmetry of gingival margins and zeniths, color, health, and papillary position. [13] Dental factors are color, dimensions, shape, position, midline position, dental and facial midline symmetry, smile line, visibility, and gingival/dentoalveolar

interface. All these factors play a role in the final esthetic appearance. [15] Symmetry seems to have an evolutionary role. Several studies have shown connection between symmetry and growth, fertility, or survival. Asymmetric subjects appear to have more health problems. Certain societies seem to prefer symmetry more than others. A study comparing a hunter-gatherer tribe to data from the United Kingdom has found that while both groups preferred symmetry, the hunter-gatherer tribe showed a higher preference. Sex and self-perceived attractiveness can affect preferences as well. Women who find themselves attractive, prefer symmetric male faces over more asymmetrical ones. [16]

Facial profile

While the aforementioned factors are those of a frontal aspect, the lateral aspect, specifically facial profile is equally important. Human subjects perceive themselves looking into a mirror; thus, from a frontal aspect. However, photos reveal the facial profile as well. Both aspects contribute to the complete esthetic perception. [17] Profile analysis includes the evaluation of the position of the forehead, the nose, the lips, the chin, and the neck. The most commonly used methods are based on the works of Leonardo, dividing the face into equal thirds. [2] The upper third lies between the trichion and the nasion, the middle third between the nasion and the subnasale, while the lower third between the subnasale and the mentum. Ideally the ratio of these thirds is 1:1:1, however, the upper third might show greater variability because of the changes of the hairline. Several anatomical points and angles can be included in the analysis, such as the naso-frontal angle, the cervico-mental angle, or the shape of the dorsum nasi. The lower third is defined by the lips and the chin. Ideally, the height of the upper lip is equal to half of the cumulative height of the lower lip and mentum. Chin profile can only be evaluated together with every other relevant structure of the facial profile. [17] Bui et al. have shown that facial profile within the normal range cannot be fully described by only the lower third; thus, the facial profile should be evaluated as a whole. [18] Ricketts has studied ideal facial profile in medicine as well as in arts. It is well established that the facial proportions of a person perceived as attractive are quite similar to the mean values of the population. There are other important factors of perceived attractiveness besides proportions, such as skin tone, skin surface, and dental appearance. [3] The literature has

plenty of data regarding normal cephalometric values, however, most of these are merely the mean of the values measured amongst subjects with an adequate occlusion and a harmonic facial appearance. While these means might represent the sample, they might not do so with the esthetics of the profile. The latter can be more relevant in orthodontic treatment, as well as in orthognathic and plastic surgery, giving these factors clinical significance. Despite its evident importance, the number of studies regarding this topic is limited, and even the bigger studies include samples of around only 60 subjects. There are some methodological limits as well. Some of them does not define the affecting factors clearly enough, others use drawings instead of photos or silhouettes, and there are studies that only use male subjects. [19] One study has established three hypotheses regarding beauty. The first one is the "hypothesis of means": a face is perceived as attractive, if its proportions are close to the mean of the population. The second one is the "hypothesis of symmetry": the more symmetric a face is, the more attractive it is perceived as. The third one is the "hypothesis of dimorphism": female faces are as attractive as feminine they are, while male faces are as attractive as masculine they are. [2] Skinazi et al. have found that the nose plays a crucial role in the perception of female facial profiles, while the chin plays a similar role in case of male profiles. According to their data, both lips play a similar role in both female and male facial attractiveness. They have stated that female profiles are more convex, while male profile tend to be relatively straight. [20] Maganzini et al., Soh et al., and Chan et al. have used imaging studies to study facial profile preferences. Their data show a preference towards straight and bimaxillary retruded profiles. [21,22,23] Contrary to this, Farrow et al. have found that most people prefer protruded profiles besides the cephalometric norms. [24] Czarnecki and Nanda have studied the role of the nose, the lips and the chin in facial profile perceptions. They have found that men prefer straight profiles, while women tend to prefer convex ones. [25]

The significance and influence of dentofacial esthetics

Physical appearance affects social appreciation. The perception of this physical appearance is heavily influenced by dentofacial esthetics. [26] This crucial role in self-perception and social judgement is well documented. Esthetically pleasing children and adults are judged more positively. [27] Studies show that people with esthetic smiles are

judged by other individuals to have better intellectual and social capacities. Men and women have been shown to have similar preferences. [6] Individuals with an esthetics smile are considered to be more attractive by the other sex as well. [28] Physical appearance and the perception of esthetic abnormalities have an influence on the individual's self-esteem too. Facial esthetics show a correlation with confidence and openness as well. [26,27] Dong et al. have shown a connection between smile esthetics and openness or anxiety, with significant results in case of female subjects. [6] Malocclusion is a frequent abnormality; however, it can be considered a deviation from the esthetic norm, rather than a disease. Several studies have shown its effect on the quality of life, concluding that highly visible cases might result in unpleasant social interactions and an unfavorable self-perception. [29,30,31] Taking several perspectives into account, there is no widely accepted dogma regarding facial esthetics or ideal facial profiles. [2]. All viewpoints can be accepted to a certain extent; however, defining a universally acceptable definition is not possible because of the subjective aspects of esthetics and beauty. A lot of patients are content or even happy with a severe malocclusion, whereas other individuals might become uncomfortable with less significant abnormalities. [32]

The perception of beauty is highly individual, with some overlaps. This might depend on sex, age, education background, and individual experiences. Ethnicity is a major factor in facial perception as well. Social background and media are of high significance as well. The latter projects faces and smiles that are considered beautiful and perfect, connecting these with success. [30,33]

The role of esthetics in dentistry

A lot of patients seek medical and dental professional help because of the patterns dictated by society and media. [1] Esthetics gain more and more ground in dentistry, with patient expectations rising significantly. There is a tendency towards prioritizing esthetics over functionality. [34] These expectations are mostly unrealistic. The dentist should only seek to satisfy these expectations to the point where functional rehabilitation is not compromised. Several treatment options should be presented, and the dental professional should be able to establish an aim that is acceptable for both parties. This relies on the

professional's sound knowledge concerning his/her own esthetic preferences and capabilities. [35] Bui et al. have shown that dentist, orthodontist specialists and laypersons all consider dental abnormalities to be more significant than other facial abnormalities. All groups prefer normal facial profiles. Upper lip protrusions are preferred over lower lip protrusions. Sex plays no role in these preferences. [18] The dental professionals' preferences are supposedly based on not only their personal ones, but their knowledge and professional experiences too. It has been shown that dentist tend to judge even little deviations from normal occlusion as significant. While general dentists concentrate on dental abnormalities, orthodontist put an emphasis on positional ones. [36,37] There are several studies in the literature that observed the esthetic judgement of professionals and laypersons; however, the number of studies that include self-perception is low. [30] Moreover, there are very limited data concerning dental students. This topic is of importance because a student can be considered an intermediary subject. It is also important to note that esthetics gain more and more ground in the dental curriculum; thus, investigating the dentofacial preferences of dental students can throw light upon the role of education in its development.

Studies concerning profile evaluations amongst students is scarce, when compared to those concerning frontal aspects. Most profile studies concentrate on Class II. and Class III. malocclusions and their correction; however, while malocclusion is very important, other aspects, such as nasal length, chin prominence, nose-lip ration, or incisor inclinations are relevant too. These studies show a major geographical and cultural variability; thus, their results should be used to determine the critical point of perception, and not to establish a universal model.

There is no study available in the literature, that has performed a comprehensive investigation amongst all tiers of dental education. Armalaite et al. and Althagafi et al. studied 4th and 5th year students, whereas Tufekci et al. investigated 1st and 3rd year students. [38,12,39] El Mourad studied the esthetic preferences of 5th year students in connection with their financial background [30], however, most studies regarded dental students as a homogenous group. Several studies have concluded that it is dental education itself that differentiates between dental students and laypersons. Al-Saleh have shown that dental education does have an effect on dental students' esthetic preferences

and their formation of treatment plans alike. The author's other conclusion is that the ability to recognize smile discrepancies improves as the students' clinical experience and knowledge increases. [14]

Following the third year of studies, the curriculum tends to concentrate on more detailed aspects of dentistry and smile esthetics [12]; however, the exact principles taught can be quite divergent at the different dental schools. There are scarce data available concerning these differences. [14] There is a consensus though regarding the fact that the smile esthetics knowledge of dental students is improving during their studies. [12]

The importance of studying the above detailed factors lies in two major aspects:

- Any potential discrepancies between the dental professional's vision and the patient's expectation might result in an unacceptable result.
- Defining specific esthetic principles can influence the dental curriculum.

Aims

The aim of the present questionnaire- and photo-evaluation based, cross-sectional study was to describe the dynamic changes of dentofacial esthetics throughout dental school.

The correlation between school grade, esthetic self-perception, perception of certain profile, miniesthetic and microesthetic features, and sex was studied. The null hypotheses were the following:

- grade does not have a significant effect on students' esthetic self-perception,
- sex does not have a significant effect on students' esthetic self-perception,
- grade does not have a significant effect on students' esthetic preferences,
- sex does not have a significant effect on students' esthetic preferences,
- self-perception does not have a significant effect on students' esthetic preferences.

Materials and methods

Subjects and sampling

All five Hungarian-speaking grades of all the four Hungarian dental schools were involved:

- University of Szeged, Faculty of Dentistry, Szeged,
- Semmelweis University, Faculty of Dentistry, Budapest,
- University of Debrecen, Faculty of Dentistry, Debrecen,
- University of Pécs, Dental School, Department of Dentistry, Oral and Maxillofacial Surgery, Pécs.

A questionnaire was handed out and was accompanied by a photo series containing smile and profile photos. Altogether 1011 questionnaires were handed out for a total number of 919 students. The students were thoroughly instructed by the authors and had 30 minutes to fill out the questionnaire. Completion was voluntary and was performed anonymously. The study was conducted between October 2018 and August 2019. Study protocol and the instruments applied were approved beforehand by the Regional Ethics Committee for Research in Human Medical Biology at the University of Szeged (No. 178/2018-SZTE). Written informed consent was not required. The study was approved by the deans of the four faculties as well.

Questionnaire

Several instruments related to dentofacial esthetics are available in the literature. There are traditional indices, like the Dental Esthetic Index (DAI) or the Index of Orthodontic Treatment Need (IOTN). These indices are considered valid and reliable; however, they were developed for older adults. Thus, their application was avoided. Other indices, such as Oral Health Related Quality of Life (OHRQoL) focuses on subjective aspects of general oral health, with little emphasis on esthetics. Psychosocial Impact of Dental Esthetics Questionnaire (PIDAQ) and Orthognathic Quality of Life Questionnaire (OQoLQ) might be the most appropriate instruments available; however, the authors proposed that combining the elements of the existing questionnaires might be the optimal solution for this study. This instrument was named Dentofacial Esthetics Instrument for

Dental Students. It was developed for the Hungarian language; however, there is an authentic English translation available that is still to be tested. This new instrument contains the following main elements:

1. Demographic data (3 items)

    1.1 Sex   FEMALE / MALE

    1.2 Age (years)

    1.3 Academic year   1 2 3 4 5

2. Self-Aesthetics I (multiple choice, 11 items)

    2.1 Have you ever avoided smiling because of the appearance of your teeth?

        yes / no

    2.2 How do you smile for photos?

        with a full smile (lips open) / with a partial smile (lips partially open) / with closed lips

    2.3 Have you ever noticed that you were looking at others because you wished you had their smile?

        yes / no

    2.4 Would you like to change your smile?

        yes / no

    2.5 Are you satisfied with the color of your teeth?

        yes / no / partly

    2.6 In your opinion, are the shape and size of your teeth in harmony?

        yes /no / partly

    2.7 Are your teeth crowded?

        yes, in both arches / yes, in one of the arches / no

    2.8 Does the line between your upper central incisors fall in the midline of your face?

        yes / no / I have never observed

    2.9 Does the line between your lower central incisors fall in the midline of your face?

        yes / no / I have never observed

2.10 Do the lines between your upper and lower incisors fall in the same line?

yes / no / I have never observed

2.11 Is your gum visible when you smile?

yes / no / I have never observed

3. Self-Aesthetics II (rating, 6 items)

Instruction: Please indicate your satisfaction with different aspects of your dental and facial aesthetics on a 1 to 5 scale, where 1 means "not at all" and 5 means "absolutely".

3.1 How satisfied are you with the shape of your

1 (not at all) 2 3 4 5 (absolutely)

teeth?

3.2 How satisfied are you with the size of your teeth?

1 (not at all) 2 3 4 5 (absolutely)

3.3 How satisfied are you with the orderliness of your teeth?

1 (not at all) 2 3 4 5 (absolutely)

3.4 How satisfied are you with the whiteness of your teeth?

1 (not at all) 2 3 4 5 (absolutely)

3.5 How satisfied are you with the harmony between your teeth and lips?

1 (not at all) 2 3 4 5 (absolutely)

3.6 How satisfied are you with the aesthetics of your smile in general?

1 (not at all) 2 3 4 5 (absolutely) 4. Photo Rating (smile, A to E, 10 items, 5 images per item, with photo album)

4.1-4.10 Choose the image that you find the most attractive. / I. (smile photo series containing 10 items)

A B C D E [with five different images]

5.1-5.6 Choose the image that you find the most attractive. / II. (profile phot series containing 6 items)

A B C D E [with five different images]

The questionnaire was aimed at describing esthetic self-perception, whereas the photo series evaluation was aimed at studying subjective esthetics preferences.

Photo series

The photo series used in the study were prepared and edited by the authors. The model was chosen according to literature data: a Caucasian woman of Hungarian origin with a clinically normal smile, normal occlusion, normal cephalometric data, without any clinical abnormalities affecting her facial profile.

The smile image was obtained from a standard frontal view with visible incisors and canines, soft tissues (gingiva), and lips. The image was cropped, removing the chin, the nose, and the cheeks, in order to rule out any interfering macroesthetic factors.

The profile photo was obtained from a standard lateral view, showing the lower and middle thirds of the face, including the nose, incisors and canine, the lips, and the chin. The upper border was defined by the infraorbital rim.

The photos were taken from a distance of 1.5 m using a Nikon D700 (Nikon Corporation, Tokyo, Japan) camera and a Nikon 105 mm F 2.8G VR AF-S ED.IF Nikkor objective (Nikon Corporation, Tokyo, Japan). The model was instructed to obtain a standing position with a natural head posture, looking forward. The photos were taken at noon, on a sunny day, in a room well lit by natural light.

Photo modifications were performed to affect the esthetically most relevant smile and profile elements. These modification are discussed in detail in Tables 1 and 2.

Series No.	Item No.	Feature	Description
1.	4.1	Smile arc (SA)	The relation of the maxillary incisal edges to the lower lip. From markedly convex to markedly inverted. Arc modified by tilting the maxillary arch in 10° steps upward and downward.
2.	4.2	Gingival smile (GS)	The anterior gingival display was measured from the lower border of the upper lip till the gingival margin of the anterior teeth. The degree of the visibility of the upper gingiva is modified by shifting the arches upward and downward -2 mm to +2 mm in 1 mm steps.
3.	4.3	Length of canines and lateral incisors (LCLI)	The length of the canines and lateral incisors is modified, in varying combinations.
4.	4.4	Width of buccal corridor (WBC)	The buccal corridor is the space between the posterior teeth buccal surfaces and the lip commissures. The width of the buccal corridor is increased, up to +4 mm as compared to the original.
5.	4.5	Vertical position of the canine cusps (VPCC)	The position of the canine cusps is shifted above and below the arch level.
6.	4.6	Zenith of the front teeth (ZFT)	Horizontal, upward arching and downward arching variations.
7.	4.7	Length of frontal interdental papillae (LFIP)	The length of frontal interdental papillae is modified a) between the central and lateral incisors and b) between the lateral incisors and canines.
8.	4.8	Midline shift (MS)	The midline, defined as the vertical line between the central incisors, is shifted to right 1 mm and 2 mm and left 1 mm and 2 mm as compared to the original image.
9.	4.9	Position of the commissures (PC)	The position of commissures is shifted downward 1 mm to 4 mm in 1 mm steps.
10.	4.10	Relative visibility of the arches (RVA)	The degree of the relative visibility of the arches is modified by moving them vertically - 0.5 mm, -1mm and +0.5 mm, +1 mm behind the lips.

Table 1. Photo preferences. Modified dentofacial mini- and microesthetic features.

| Series No.	Item No.	Feature	Description
1.	5.1	Nose length (NL)	The length of the nose changes between -2 mm and +2 mm as compared to the original image in 1 mm steps.
2.	5.2	Chin prominence (CP)	The prominence of the chin changes between -2 mm retrusion and +2 mm protrusion as compared to the original image in 1 mm steps. Chin prominence was defined as the prominence of the soft tissues of the chin. The position of the mandible was not changed. Inclination is represented by the angle.
3.	5.3	Occlusal plane inclination (IOP)	The inclination of the occlusal plane changes between 10° downward and 10° upward as compared to the original image in 5° steps.
4.	5.4	Vertical position of the maxillary arch (VPM)	The maxillary arch is shifted vertically between -2 mm and +2 mm (downward and upward) as compared to the original image in 1 mm steps.
5.	5.5	Sagittal position of the maxillary arch (SPM)	The maxillary arch is shifted sagittally between -2mm and +2 mm as compared to the original image in 1 mm steps.
6.	5.6	Nose length and chin prominence (NC)	The length of the nose and the prominence of the chin change simultaneously between -2 mm and +2 mm as compared to the original image in 1 mm steps.

Table 2. Photo preferences. Modified profile features.

The original photo plus four modifications were used in case of every esthetic feature; thus, all series contained five images (see Figures 1 and 2). The modifications were performed using Adobe Photoshop CC 2015 (Adobe Systems, USA). Altogether 50 smile photos and 30 profiles photos were produced. The photos were arranged into a photo album. Photos from the same series were on the same page, but the order was randomized. For didactive reasons, figures in the present thesis contain the images without randomization. The photos were presented in life-size. The unmodified photo was not noted in any way.
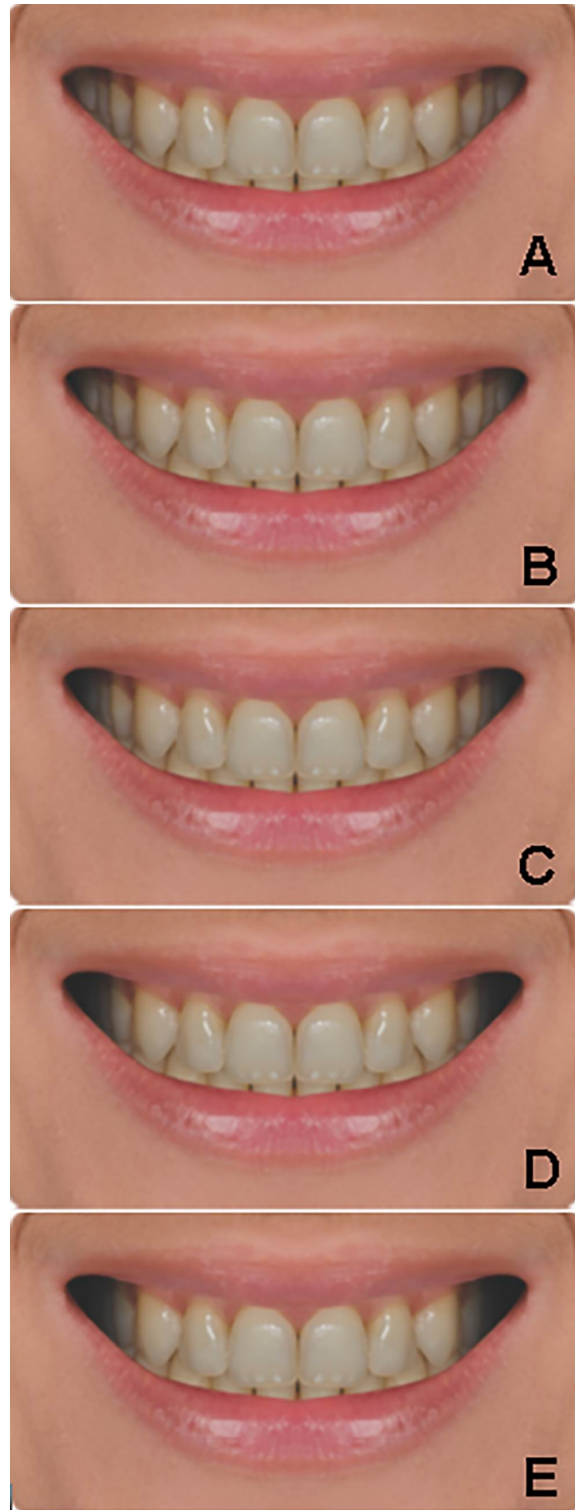
Figure 1. Sample series from smile photo evaluation. Modifications were the following: A – no midification, B-E – buccal corridor grows in 1 mm increments.
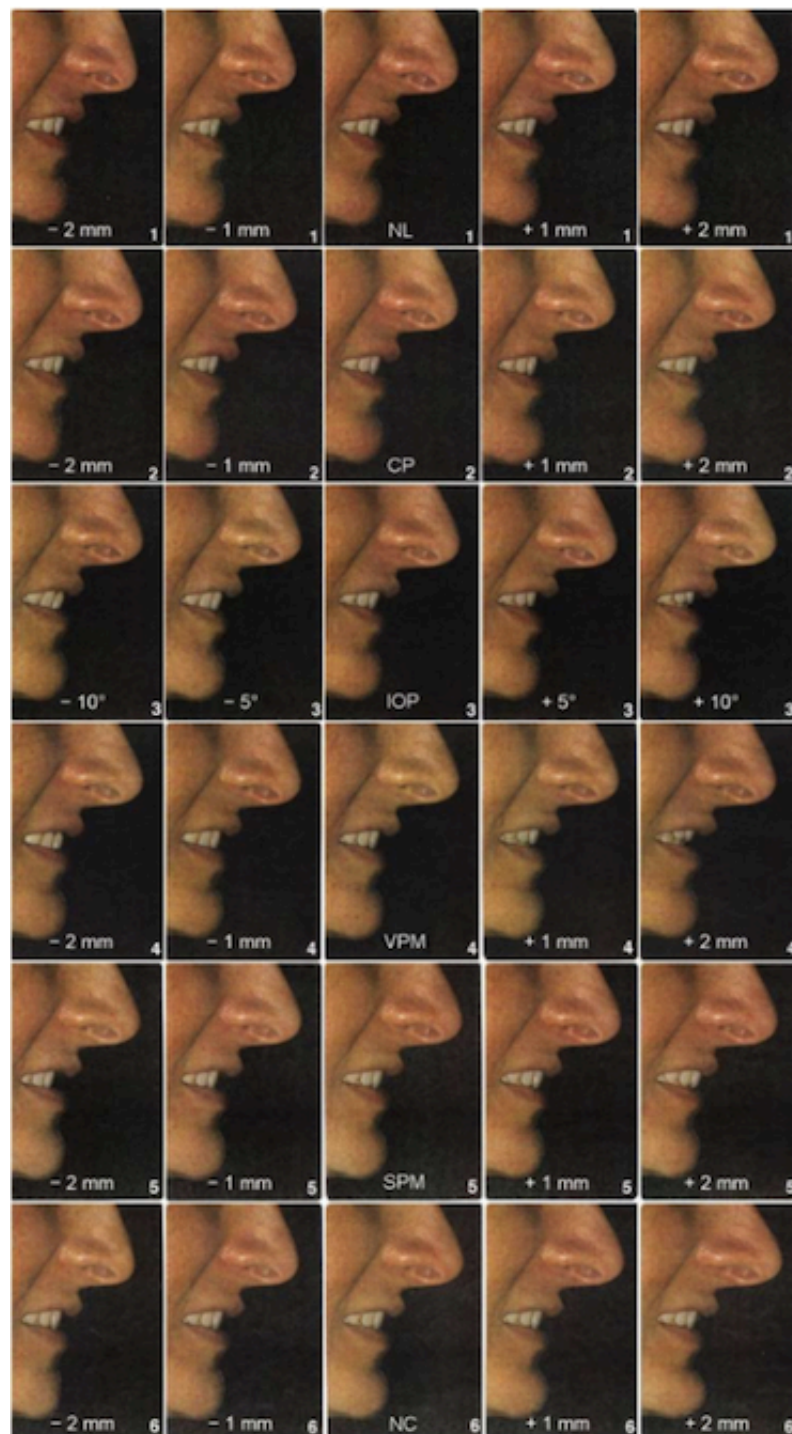
Figure 2. The six profile series. The unmodified photo is always in the middle. The abbreviations are discussed in detail in Table 2.

Statistical analysis

Statistical analysis was carried out by an independent evaluator (see Acknowledgements). The analysis was blind: the evaluator received coded results and was told what analyses to carry out using what coding, without knowledge of the meaning of the codes.

The results were analyzed in SPSS 22.0 (IBM Corp., Armonk, NY, USA). Continuous variables were characterized by means with standard deviations and medians. Categorical variables were described with the number of observed cases and frequencies expressed in percentages. For hypothesis testing, linear regression analysis, the chi-square test and the Kruskal-Wallis test were used, as appropriate. For the analyses, the multiple-choice items were treated as categorical variables and the Likert-type responses were treated as continuous variables (as they express degree rather than discrete options).

To test the contribution of students' gender, grade, and institution to the variability of their preferences, a multinomial regression model was built, in which students' preferences were entered as the dependent variable, and the said predictors were entered as factors. The reference grade was always Grade 1, and the reference image was always the unmodified image. This analysis was performed for each of the ten and six photo series. The null hypothesis was that none of the factors had significant contribution to the variability of student preferences. The level of significance was $p = 0.05$, unless otherwise indicated.

Results

Subjects

Altogether 861 questionnaires were obtained from the 919 students. This is equal to a rate of 93.7%. The response rate to the specific questions was relatively good, as we managed to get 738 to 861 responses to each item. Missing responses were obtained for the following questions:

- 1.2. Age (N = 842),
- 2.8. Does the line between your upper central incisors fall in the midline of your face? (N = 763),
- 2.9. Does the line between your lower central incisors fall in the midline of your face? (N = 742),
- 2.10. Do the lines between your upper and lower incisors fall in the same line? (N = 738),
- 2.11. Is your gum visible when you smile? (N = 774).

Profile photo evaluation was completed by 843-855 respondents, depending on the specific series (97.9-99.3%).

The mean age of the 861 respondents was 22.34 ± 4.2 years. The sex distribution was 560 female (65%) and 301 male (35%) students, that correlates with the feminized nature of the dental profession in Hungary. 296 students (34.4%) were enrolled at Semmelweis University, 206 students (23.9%) at the University of Debrecen, 218 students (25.3%) at the University of Szeged, and 141 students (16.4%) at the University of Pécs. These proportions are in accordance with the relative sizes of these faculties. Sex distribution by school grade is shown on Table 3.

Grade	N	Gender (N(%))		Age (mean± SD)
1st	187	M: 71 (38%)		19.99 ± 4.03 yrs
		F: 116 (62%)		
2nd	184	M:61 (33%)		21.40 ± 2.96 yrs
		F: 123 (67%)		
3rd	137	M: 41 (30%)		22.23 ± 5.31 yrs
		F: 96 (70%)		
4th	169	M: 62 (37%)		23.92 ± 3.33 yrs
		F: 107 (63%)		
5th	184	M: 66 (36%)		24.31 ± 3.52 yrs
		F: 118 (64%)		

Table 3. Demographic data of respondents. N=861. M: male. F: female.

Self-perceived dentofacial esthetics

The chi-square test did not show a significant association between the responses to the multiple-choice items (2.1–2.11) or grade, and there was no significant association with gender (entered as a control variable). We can conclude that grade and gender made no significant difference on the students' esthetic self-perception according to the parameters we studied; thus, to characterize students' self-perception, we analyzed the answers to these items as a whole, instead of performing it grade-to-grade. The results show that the students had a positive perception of their own smile in general. 210 of the respondents (24.4%) indicated that they were trying to avoid smiling because of the condition of their teeth at some point in their life or that it was a problem for them at the time of sampling. 116 students (13.5%) responded that they smile with closed mouth when being photographed. 556 students (64.6%) said that they had never looked at somebody else wishing that their smile would be like the smile of that person. 515 students (59.8%) responded with "no" to the question as to whether they wished to change their smile. A great majority of the respondents, 740 students (85.9%) were absolutely or partially satisfied with the color of their teeth. Only 121 respondents (14.1%) indicated complete dissatisfaction. A similarly high number of respondents, 688 students (79.9%) found that

the shape and size of their teeth were harmonious. Crowding was problematic to 365 students (42.4%), and 90 of them indicated that they had crowding of both arches. 710 (82.5%) students responded that their interincisal line fell exactly in the midline of their face, whereas only 587 (68.2%) students found that their lower interincisal line fell in the same line. 508 (59%) students indicated that their upper and lower interincisal lines were the same. It should be noted that more than 10% of all respondents indicated that they had never studied these particular features of their smile. Finally, to the question regarding the visibility of their gums when smiling, 586 (68.1%) students responded "no", 208 (24.2%) students responded "yes", and only 67 (7.8%) students said that they had never observed this feature. As for the Likert-type self-evaluation (specifically items 3.1–3.6), linear regression analysis was used to determine if grade or gender had a significant effect on responses. Similarly to the multiple-choice items, no significant effect was detected; thus, the sample was analyzed descriptively, as a whole. The results are summarized in Table 3. The respondents were the most satisfied with the size, and the least satisfied with the color of their teeth.

Items	N	Mean	SD	Median	Mode	Frequency of mode	Min.	Max.
3.1. How satisfied are you with the shape of your teeth?	861	4.34	0.76	4.00	5	48.32%	0.00	5.00
3.2. How satisfied are you with the size of your teeth?	861	4.43	0.83	5.00	5	56.80%	0.00	5.00
3.3. How satisfied are you with the orderliness of your teeth?	861	3.86	0.96	4.00	4	39.61%	0.00	5.00
3.4. How satisfied are you with the whiteness of your teeth?	861	3.66	0.94	4.00	4	43.32%	0.00	5.00
3.5. How satisfied are you with the harmony between your teeth and lips?	861	4.36	0.87	5.00	5	55.17%	0.00	5.00
3.6. How satisfied are you with the aesthetics of your smile in general?	861	4.07	0.87	4.00	4	45.53%	0.00	5.00

Table 4. Results of the third group of items. The respondents had to indicate how much they agreed with the given statements on a 1 to 5 scale. 1: not at all, 5: absolutely.

Evaluation of smile photo ratings

Chi-square test showed a significant association between grade and items 4.8 (namely, midline shift, $p < 0.01$) and 4.10 (namely, the relative visibility of the arches, $p < 0.01$). No significant effect of gender was detected for any of the photo series. Figures 3 and 4 show the distribution of midline shift and relative visibility preferences across grades, respectively. The 2 mm right shift was the least preferred modification regardless of grade. An interesting pattern was found regarding the 2 mm left shift. In the first grade, it was the second most preferred modification, nearly as preferred as the most highly rated 1 mm left shift (with only 1% of difference). In the second grade, however, it ranked only fourth. In the third grade, it became the most preferred variation. In the fourth grade, it fell back to the third place, and in the fifth grade it third most preferred choice too. In summary, there was a significant variation of preference for this specific modification across the grades. Another interesting finding is that the unmodified image was the most preferred only in the fourth grade. It ranked third in all other grades. In the first, second and fifth grades, the 1 mm left shift was the most preferred choice. We can conclude, that the preferences showed a quite even distribution across the variations, with not much difference. Fifth grade, however, was an exception. The differences between the preferences for each variation were the largest in that grade, resulting in a real rank order. Moreover, third year appears to be a turning point, where preferences stabilize, and from the fourth year on, no real variation is seen in the preference order. Comparing the first and fifth grades, it is interesting to see that the preferences of the two grades are almost the same, with the single exception of the 2 mm to left variation, which is almost as preferred as the first-ranking choice in the first year, but clearly falls back to the third place by the fifth year.
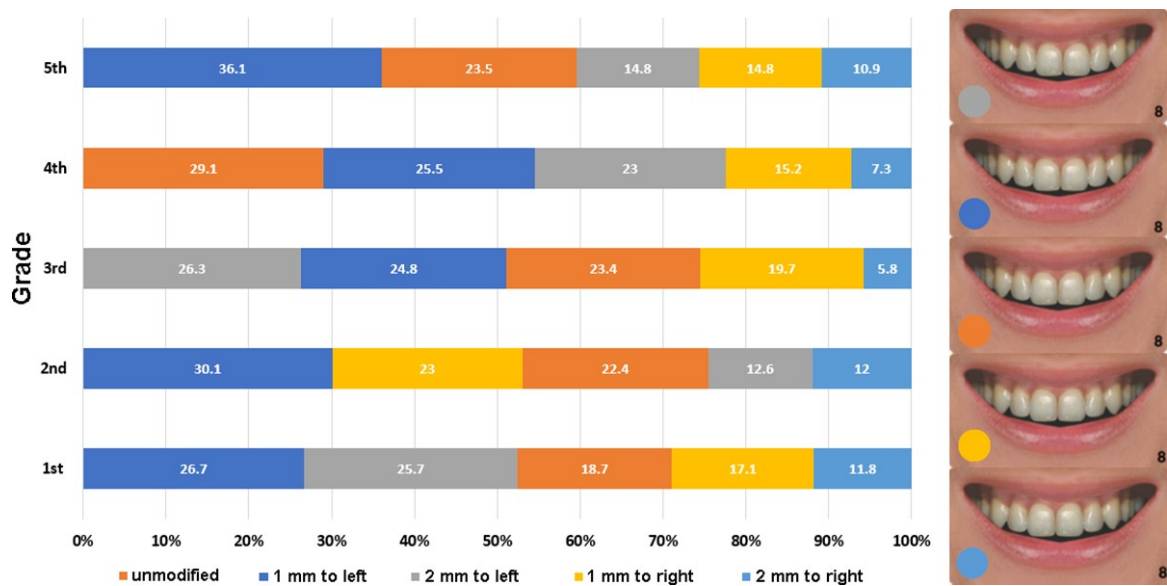
Figure 3. Distribution of preferences in the five grades for midline shift. The vertical line between the central incisors was shifted to the left and to the right in 1 mm steps (percentages, N=861).

As for the relative visibility of the arches, the variability of preferences across the grades is obvious at first sight. The unmodified variation turned out to be the most preferred in 3 of the 5 grades, but it never ranked lower than 3rd (namely, in the third grade). The least preferred variation, basically regardless of grade, was the 1 mm downward shift (where the least of the lower arch is visible). Preferences for the 1 mm up and 0.5 mm down variations varied the most across the grades. Similarly to what was observed in connection with the midline shift, the third grade appears to be a turning point. The preferences are distributed across the variations less evenly from there on, and a real rank order seems to develop. Unlike in the case of the midline shift, the preference order in the fifth grade was markedly different from that in the first grade, except for the unmodified variation being the most preferred one in both grades. Regarding the rest of the photo series, we did not find any significant association with grade. The sample showed approximately the same preferences, regardless of grade. In Table 5, however, we provide the most and least preferred variations by grade. It characterizes the preferences of the sample in general.
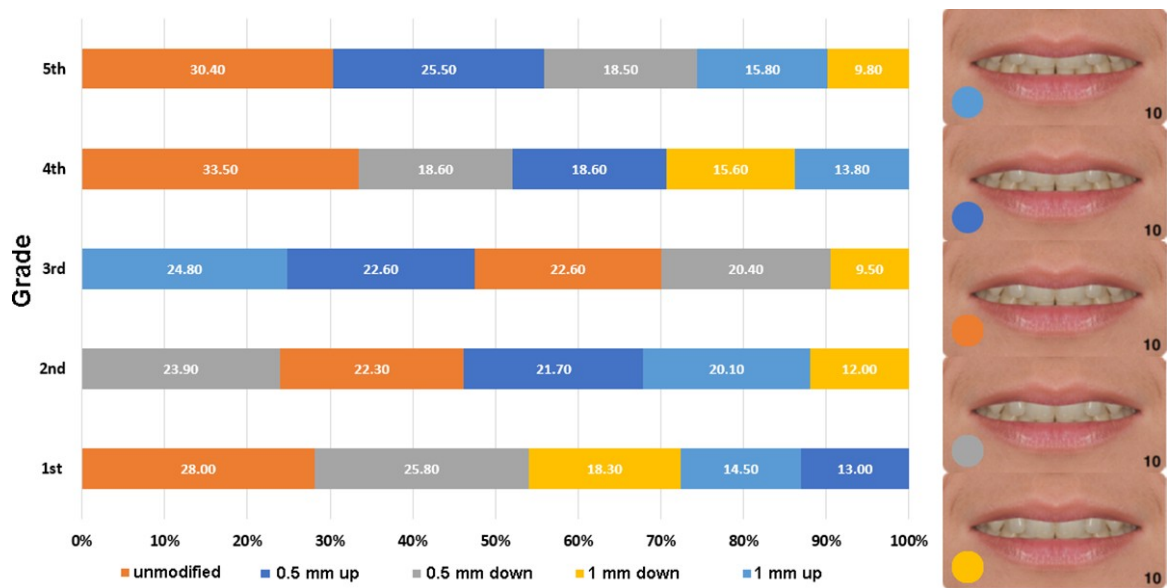
Figure 4. Distribution of preferences in the five grades for the relative visibility of the arches. The arches were moved upward and downward behind the lips in 0.5 mm steps (percentages, N=861).

Feature	Most preferred (%)	Least preferred (%)
SA	Inverse 1 (55%)	Concave 1 (0.6%)
GS	Arches 2 mm up (44%)	Arches 2 mm down (2.7%)
LCLI	Canines 1 mm shorter (29%)	Canines and lateral incisors 1 mm longer (11.5%)
WBC	Unmodified (23.5%)	Buccal corridor 2 mm wider (16%)
VPCC	Cusps 1 mm above arch level (24.8%)	Unmodified (15.8%)
ZFT	Horizontal zenith (35.5%)	Upward arching (8.73%)
LFIP	Unmodified (31.2%)	All papillae shorter (5.74%)
PC	Unmodified (36%)	Commissures 3 mm downward (12.35%)

Table 5. The most and the least preferred variations by grade for the photo series where no significant association with grade was found (N=861). The conventions are the same as in Table 1.

Evaluation of profile photo ratings

The null hypothesis was retained for gender and institution in all photo series. Regression analysis indicated a significant effect of grade for photo series 2 (chin prominence, CP, $p < 0.05$), 5 (sagittal position of the maxillary arch, SPM, $p < 0.05$), and 6 (simultaneous modification of nose and chin, NC, $p < 0.01$).

Table 6 shows the preferences for the individual photos in the CP series by grade. According to the results of the regression analysis, students in the fifth (final) grade opted significantly more frequently for the -1 mm modification than the original as compared to the preferences of the first-grade students (odds ratio (OR): 1.998, confidence interval (CI) 95%: 1.078–3.705, $p < 0.05$). In fact, as the table shows, students in the first grade preferred the original image over the -1 mm modification. In the fifth grade, just the opposite was observed. Preference for a retruded chin was a general tendency: the majority of the choices (>60%) were distributed across the original and the retruded modifications in all grades (approximately evenly, apart from grades 1 and 5). Preference for the original was the lowest in the fifth grade (19.1%) and the highest in the third grade (27.2%), where it was also the most popular choice.

			-2 mm	-1 mm	Original	+1 mm	+2 mm	Total
Grade	1	Count % within Grade	50 26.9%	34 18.3%	45 24.2%	36 19.4%	21 11.3%	186 100.0%
	2	Count % within Grade	49 26.8%	39 21.3%	45 24.6%	33 18.0%	17 9.3%	183 100.0%
	3	Count % within Grade	34 25.0%	34 25.0%	37 27.2%	17 12.5%	14 10.3%	136 100.0%
	4	Count % within Grade	47 28.3%	37 22.3%	43 25.9%	11 6.6%	28 16.9%	166 100.0%
	5	Count % within Grade	54 29.5%	53 29.0%	35 19.1%	22 12.0%	19 10.4%	183 100.0%
Total		Count % within Grade	234 27.4%	197 23.1%	205 24.0%	119 13.9%	99 11.6%	854 100.0%

Table 6. Distribution of preferences across grades regarding chin prominence (CP, photo series No. 2).

Table 7 summarizes the preferences for the SPM series. Here, a quite peculiar tendency was observed: the popularity of the +2 mm modification constantly rose from the first through the fifth grade (29% to 41.5%). This was also reflected in the result of the regression analysis: fifth graders opted significantly more frequently for the +2 mm modification than the original as compared to the preferences of the first graders (odd ratio (OR): 1.721, confidence interval (CI) 95%: 0.887–3.338, $p < 0.05$). This gain did not

happen at the cost of any single modification. Another minor observation was that second graders opted for the -1 mm modification significantly less frequently than first graders (OR: 0.422, CI 95%: 0.212–0.839, $p < 0.05$). Preference for the original image was the lowest in the fifth grade (12.0%) and the highest in the second grade (27.2%). In none of the grades was the unmodified image the most popular choice. The overall tendency was an increasing preference for a frontally shifted maxillary arch.

			-2 mm	-1 mm	Original	+1 mm	+2 mm	Total
Grade	1	Count % within Grade	19 10.2%	45 24.2%	27 14.5%	41 22.0%	54 29.0%	186 100.0%
	2	Count % within Grade	16 8.7%	27 14.7%	38 20.7%	50 27.2%	53 28.8%	184 100.0%
	3	Count % within Grade	20 14.7%	27 19.9%	22 16.2%	24 17.6%	43 31.6%	136 100.0%
	4	Count % within Grade	20 12.0%	28 16.9%	24 14.5%	28 16.9%	66 39.8%	166 100.0%
	5	Count % within Grade	18 9.8%	26 14.2%	22 12.0%	41 22.4%	76 41.5%	183 100.0%
Total		Count % within Grade	93 10.9%	153 17.9%	133 15.6%	184 21.5%	292 34.2%	855 100.0%

Table 7. Distribution of preferences across grades regarding the sagittal position of the maxillary arch (SPM, photo series No. 5).

Table 8 gives an overview of the preferences for the NC series. The regression analysis indicated that both fourth graders (odd ratio (OR): 0.422, confidence interval (CI) 95%: 0.212–0.839, $p < 0.05$) and fifth graders (odd ratio (OR): 0.397, confidence interval (CI) 95%: 0.208–0.757, $p < 0.01$) opted significantly less frequently for the +1 mm modification than the original as compared to the preferences of the first-grade students. Furthermore, fifth-grade students also opted significantly less frequently for the +2 mm modification (odd ratio (OR): 0.418, confidence interval (CI) 95%: 0.219–0.798, $p < 0.01$). As for the pattern of preferences: the first grade preferred the two extremes (±2

mm), slightly more than half of the respondents opted for either of these. By the second grade, +2 mm and -1 mm dominated the choices. In grades 3 and 4, the -1 mm modification was the most popular, and in the fifth grade, the original, unmodified image was the most frequently chosen. That is, students' choices appear to have moved from the extremes toward the original from the first through the fifth grades. As for the rest of the photo series, no significant effect of any of the predictors could be found, and the choices were remarkably evenly distributed across the image versions.

			-2 mm	-1 mm	Original	+1 mm	+2 mm	Total
Grade	1	Count % within Grade	35 18.8%	30 16.1%	27 14.5%	48 25.8%	46 24.7%	186 100.0%
	2	Count % within Grade	34 18.5%	46 25.0%	30 16.3%	28 15.2%	46 25.0%	184 100.0%
	3	Count % within Grade	19 14.0%	44 32.4%	23 16.9%	31 22.8%	19 14.0%	136 100.0%
	4	Count % within Grade	33 19.9%	50 30.1%	30 18.1%	25 15.1%	28 16.9%	166 100.0%
	5	Count % within Grade	33 18.0%	34 18.6%	48 26.2%	34 18.6%	34 18.6%	183 100.0%
Total		Count % within Grade	154 18.0%	204 23.9%	158 18.5%	166 19.4%	173 20.2%	855 100.0%

Table 8. Distribution of preferences across grades regarding the simultaneous modifications of the nose and chin (NC, photo series No. 6).

Self-perception and photo preference

Significant associations were detected between items 3.1 and 4.10 for gender ($p < 0.05$), 3.2. and 4.10 for gender and grade ($p < 0.01$ and $p < 0.01$, respectively), and between 3.5 and 4.4 for gender ($p < 0.05$). An in-depth crosstable analysis showed, however, that these were only apparent effects stemming from the distorting effect of the extremely low number of students with low self-evaluation scores. We concluded that the data did not support the existence of significant association between dentofacial autoperception and heteroperception.

Discussion and conclusions

Esthetic perception of dental students and dental professionals has been studied since the 80's. Brisman have compared the upper incisor esthetic preferences of patients, dental students, and dental professionals. The results have shown a significant difference between the three groups, emphasizing the role of dental education. Gender has shown no effect on the preferences. [40] Phillips et al. have studied orthodontic trainees, dental students, and non-dental students, with similar results. [41] Tufecki et al. have had the same conclusion, studying laypeople, orthodontic patients, first grade dental students, and third grade dental students. [39] Kokich et al. have shown that orthodontist are more critical in terms of esthetic preferences, than general dentist or laypersons. [30] It is interesting to note that one study by Saffarpour et al. have found no differences between dental professionals and laypeople; however, the extremely low number of participants might explain this. [42] In conclusion, there is a consensus in the literature regarding the fact that dental education does affect one's esthetic perception.

As the students' knowledge grows, their esthetic preferences are advancing as well. In general, clinicians have a better ability to diagnose certain abnormalities, than students. These aspects include the following: gingival esthetics, midline shift, dental features, facial height, facial profile, buccal corridor, and occlusal plane. Al-Saleh's study has shown, that students are less likely to diagnose slight gingival abnormalities, particularly in case of the lip and the midline. On the other hand, dental ratios and crowding are just as well diagnosed by both students and clinicians. Specialists have a significantly better diagnostic ability, when compared to general dentists in terms of the following: facial features, crowding, buccal corridor, and occlusal plane abnormalities. [14]

The role of gender in the dentofacial preferences of students and dental professionals is controversial. Literature shows that women are more aware of their own dentofacial features and put a bigger emphasis on it. [12] As mentioned before, Brisman have found no effect of gender. [40] Althagafi have studied the effect of gender and grade on the esthetic perception of smile, finding no significant difference between the smile and buccal corridor preferences of male and female respondents [12] The results of Moore and Ioi confirm that smile esthetic preferences are basically the same regardless of

gender. [36, 43] Strajnic et al. have studied patients' self-perception and satisfaction, with no differences between male and female respondents. [44]

Contrary to that, Armalaite have found a significant difference between male and female dental students in terms of the perception of gummy smile and crowding, concluding that female students tend to be much more critical in these aspects. [38] Abu Alhaija et al. have had similar results, with female respondents being more sensitive in perceiving gummy smile or a diastema. [45] In contrast, Alhammadi et al have studied 408 saudi dental students and have indicated that male students have a better dentofacial perception. [46] It is not clear what causes these opposing results; however, one can assume that it is very much dependent on the cultural bases.

The aim of our present study was to give a cross-section of the dentofacial perception of dental students from different dental schools, with a particular emphasis on the possible role of gender on it. There are no available studies that have investigated all dental school grades from the same culture and geographical region. We showed the effect of dental education, but no impact of gender was detected, and we found no reliable connection between autoperception and heteroperception. It should be noted that we developed our own questionnaire for the study, but no formal pre-study evaluation of it was performed, limiting the strength of our investigation.

Our study focused on four specific questions. These are discussed in detail in the following sections.

1. Does grade affect dentofacial esthetic self-perception?

We hypothesized that dentofacial self-perception can affect dentofacial preferences. Multiple-choice questions were utilized. No detectable connection was found, despite the fact that gender had a significant effect on self-perception. It appears so, that the 861 participant are more or less a homogeneous and satisfied group in term of esthetic self-perception. No item of autoperception was rated below 3 out of 5 by any respondent. These results are hard to compare to the literature, as there are scarce data available regarding these aspects in dental students. Althagafi has involved only 4th and 5th grade students, with results showing that the lower grade students prefer whiter teeth, while the

higher grade students consider natural teeth more esthetic. It has been shown that students would like to receive teeth whitening and orthodontic treatment the most. [12]

The lack of any significant affect of gender is quite surprising, as literature data show that female non-dental students tend to be more critical about their own body. However, it should be noted that these studies mostly concentrate on weight. Is dentofacial autoperception an exception to the rule? Or is it because dental students are somehow different from other students? Literature data are lacking; thus, further investigations are clearly required.

2. Does grade affect miniesthetic and microesthetic preferences?

Digitally modified pictures were utilized for investigating this question. There was a significant connection between grade and midline-shift, as well as between grade and relative visibility of the arches. It should be noted, though, that the variability of responses to these items was high. Gender appeared to have no effect in this aspect; thus, results were analyzed according to grades.

Midline-shift

To achieve an optimal esthetic result, facial midline should be in the same line as the upper and lower dental midlines, or at least be parallel with them. Minor discrepancies of 1.5-2 mm are acceptable. It should be noted that about 75% of the population has some discrepancy of the midlines. Studies have shown that upper arch midline shift is detectable for laypersons, if it exceeds 2 mm. Ker et al. have found that laypeople consider a maximum upper arch midline shift of 2.9 mm acceptable. [47] In Al-Saleh's study, more than half of the participating dentists and dental students considered a shift exceeding 2 mm unesthetic. Only a minority of participants were able to detect a shift below 2 mm. [14] The relevance of the upper midline is well documented in the literature. Johnston et al. have shown that orthodontist and laypersons consider a smile with bigger discrepancy of the upper midline less esthetic. [48]. Armalaite et al. have found that dental students find midline shift unesthetic, regardless of gender or grade. [38] Alhammadi et al. have studied dental students. Their results show that the students can detect even a 1 mm discrepancy of the midline. [46]

These results indicate that the upper arch midline is a very sensitive esthetic factor; thus, it is not surprising that our own study showed a significant connection of midline shift with dental school grade. It is interesting to note that three out of the five grades showed a preference for the 1 mm left-sided shift, and this was the second most preferred choice in the other two grades as well. The non-modified, normal version was the most-preferred choice only in the 4th grade. A rational explanation for this phenomenon is hard to give. The population at large might have a tendency to prefer a not precisely central midline.

Relative visibility of the upper and lower arches

The relative visibility of the upper and lower arches is an other feature that showed a significant connection with grade. While there was a clear preference for the non-modified version, some of the modifications were more controversial. The upper 1 mm modification was found the most esthetic one by the 3rd grade, but the least esthetic one by the 4th grade. An explanation might be that this modification shows a major resemblance to edge-to-edge bite; thus, considered to be a malocclusion. If this result is not an artifact, it might show that the Hungarian dental education establishes a deeper knowledge in esthetics after the 3rd grade. This might also explain the fact that preferences show a real rank order only in the 4th and 5th grade. While midline shift is a harsh modification, the relative visibility is a finer feature. It might be assumed that the 0.5 mm modifications were too minor for the respondents to be able to establish a real order. There is a lack of literature data in this aspect; thus, a clear explanation is hard to give.

Cultural factors and the dental curriculum might explain the fact the these were the two features that showed a connection with grade in our study. Our results confirm that dental knowledge affects dentofacial esthetic perception.

As to those items that did not show a significant connection with grade, the following pattern was found: the non-modified photo was considered the most esthetic in only three out of the eight features (buccal corridor, length of frontal interdental papillae, and position of the commissures), and the original photo was the least-esthetic for the students in case of one item (vertical position of the canine cusps). The latter might be explained by the fact that our model has long canines, with cusps exceeding the incisor edges. Li et

al. have found that orthodontist and laypersons show little tolerance towards any discrepancy between length of the incisors and the canines, and they prefer the canines to be slightly shorter. [49] Our results confirm this: shorter canines have a better esthetic perception compared to longer ones.

As to the question of gingival display, our result showed a preference towards the least display. In Armalaite et al.'s study, students considered gummy smile unacceptable, and there is a consensus in the literature, that it is an abnormality that should be addressed.

[38] However, this negative tendency towards gummy smile is not universal, and Brazilian and Japanese studies have found that gingival display does not affect the esthetic perception of a smile negatively.

As to the smile arc, the slightly inverted version was the most preferred one. This is contrary to the known esthetic norm of a slightly convex arc that follows the line of the lower lip.

3. Does dentofacial esthetic self-perception affect one's esthetic preferences?

A significant connection was found between satisfaction with the shape of one's teeth and the perception of relative visibility of the arches, between satisfaction with the size of one's teeth and perception of relative visibility of the arches, as well as between satisfaction with the harmony of one's teeth and lips and perception of the buccal corridor. A detailed cross-table analysis indicated that these significant connections might be mere artifacts; thus, we cannot draw any conclusion regarding the possible connection between autoperception and heteroperception. However, this does not mean that there is no such connection. A possible explanation might lie in the fact that most of the respondents were generally satisfied with their own dentofacial features. Further investigations are necessary.

4. Does gender, grade, or the specific dental school affect esthetic preferences?

Gender and the specific dental school did not show any connection with preferences, but grade did so in case of three items. The lack of any effect of gender is not surprising, as the same phenomenon was detected in other aspects in our study.

It is well known in the literature that esthetic preferences show geographical variability. Strajnic et al. have studied Serbian patients, finding no connection with gender, whereas Pzylipiak et al. have found in a Polish sample that women tend to prefer mean nose length less, when compared to male respondents. [44,50] The present study investigated nose length preferences too, but no significant connection with gender was found. It should be noted that most literature data is of laypersons; thus, the question arises that dental education might homogenize these otherwise gender-dependent preferences.

The lack of any effect of the specific dental school is not surprising, as Hungary is a culturally homogenous country, with most of the Hungarian students coming from similar backgrounds. The Hungarian dental community can be considered a small professional group; thus, dental professionals have an adequate knowledge concerning each other's views. This might have a homogenizing effect on the dental curriculum as well. It should also be noted that all four dental schools are state-funded, further homogenizing the curriculum.

In terms of evaluating our profile-specific results, it should be emphasized that Caucasian students from homogenous cultural backgrounds evaluated photos of a Caucasian woman. This limits the generalizability of our results.

The results showed that progressing dental education does affect the students' profile preferences in terms of chin prominence, upper arch position, and chin-nose harmony.

Chin prominence

Investigators from different ethnic and cultural backgrounds all consider chin prominence a major facial esthetic feature.

Al Taki has concluded that lower jaw position is a more important factor of esthetic perception than upper jaw position. Most of the respondents in that study, dental students,

general dentist, oral surgeons, and orthodontist alike, have considered the chin the cornerstone of facial profile perception. Laypeople, however, have seen that the nose has a more important role. The same study has found that male bimaxillary protrusion is the least esthetic for all groups; however, the same feature is much more acceptable in women. [51]

A less prominent, slightly retruded chin is considered a feminine feature. Torsello et al. have found that both laypersons and orthodontist are more accepting of a female nose protrusion than a similar chin protrusion. Hongyu et al. have found that laypersons put a bigger emphasis on chin prominence than orthodontists. [52] On a Korean sample, Kim et al. have concluded that a retruded chin might play a substantial role in perceiving a female face as nice. [53] Al Taki have found that while laypeople are less tolerant towards a retruded chin, orthodontist do so in case of a chin protrusion. [51] Lee has investigated plastic surgery of the chin and have concluded that chin projection should be 3 mm behind the line drawn between the nose and the lips; thus, producing a slightly retruded chin is advisable. [54] In conclusion, a slightly retruded chin seems to be a cornerstone of an esthetic female face, and in some instances of an esthetic male face as well. Our results confirm these.

Sagittal position of the upper arch

Our results showed that the preference towards a maxillary protrusion is increasing with the dental school grade. The most probable explanation of this might lie in the position of the upper incisors, which is well documented to have a significant effect on facial profile esthetics. Most studies explain this phenomenon with the movement of the soft tissues. However, this theory does not explain our results, as our antero-posterior modifications were too minor to cause detectable soft-tissue changes. Andrews have concluded that a Caucasian female profile is harmonious if the upper incisors are anterior to the FFA and posterior to the glabella. [55] The connection between the position of the upper incisors and the forehead is established in other populations as well. Unfortunately, our study used picture that were cropped at the level of the infraorbital rim; thus, the respondents were unable to observe such connections. Our results confirm the importance of the antero-

posterior position of the upper incisors. We can also assume that this particular feature might affect esthetic perception even without observing the forehead.

It can be concluded that dental students gradually establish a preference towards an anteriorly displaced upper arch. These are previously undocumented aspects; however, further investigations should be performed in the future to involve laypeople, general dentists, and orthodontists as well.

Concordant changes of the nose and the chin

As previously stated, retruded chin was preferred by the vast majority of respondents. In case of the nose the preferences were homogenous in the sample. This might be contrary to the available literature data that have shown that a shorter nose is better accepted esthetically. It should be noted though, that these studies investigated the preferences of laypersons; thus, their result are not directly comparable to ours. The scarce literature concerning the facial profile preferences of dental students do not involve any results regarding the role of the nose; thus, we cannot tell if the relative indifference regarding the size of the nose is a general characteristic of dental students.

What happens if modifications of the chin and the nose are connected? As previously mentioned, students' choices are gradually shifting towards the unmodified pictures; however, this should not be simplified to say that 5th grade students have learned enough to be able to differentiate the normal from the abnormal. Our results in the 5th grade group showed that the distribution of preferences is quite homogenous, and only the non-modified version is the one that shows higher preference. Our interpretation is that any sagittal modification of the nose or the chin can be perceived as esthetic if it is proportionate with the modification of the other. The harmony between the nose and the chin is more important than their individual size. The practical implication is that any treatment that modifies the sagittal position of the chin or the nose, should take the dimensions of both structures into consideration.

Three studied parameters did not show any significant effect on preferences: nose, occlusal plane inclination, and the vertical position of the upper arch. The nose has already been discussed. The latter two are usually considered as major factors of smile

esthetics. There are no available studied regarding the role of these factors in facial profile preferences. Our result showed no significant effect.

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References

1. Silva GC, Castilhos ED, Masotti AS, Rodrigues-Junior SA: Dental esthetic self-perception of Brazilian dental students. RSBO 2012; 4: 375- 381.

2. Heppt WJ, Vent J: The Facial Profile in the Context of Facial Aesthetics. Facial Plast Surg. 2015 Oct;31(5):421-30.

3. Malkoc S, Fidancioglu A: The role of ideal angles, ratios, and divine proportions in aesthetic evaluation of adolescents. Aesthetic Plast Surg. 2016 Feb; 40(1):1-12.

4. Adamson PA, Doud Galli SK: Modern concepts of beauty. Last Surg Nurs. 2009;29(1):5-9.

5. Naini FB, Moss JP, Gill DS: The enigma of facial beauty: esthetics, proportions, deformity, and controversy. Am J Orthod Dentofacial Orthop. 2006 Sep;130(3):277-82.

6. Van Der Geld P, Oosterveld P, Van Heck G, Kuijpers- Jagtman AM: Smile Attractiveness. Angle Orthodontist 2007; 77: 759-765.

7. Flores-Mir C, Silva E, Barriga MI, Lagravére MO, Major PW: Lay person's perception of smile aesthetics in dental and facial views. Journal of Orthodontics 2004; 31: 204-209.

8. Mafi AA, Shahverdiani R, Mafi P :Ideal Soft Tissue Facial Profile in Iranian Males and Females: Clinical Implications. World J Plast Surg 2018;7(2):179-185.

9. Naini FB, Donaldson ANA, Cobourne MT, Mcdonald F: Assessing the influence of mandibular prominence on perceived attractiveness in the orthognathic patient, clinician, and layperson. European Journal of Orthodontics 2012; 34: 738-746.

10. Martin AJ, Buschang PH, Boley JC, Taylor RW, Mckinney TW: The impact of buccal corridors on smile attractiveness. European Journal of Orthodontics 2007; 29: 530-537.

11. Davis NC: Smile design. Dent Clin North Am. 2007 Apr;51(2):299-318.

12. Althagafi N: Esthetic Smile Perception Among Dental Students at Different Educational Levels Clin Cosmet Investig Dent. 2021 May 7;13:163-172.

13. Alomari SA, Alhaija ESA, AlWahadni AM, Al-Tawachi AK: Smile microesthetics as perceived by dental professionals and laypersons. Angle Orthod. 2022 Jan 1;92(1):101-109.

14. Al-Saleh SA, Al-Shammery DA, Al-Shehri NA, Al-Madi EM: Awareness of Dental Esthetic Standards Among Dental Students and Professionals. Clin Cosmet Investig Dent. 2019 Dec 2;11:373-382.

15. Tin-Oo MM, Saddki N, Hassan N: Factors influencing patient satisfaction with dental appearance and treatments they desire to improve aesthetics. BMC Oral Health 2011; 11:6.

16. Little AC, Apicella CL, Marlowe FW: Preferences for symmetry in human faces in two cultures: data from the UK and the Hadza, an isolated group of hunter-gatherers. Proceedings of The Royal Society B 2007; 274: 3113-3117.

17. Floyd EM, Perkins SW: Anatomy of the Facial Profile. Facial Plast Surg. 2019 Oct;35(5):423-429.

18. Tauk A, Bassil-Nassif N, Mouhanna-Fattal C, Bouserhal J: The importance of using the entire face to assess facial profile attractiveness. Int Orthod. 2016 Mar;14(1):65-79.

19. Ghorbanyjavadpour F, Rakhshan V. Factors associated with the beauty of soft-tissue profile. Am J Orthod Dentofacial Orthop. 2019;155:832-843.

20. Skinazi GL, Lindauer SJ, Isaacson RJ: Chin, nose, and lips. Normal ratios in young men and women. Am J Orthod Dentofacial Orthop. 1994 Nov;106(5):518-23.

21. Maganzini AL, Tseng JY, Epstein JZ: Perception of facial esthetics by native Chinese participants by using manipulated digital imagery techniques. Angle Orthod. 2000 Oct;70(5):393-9.

22. Soh, J.; Chew, M.T.; Wong, H.B. A comparative assessment of the perception of Chinese facial profile esthetics. Am. J. Orthod. Dentofac. Orthop. 2005, 127, 692–699.

23. Chen, Y.H.; Cheng, Y.L.; Cheng, H.; Yu, H. Comparison of smile esthetics among celebrities, dentists, and dental students in a Han Chinese population. J. Prosthet. Dent. 2020, 123, 845–849.

24. Farrow AL, Zarrinnia K, Azizi K: Bimaxillary protrusion in black Americans--an esthetic evaluation and the treatment considerations. Am J Orthod Dentofacial Orthop. 1993 Sep;104(3):240-50.

25. Czarnecki ST, Nanda RS, Currier GF: Perceptions of a balanced facial profile. Am J Orthod Dentofacial Orthop. 1993 Aug;104(2):180-7.

26. Josefsson E, Bjerklin K, Halling A. Self-perceived orthodontic treatment need and culturally related differences among adolescents in Sweden. Eur J Orthod. 2005;27(2):140-7.

27. Wedrychowska Szulc B., Syrynska M. Patient and parent motivation for orthodontic treatment - a questionnaire study. Eur J Orthod. 2010;32(4):447-52.

28. Ghaleb N, Bourserhal J, Bassil-Nassif N: Aesthetic evaluation of profile incisor inclination. European Journal of Orthodontics 2011; 33: 228-235.

29. Montiel-Company JM, Bellot-Arcís C, Almerich-Silla JM: Validation of the psychosocial impact of dental aesthetics questionnaire (Pidaq) in Spanish adolescents. Med Oral Patol Cir Bucal 2013; 18:168-173.

30. Kokich VO, Kokich VG, Kiyak HA: Perceptions of dental professionals and laypersons to altered dental esthetics: Asymmetric and symmetric situations. American Journal of Orthodontics and Dentofacial Orthopedics 2006; 130: 141- 151.

31. Khan M, Fida M: Assessment of Psychosocial Impact of Dental Aesthetics. Journal of The College of Physicians and Surgeons Pakistan 2008; 18: 559-564.

32. De Baets E, Lambrechts H, Lemiere J, Diya L, Willems G: Impact of self-esteem on the relationship between orthodontic treatment need and oral health-related quality of life in 11 – to 16-year-old children. European Journal of Orthodontics 2012; 34: 731-737.

33. Mafi AA, Shahverdiani R, Mafi P. Ideal Soft Tissue Facial Profile in Iranian Males and Females: Clinical Implications. World J Plast Surg 2018;7(2):179-185.

34. Thiyagarajan A, Kumar D. Perception from Future Dental Professionals. Acta Scientific Dental Sciences 24. 2018:03-05.

35. El Mourad AM, Al Shamrani A, Al Mohaimeed M, Al Sougi S, Al Ghanem S, Al Manie W: Self-Perception of Dental Esthetics among Dental Students at King Saud University and Their Desired Treatment. Int J Dent. 2021 Feb 22;2021:6671112.

36. Ioi H, Nakata S, Counts AL. Influence of gingival display on smile aesthetics in Japanese. Eur J Orthod. 2010;32(6):633-7.

37. Bilal R. Self perception and satisfaction with dental esthetics in Dental students of Quassim region of Saudi Arabia. Pakistan Oral and Dental Journal 2016;36:03.

38. Armalaite J, Jarutiene M, Vasiliauskas A, Sidlauskas A, Svalkauskiene V, Sidlauskas M, Skarbalius G: Smile aesthetics as perceived by dental students: a cross-sectional study. BMC Oral Health. 2018 Dec 22;18(1):225.

39. Tufekci E, Jahangiri A, Lindauer SJ. Perception of profile among laypeople, dental students and ortho- dontic patients. Angle Orthod. 2008; 78(6):983–7.

40. Brisman, A.S. Esthetics: A comparison of dentists' and patients' concepts. J. Am. Dent. Assoc. 1980, *100*, 345–352.

41. Phillips C, Tulloch C, Dann C: Rating of facial attractiveness. Community Dent Oral Epidemiol. 1992; 20 (4):214–20.

42. Saffarpour A, Ghavam M, Saffarpour A, Dayani R, Fard M. Perception of Laypeople and Dental Profes- sionals of Smile Esthetics. J Dent (Tehran). 2016; 13(2):85–91.

43. Moore T, Southard KA, Casko JS, Qian F, Southard TE. Buccal corridors and smile esthetics. Am J Orthod Dentofac Orthop. 2005;127(2):208–213.

44. Strajnic L, Bulatovic D, Stancic I, Zivkovic R. Self-perception and satisfaction with dental appearance and aesthetics with respect to patients' age, gender, and level of education. Srp Arh Celok Lek. 2016; 144(11–12):580–9.

45. Abu Alhaija ESJ, Al-Shamsi NO, Al-Khateeb S. Perceptions of Jordanian laypersons and dental professionals to altered smile aesthetics. Eur J Orthod. 2011;33(4):450–456.

46. Alhammadi MS, Halboub E, Al-Mashraqi AA, et al. Perception of facial, dental, and smile esthetics by dental students. J Esthet Restor Dent. 2018;30(5):415–426.

47. Ker AJ, Chan R, Fields HW, Beck M, Rosenstiel S. Esthetics and smile characteristics from the layperson's perspective: a computer- based survey study. J Am Dent Assoc. 2008;139(10):1318–1327.

48. Johnston CD, Burden DJ, Stevenson MR. The influence of dental to facial midline discrepancies on dental attractiveness ratings. Eur J Orthod. 1999; 21(5):517–22.

49. Li R, Mei L, Wang P, He J, Meng Q, Zhong L, et al. Canine edge width and height affect dental esthetics in maxillary canine substitution treatment. Prog Orthod. 2019; 20(1):16.

50. Przylipiak, M.; Przylipiak, J.; Terlikowski, R.; Lubowicka, E.; Chrostek, L.; Przylipiak, A: Impact of face proportions on face attractiveness. J. Cosmet. Dermatol. 2018, 17, 954–959.

51. Al Taki A, Guidoum A: Facial profile preferences, self-awareness and perception among groups of people in the United Arab Emirates. J Orthod Sci. 2014 Apr;3(2):55-61.

52. Hongyu, R.; Xin, C.; Yongqing, Z: Correlation between facial attractiveness and facial components assessed by laypersons and orthodontists. J. Dent. Sci. 2021, 16, 431–436.

53. Kim, S.Y.; Bayome, M.; Park, J.H.; Kook, Y.A.; Kang, J.H.; Kim, K.H.; Moon, H.B. Evaluation of the facial dimensions of young adult women with a preferred facial appearance. Korean J. Orthod. 2015, 45, 253–260.

54. Lee, E.I. Aesthetic alteration of the chin. Semin. Plast. Surg. 2013, 27, 155–160.

55. Andrews, W.A. AP relationship of the maxillary central incisors to the forehead in adult white females. Angle Orthod. 2008, 78, 662–669.

Appendix

Publication No. I.

PLOS ONE

RESEARCH ARTICLE

Dentofacial mini- and microesthetics as perceived by dental students: A cross-sectional multi-site study

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Abstract

Background

How dental education influences students' dental and dentofacial esthetic perception has been studied for some time, given the importance of esthetics in dentistry. However, no study before has studied this question in a large sample of students from all grades of dental school. This study sought to fill that gap. The aim was to assess if students' dentofacial esthetic autoperception and heteroperception are associated with their actual stage of studies (grade) and if autoperception has any effect on heteroperception.

Methods

Between October 2018 and August 2019, a questionnaire was distributed to 919 dental students of all 5 grades of dental school at all four dental schools in Hungary. The questionnaire consisted of the following parts (see also the supplementary material): 1. Demographic data (3 items), Self-Esthetics I (11 multiple- choice items regarding the respondents' perception of their own dentofacial esthetics), Self-Esthetics II (6 Likert-type items regarding the respondents' perception of their own dentofacial esthetics), and Image rating (10 items, 5 images each, of which the respondents have to choose the one they find the most attractive). Both the self-esthetics and the photo rating items were aimed at the assessment of mini- and microesthetic features.

Results

The response rate was 93.7% (861 students). The self-perception of the respondents was highly favorable, regardless of grade or gender. Grade and heteroperception were significantly associated regarding maxillary midline shift (p < 0.01) and the relative visibility of the arches behind the lips (p < 0.01). Detailed analysis showed a characteristic pattern of preference changes across grades for both esthetic aspects. The third year of studies appeared to be a dividing line in both cases, after which a real preference order was established. Association between autoperception and heteroperception could not be verified for statistical reasons.

at the time +10% (to cover lost, damaged, etc. copies). Altogether 1011 questionnaires were distributed for 919 students. The final sample size was determined by the number of non-responders (see below). The authors administered the questionnaires personally to ensure that the instructions and explanations would be the same at all sites and in each grade. 30 minutes were allocated for answering the questions (including the rating of the photos). The questionnaires were anonymous, and participation was voluntary. Sampling took place between October 2018 and August 2019. The study protocol and the applied instrument were approved by the Regional Ethics Committee for Research in Human Medical Biology at the University of Szeged (No. 178/2018-SZTE). Written informed consent was not required. The students were free not to participate or quit at any time.

The instrument

Several instruments exist that are related to dentofacial esthetics in some way. Traditional indices, such as the *Dental Esthetic Index* (DAI) or the *Index of Orthodontic Treatment Need* (IOTN) are valid and reliable, but they were developed for older adults [13], and the assessment of subjective satisfaction is not among the primary aims of these instruments [4]. For these reasons, we could not use them for our study. Other indices, like *Oral Health Related Quality of Life* (OHRQoL) do concentrate on subjective factors, but predominantly as determined by oral health in general [14], with esthetics only as a marginal factor. The *Psychosocial Impact of Dental Esthetics Questionnaire* (PIDAQ) and the *Orthognathic Quality of Life Questionnaire* (OQLQ) may be the closest to what we needed for the present study, but still, we found that some combination of the existing questionnaires would be the optimal.

It was for this reason that we developed our own instrument, by combining items from already existing ones [2, 3, 15–17]. The instrument got the working name *Dentofacial Esthetics Instrument for Dental Students*, was developed first in the Hungarian language (an authenticated English translation exists but has not been tested), and it consists of the following parts (see also the supplementary material): 1. Demographic data (3 items), Self-Esthetics I (11 multiple choice items regarding the respondents' perception of their own dentofacial esthetics), Self-Esthetics II (6 5-grade Likert-type items regarding the respondents' perception of their own dentofacial esthetics), and Image rating (10 items, 5 images each, of which the respondents have to choose the one they find the most attractive). Both the self-esthetics and the photo rating items were aimed at the assessment of mini- and microesthetic features, as defined by Sarver [18]. Those features were chosen that are considered to influence the esthetic perception of a smile the most [19, 20].

The smile photos for rating we prepared ourselves. The choice of the model was based on the literature [10, 21, 22]: a clinically normal smile with normal occlusion and features that are generally perceived as esthetic. The image was a standard frontal view showing the anterior teeth, the surrounding gingival tissues and the lips. The image was cropped to remove the chin, nose and cheeks to exclude the confounding effect of macroesthetic features. The photos were taken from a 1.5 m distance, with a Nikon D7000 camera equipped with a Nikon 105mm F 2.8G VR AF-S ED.IF Nikkor objective. The model was standing while being photographed. The photo shooting session took place on a sunny day, in a room amply and evenly lit by natural light, at noontime.

For all esthetic features, the original (unmodified) photo and four modified versions of it were used, so all series (as defined by one feature) consisted of 5 photos (Fig 1). Modifications were always made to the unmodified image. For the modifications, Adobe Photoshop CC 2015 (Adobe Systems, USA) was used. The resulting 50 photos were arranged in an album in a way that items from the same series were always shown on the same page, in random order. Life-

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Conclusion

Our findings corroborate the results of most previous studies regarding the effect of dental education on the dentofacial esthetic perception of students. We have shown that the effect can be demonstrated on the grade level, which we attribute to the specific curricular contents. We found no gender effect, which, in the light of the literature, suggests that the gender effect in dentofacial esthetic perception is highly culture dependent. The results allow no conclusion regarding the relation between autoperception and heteroperception.

Introduction

Most contemporary societies put heavy emphasis on esthetic personal appearance. It is well documented that dentofacial esthetics has a profound influence on one's social perception [1], and on self-perception as well [2–4]. For some time now, esthetics has been a central issue in dentistry, as patients put increasing emphasis on this aspect—sometimes prioritizing it over functional considerations [5, 6]. This "esthetic turn" in patients' expectations prompted dental professionals to investigate what counts as esthetic in dentistry, both from the perspectives of the patient and the dentist.

A specific question that has been investigated in several studies since the 1980s is whether dental education (the process of becoming a professional) has a significant effect on one's perception of dental esthetics [7–12].

While the methodologies and sample sizes of earlier studies dealing with the esthetic perception of dental students were mostly proper, no study has ever considered all grades of the dental school comprehensively. Armalaite and colleagues studied only 4th- and 5th- year students [12], the student sample of Tufekci and colleagues consisted of 1st- and 3rd- year students, while other studies did not even differentiate between grades, they treated dental students as a homogeneous group instead.

Another issue that has been brought up by the cited studies is that of gender. The literature is quite divided as to whether gender is a factor in dentofacial esthetic perception in the context of becoming a dental professional.

In the present questionnaire- based, cross-sectional study, we sought to give a description of the dynamics of dental esthetic perception in the process of dental education, covering all five grades of the dental school in all four dental schools in Hungary. We sought to examine in this large student sample if there is association between the stage of studies (grade) and a) one's esthetic self- perception and b) one's esthetic preferences regarding various mini- and microesthetic features, and c) if satisfaction with one's dentofacial esthetics influences dentofacial esthetic preferences. We also sought to study if gender plays a significant role in any of these. As null hypotheses, we hypothesized that a) neither grade nor gender would have a significant association with the students' self-perception and b) esthetic preferences and that c) self-perception would not have an effect on esthetic preferences.

Methods

Participants and sampling

All five grades of all the four dental faculties of Hungary (associated with the universities in Szeged, Debrecen, Pécs and Budapest) were involved in the study. After having obtained the deans' approval, printed questionnaires were distributed among the faculties. Each faculty received questionnaires the total number of their Hungarian-speaking students in each grade

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Fig 1. A sample series of images from the album used for the study. The modified feature is the width of the buccal corridor. A: the unmodified image. B-E: the buccal corridor widens by 1 mm steps up to + 4 mm (compared to the unmodified image).

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size photos were shown. The respondents were not told which the unmodified variant was. All image series with explanation are provided as supplementary material. The modifications are summarized in Table 1. Please note that the questionnaire had not been formally evaluated before this study.

Statistical analysis

Statistical analysis was carried out by an independent evaluator (see Acknowledgements). The evaluator received the results in a coded format and was told what analyses to carry out according to which codes. The evaluator was blinded to the meaning of the codes.

The results were analyzed in SPSS 22.0 (IBM, USA). Continuous variables were characterized by means with standard deviations and medians, categorical variables were described with the number of observed cases and frequencies expressed in percentages. For hypothesis testing, linear regression analysis, the chi-square test and the Kruskal-Wallis test were used, as appropriate. For the analyses, the multiple-choice items were treated as categorical variables and the Likert-type responses were treated as continuous variables (as they express degree rather than discrete options). The level of significance was $p = 0.05$, unless otherwise indicated.

Results

Participants

Of the 919 students, 861 (93.7%) responded. Response willingness to the individual items was also quite good, we managed to obtain 738 to 861 responses to each item. Items with missing

Table 1. Photo rating: The modified mini- and microesthetic features. See also supplementary material.

Series No.	Item No.	Feature	Description
1	4.1.	Smile arc (SA)	The relation of the maxillary incisal edges to the lower lip. From markedly convex to markedly inverted. Arc modified by tilting the maxillary arch in 10° steps upward and downward.
2	4.2	Gingival smile (GS)	The degree of the visibility of the upper gingiva is modified by shifting the arches downward.
3	4.3.	Length of canines and lateral incisors (LCLI)	The length of the canines and lateral incisors is modified, in varying combinations.
4	4.4.	Width of buccal corridor (WBC)	The width of the buccal corridor is increased, up to +4 mm as compared to the original.
5	4.5	Vertical position of the canine cusps (VPCC)	The position of the canine cusps is shifted above and below the arch level.
6	4.6	The zenith of the front teeth (ZFT)	Horizontal, upward arching and downward arching variations.
7	4.7	The length of frontal interdental papillae (LFIP)	The length of the interdental papillae is modified a) between the central and lateral incisors and b) between the lateral incisors and canines.
8	4.8	Midline shift (MS)	The midline, defined as the vertical line between the central incisors, is shifted to right and left.
9	4.9	Position of the commissures (PC)	The position of the commissures is shifted downward.
10	4.10	The relative visibility of the arches (RVA)	The degree of the relative visibility of the arches is modified by moving them vertically behind the lips.

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Table 2. The number of students and distribution of genders by grade.

Grade	N	Gender (N(%))
1st	187	M: 71 (38%)
		F: 116 (62%)
2nd	184	M: 61 (33%)
		F: 123 (67%)
3rd	137	M: 41 (30%)
		F: 96 (70%)
4th	169	M: 62 (37%)
		F: 107 (63%)
5th	184	M: 66 (36%)
		F: 118 (64%)

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responses were: 1.2 Age (N = 842); 2.8 Upper central midline (N = 763); 2.9 Lower central midline (N = 742); 2.10 Upper and lower incisal midline alignment (N = 738); 2.11 Gummy smile (N = 774). The mean age of the 861 respondents was 22.34 ± 4.2 years. The number of students and distribution of genders in each grade are given Table 2.

Esthetic perception of own smile

As the chi-square test did not indicate a significant association between the responses to the multiple choice items (2.1–2.11) and grade, and neither did we find a significant association with gender (entered as a control variable), we concluded that grade and gender made no significant difference on how esthetic students perceived their own smile according to the parameters we asked them about. Thus, to characterize students' self-perception, we analyzed the answers to these items as a whole, instead of breaking the analysis down to grades.

The percentages show that the students had a generally positive perception of their own smile. 210 respondents (24.4%) indicated that they had tried to avoid smiling because of the condition of their teeth at some point in their life or that it was a problem for them at the time of sampling. 116 students (13.5%) indicated that they smile with closed mouth while being photographed. 556 students (64.6%) said that they had never looked at somebody else wishing that their smile would be like the smile of that person. 515 students (59.8%) responded with "no" to the question as to whether they wished to change their smile in any way. The vast majority of the respondents, 740 students (85.9%) were absolutely or partially satisfied with the color of their teeth. Only 121 respondents (14.1%) indicated complete dissatisfaction. A similarly high number of respondents, 688 students (79.9%) found that the shape and size of their teeth were in harmony. Crowding of the teeth was a problem to 365 students (42.4%), and 90 of them indicated that they had crowded teeth in both arches. 710 (82.5%) students indicated that their interincisal line fell exactly in the midline of their face. 587 (68.2%) students found that their lower interincisal line fell exactly in the midline of their face. 508 (59%) students indicated that the upper and lower interincisal lines fell in the same line. It must be noted in connection with the latter 3 items that >10% of all respondents indicated that they had never observed these features of their smile. Finally, 586 (68.1%) students said no when asked whether their upper gum was visible while smiling. 208 (24.2%) students said that their gum was visible while smiling, and 67 (7.8%) students said that they had never observed/considered this.

As for the Likert-type self-evaluation (items 3.1–3.6), we used linear regression analysis to determine if grade or gender had significant effect on the respondents' choices. The effect of grade and gender were analyzed in the same model. Similarly to the multiple choice items, no

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Dentofacial esthetics as perceived by dental students

Table 3. Results of the Likert-type items. The respondents had to indicate how much they agreed with the given statements on a 1 to 5 scale where 1 meant not at all and 5 meant absolutely.

Item	N	Mean	SD	Median	Mode	Frequency of mode	Min.	Max.
3.1. How satisfied are you with the shape of your teeth?	861	4.34	0.76	4.00	5	48.32%	0.00	5.00
3.2. How satisfied are you with the size of your teeth?	861	4.43	0.83	5.00	5	56.80%	0.00	5.00
3.3. How satisfied are you with the orderliness of your teeth?	861	3.86	0.96	4.00	4	39.61%	0.00	5.00
3.4. How satisfied are you with the whiteness of your teeth?	861	3.66	0.94	4.00	4	43.32%	0.00	5.00
3.5. How satisfied are you with the harmony between your teeth and lips?	861	4.36	0.87	5.00	5	55.17%	0.00	5.00
3.6. How satisfied are you with the aesthetics of your smile in general?	861	4.07	0.87	4.00	4	45.53%	0.00	5.00

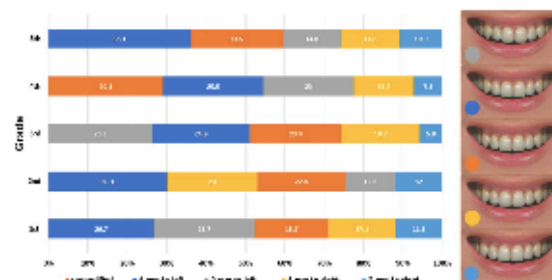https://doi.org/10.1371/journal.pone.0230182.t003

significant effect was found for any of the items, and thus the sample was analyzed descriptively and as a whole. The results are summarized in Table 3. The students were the most satisfied with the size of their teeth and the least satisfied with the whiteness (color) of their teeth.
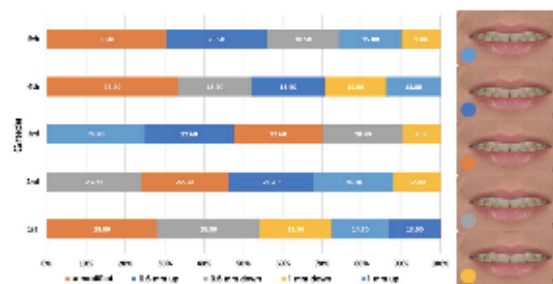
Photo rating

The chi-square test indicated significant association between grade and items 4.8 (midline shift, $p < 0.01$) and 4.10 (the relative visibility of the arches, $p < 0.01$). No significant association was found with gender for any of the photo series. Figs 2 and 3 show the distribution of preferences across the five grades.

As for the midline shift (Fig 2), it was a common finding for all grades that the 2 mm right shift was the least preferred modification. Regarding the 2 mm left shift, an interesting pattern was found: in the first grade, it was the second most preferred modification, almost exactly as preferred as the most highly rated 1 mm left shift (with only 1% difference). In the second grade, however, it ranked only fourth, but in the third grade, it became the most preferred variation. In the fourth grade, it fell back to the third place, and in the fifth grade it ranked third too. To sum it up, there was a significant variation in the preference for this specific modification across the grades. Another finding to mention is that the unmodified image was the most preferred only in the fourth grade, in the rest of the grades, it ranked third. In the first, second and fifth grades, the 1 mm left shift was the most preferred variation. In general, the preferences were quite evenly distributed across the variations, with not much difference between the variations. The only exception seems to be the fifth grade, where the differences between the preferences for each variation were the largest, resulting in what can be considered a real rank order. Furthermore, the third year appears to be a turning point, where preferences

Fig 2. Distribution of preferences in the five grades for midline shift. The vertical line between the central incisors was shifted to the left and to the right in 1 mm steps (percentages, N = 861).

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Fig 3. Distribution of preferences in the five grades for the relative visibility of the arches. The arches were moved upward and downward behind the lips in 0.5 mm steps (percentages, N = 861).

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stabilize, and from the fourth year on, no real variation is seen in the preference order. Comparing the first and fifth grades, it is interesting to see that the preferences of the two grades are almost the same, with the single exception of the 2 mm to left variation, which is almost as preferred as the first-ranking choice in the first year, but clearly falls back to the third place by the fifth year.

As for the relative visibility of the arches (modified by moving the arches up and down behind the lips, Fig 3), the variability of preferences across the grades is obvious at first sight. The unmodified variation turned to be the most preferred in 3 of the 5 grades, but it never ranked lower than 3rd (in the third grade). The least preferred variation, almost regardless of grade, was the 1 mm downward shift (where the least of the lower arch is visible). Preferences for the 1 mm up and 0.5 mm down variations varied the most across the grades. Similarly to what was observed in connection with the midline shift, the third grade appears to be a turning point, from where on, the preferences are distributed across the variations less evenly, and a real rank order seems to develop. Unlike in the case of the midline shift, the preference order in the fifth grade was markedly different from that in the first grade, except for the unmodified variation being the most preferred one in both grades.

Regarding the rest of the photo series, we did not find significant association with grade, that is, the sample showed approximately the same preferences, regardless of grade. In Table 4, however, we provide the most and least preferred variations by grade, to give a characterization of the preferences of the sample in general.

Table 4. The most and the least preferred variations by grade for the photo series where no significant association with grade was found (N = 861). The conventions are the same as in Table 1.

Feature	Most preferred (%)	Least preferred (%)
SA	Inverse 1 (55%)	Concave 1 (0.6%)
GS	Arches 2 mm up (44%)	Arches 2 mm down (2.7%)
LCLI	Canines 1 mm shorter (29%)	Canines and lateral incisors 1 mm longer (11.5%)
WBC	Unmodified (23.5%)	Buccal corridor 2 mm wider (16%)
VPCC	Cusps 1 mm above arch level (24.8%)	Unmodified (15.8%)
ZFT	Horizontal zenith (35.5%)	Upward arching (8.73%)
LFIP	Unmodified (31.2%)	All papillae shorter (5.74%)
PC	Unmodified (36%)	Commissures 3 mm downward (12.35%)

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Self-perception and photo rating

Significant associations were found between items 3.1 and 4.10 for gender (p < 0.05), 3.2. and 4.10 for gender and grade (p < 0.01 and p < 0.01, respectively), and between 3.5 and 4.4 for gender (p < 0.05). An in-depth crosstable analysis showed, however, that these were only apparent effects stemming from the distorting effect of the extremely low number of students with low self-evaluation scores. We concluded that the data did not support the existence of significant association between dentofacial autoperception and heteroperception.

Discussion

The perception of dentofacial esthetics by dental students and dentists has been studied since the 1980s. Brisman [7] compared patients, dental students and dentists regarding their esthetic preferences in connection with maxillary central incisors. He found that the three groups significantly differed in their preferences (indicating an effect of education), and that gender was not a factor. Phillips et al. [8], studying orthodontics residents, dental students and non-dental university students came to a similar conclusion regarding the effect of education. Tufekci et al. [9] came to the same conclusion in their study of laypeople, orthodontic patients, and first- and third-year dental students. Finally, Kokich et al. [10] demonstrated that being an orthodontist does make one more critical about a number of dental esthetic features than general dentists or laypersons. Interestingly enough, one study found no difference at all between dentists and laypersons in this respect, but this can be probably put down to the unusually small sample size of 10 respondents per group [11]. In summary, there seems to be a consensus in the literature, regardless of geographical area, that studying dentistry does make a difference in one's perception of various dental esthetic features. There is less consensus as to whether the gender of the student or dentist makes a difference. As mentioned before, Brisman [7], working in the New York area, found no gender effect. In contrast, Armalaite [12], studying a larger sample of Lithuanian dental students, found a definite and significant difference between males and females in the evaluation of a number of dental esthetic features from gingival smile through dental crowding. They drew the conclusion that women were "more critical" regarding these features. Finally, Alhammadi and colleagues [23] studied 408 Saudi Arabian dental students, and came to the conclusion that "male dental students have a better perception of facial and dental esthetics." It is not clear if the remarkable difference between the results of these studies is due to the different geographical locations, the difference between the studied features or something else.

The general aim of the present study was to give a comprehensive, cross-sectional characterization of a large sample of dental students from all grades of dental school in terms of their dental esthetic (self-) perception, also considering gender as a factor. The reason for this was that no study before has examined all grades together from the same cultural and geographical region. We have shown that the effect of dental education can be demonstrated on the grade level, however, no gender effect was found and no association between autoperception and heteroperception could be reliably demonstrated. When interpreting our results, it must be taken into consideration that the questionnaire was our own development and had not been formally evaluated before the study, which is definitely a limitation.

Specifically, we sought to answer four research questions. First, we asked if there is association between the stage of studies (grade) and dentofacial esthetic self- perception. We asked this question because we assumed that dentofacial self-perception could influence dentofacial preferences (hence the third research question). This we assessed with multiple-choice questions. Had we found such associations, we should have taken them into consideration when analyzing the association between grade and esthetic preference. We found no such

associations, though, and neither was the respondents' gender significantly associated with self-perception. It seems that the 861 respondents formed a more or less homogeneous, and generally satisfied, group regarding dentofacial esthetic self-perception. While there were lower-scoring items (like the whiteness of the teeth), none of the studied aspects scored an average below 3 on a scale of 5. It is difficult to compare these results to any other published result, as few studies before asked these questions specifically in connection with dental students. The lack of gender effect was somewhat surprising, as literature (of non-dental) students suggests that female students tend to be more critical about their body [24, 25]. It is to be taken into consideration, though, that these studies mostly concentrated on body image as related to body mass. Could it be that one's dentofacial body image is an exception? Or is it simply that dental students comprise a special group in this respect? The 2016 study of Strajnic and colleagues [26] failed to find gender difference in self-perception and satisfaction with dental appearance in patients (i.e. laypersons), which supports the former hypothesis. However, this question has been rarely discussed in the literature and definitely needs further investigation.

The second question was if there is association between grade and esthetic preferences regarding various mini- and microesthetic features. To assess this, we used digitally manipulated images. Significant association was found between grade and a) midline shift and b) the relative visibility of the arches, indicating that the preferences regarding these features showed the highest variability across the grades. Gender did not turn out to be a significant factor in this analysis either, so the results were analyzed by grade alone.

The importance of the maxillary midline in dentofacial esthetics is well documented. Johnston and colleagues [27] studied the esthetic judgements of orthodontists and laypersons and found that the greater the shift, the more unattractive the given smile is found. This was true both for the professionals and the laypersons, regardless of gender, and reached significance if the shift was >2 mm (in either direction). In the study of Armalaite et al. [12], shifted maxillary midline was classified by both male and female (4th- and 5th- year) dental students as unacceptable. Alhammadi and co-workers report that the dental students in their study noticed as small a shift as 1 mm [23]. It seems, thus, that the position of the maxillary midline is a sensitive esthetic issue, so it came as no surprise that in our study it was one of the parameters significantly associated with the stage of studies. It is an intriguing finding that in 3 of the 5 grades, the 1 mm left- shifted variation was the most preferred, and even in the remaining two grades (the 3rd and the 4th), it was the second most preferred, only a few per cents behind the most preferred ones. The unmodified variation was the most preferred only in the 4th year. It is difficult to offer any rational explanation other than that the studied population does actually prefer a not precisely centered midline. While studies take zero deviation as the norm, it is safe to assume that preferences in this respect vary across cultures and geographical areas. As for the supposed effect of dental education, Fig 2 clearly shows the difference of preference orders between the grades and that a real rank order with actually meaningful differences is established only by the end of the studies.

The other modified feature to show significant association with grade was the relative visibility of the upper and lower arches. While there was a clear tendency in all grades toward preferring the unmodified variation (it was the most preferred one in three of the five grades), the 1 mm up and 0.5 mm down variations obviously divided the students. For instance, the 1 mm up variation (ranked generally low) was the most preferred in the 3rd grade, but the least preferred in the 4th. What the reason is for this high variability regarding these variations is not clear. The general unpopularity of the 1 mm up variation would be easily explained by the fact that it could remind respondents of edge-to-edge bite, taught as a form of malocclusion from the earliest stages of dental studies. However, it does not explain the high popularity seen in

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the 3rd grade. If this is a unique result and not an artifact, it probably reflects the fact that students in the Hungarian dental curricula begin to deal with the finer details of dental esthetics after the 3rd grade (in the clinical module of the curriculum). This would explain why preference ratios do not reflect a clear rank order before the 4th and 5th grades. While modification of the midline is a relatively crude modification, the relative visibility of the arches is a finer issue. It is possible that the 0.5 mm steps of modification were too fine for the students to allow a clear-cut order of preference before being able to think consciously about it. However, in lack of published data on this parameter, it is difficult to offer a firm explanation.

Why exactly the perception of these two features showed association with grade might have several reasons, from cultural factors through the exact contents of education regarding dental esthetics. However, the discussion of such background factors is clearly beyond the scope of this paper, especially that we did not gather related data. The results, however, confirm the finding of other studies that there is an association between dental knowledge (expressed as grade in this study) and the esthetic perception of dentofacial features.

As for the items not significantly associated with grade, the following pattern was found: the unmodified variation was the most preferred one in only 3 items of the 8 (the width of the buccal corridor, the length of the frontal interdental papillae and the position of the commissures), and in one item (the vertical position of the canine cusps) it was the least preferred one. The latter finding was not entirely unexpected: our photo model had long canines, which means that in the unmodified variation of the photo, the canines extended below the incisal edges of the central incisors. Li and colleagues, working with similar frontal photos to ours, found that both orthodontic experts and laypersons showed low tolerance regarding the difference between the length of the central incisors and canines and preferred situations when the canines where slightly shorter [28]. Our results corroborate this: shorter canines were preferred over longer ones. As for gingival smile, the choices indicated a marked preference for the invisibility of the gingiva, the variation with the least visible gingiva being the most preferred one. At first sight, our results seem to agree with the literature. The student sample of Armalaite et al. [12] rated gingival smile "esthetically unacceptable", and there appears to be a general agreement in the literature that gingival smile is a medical condition, as treatments are proposed [29]. It must be added, though, that this extremely negative evaluation is not uniform across cultures: studies from Brazil [30] and Japan [31] reported that the visibility of the gingiva does not necessarily influence the esthetic judgement of smile. Concerning the smile arc, the slightly inverted arc was the most frequent choice, which, again, is a slight deviation from what is generally considered to be the esthetic norm (i.e. a slightly convex arc that contours the lower lip) [32]. These can be regarded as esthetic preferences that were generally characteristic of the entire sample, regardless of grade and gender.

Finally, we asked if satisfaction with one's dentofacial esthetics influences dentofacial esthetic preferences. In this respect, we found significant associations between satisfaction with the shape of one's teeth and the relative visibility of the arches in the photo series; satisfaction with the size of one's teeth and the relative visibility of the arches in the photo series; and satisfaction with the harmony between one's teeth and lips and the width of the buccal corridor in the photo series. The detailed crosstable analysis indicated that the observed significance in these cases was statistical artifact, and thus we concluded that our data did not allow the conclusion that dentofacial autoperception influences dentofacial heteroperception. This does not necessarily mean that such an effect does not exist, though. Even if our sample was large enough to allow conclusions, our respondents were predominantly satisfied with their dentofacial esthetics, which confounded the analysis. Further studies are definitely needed, especially that, to our knowledge, this study has been the first to ask this question.

Conclusions

To our knowledge, our study has been the first to study the dentofacial esthetic auto- and heteroperception of dental students at all grades of dental school, in a large and culturally homogeneous sample. Our findings corroborate the results of most previous studies regarding the effect of dental education on the dentofacial esthetic perception of students. We have shown that the effect can be demonstrated on the grade level, which we attribute to the specific curricular contents. In this respect we suggest that the study of how specific curricular contents influence the dentofacial esthetic perception of students is a promising direction for future research. We found no gender effect, which, in the light of the literature, suggests that the gender effect in dentofacial esthetic perception is highly culture dependent. Finally, we failed to confirm association between autoperception and heteroperception, but as the analysis was confounded by the uneven distribution of the data, we cannot conclude that no such association exists.

Supporting information

S1 Data. Dentofacial aesthetics instrument for dental students.
(PDF)

S2 Data.
(PDF)

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References

1. Martin AJ, Buschang PH, Boley JC, Taylor RW, McKinney TW. The impact of buccal corridors on smile attractiveness. Eur J Orthod. 2007; 29(5):530–7. https://doi.org/10.1093/ejo/cjm063 PMID: 17974544

2. Wedrychowska-Szulc B, Syrynska M. Patient and parent motivation for orthodontic treatment—a questionnaire study. Eur J Orthod. 2010; 32(4):447–52. https://doi.org/10.1093/ejo/cjp131 PMID: 20008018

3. Josefsson E, Bjerklin K, Halling A. Self-perceived orthodontic treatment need and culturally related differences among adolescents in Sweden. Eur J Orthod. 2005; 27(2):140–7. https://doi.org/10.1093/ejo/cjh070 PMID: 15817620

4. de Paula Junior DF, Santos NC, da Silva ET, Nunes MF, Leles CR. Psychosocial impact of dental esthetics on quality of life in adolescents. Angle Orthod. 2009; 79(6):1188–93. https://doi.org/10.2319/082608-452R.1 PMID: 19852614

5. Thiyagarajan A, Kumar D. Dental Esthetics: Perception from Future Dental Professionals. Acta Scientific Dental Sciences 24. 2018:03–5.

6. Szabo R, Farkas G, Keszeg M, Eordegh G, Buzas N, Antal M. [The role of the "compromise effect" in dental treatment choice. A pilot study in 676 Hungarian volunteers]. Orv Hetil. 2019; 160(38):1503–9. https://doi.org/10.1556/650.2019.31496 PMID: 31537092

7. Brisman AS. Esthetics: a comparison of dentists' and patients' concepts. J Am Dent Assoc. 1980; 100 (3):345–52. https://doi.org/10.14219/jada.archive.1980.0093 PMID: 6928165

8. Phillips C, Tulloch C, Dann C. Rating of facial attractiveness. Community Dent Oral Epidemiol. 1992; 20 (4):214–20. https://doi.org/10.1111/j.1600-0528.1992.tb01719.x PMID: 1526107

9. Tufekci E, Jahangiri A, Lindauer SJ. Perception of profile among laypeople, dental students and orthodontic patients. Angle Orthod. 2008; 78(6):983–7. https://doi.org/10.2319/102207-503.1 PMID: 18947285

10. Kokich VO, Kokich VG, Kiyak HA. Perceptions of dental professionals and laypersons to altered dental esthetics: asymmetric and symmetric situations. Am J Orthod Dentofacial Orthop. 2006; 130(2):141–51. https://doi.org/10.1016/j.ajodo.2006.04.017 PMID: 16905057

11. Saffarpour A, Ghavam M, Saffarpour A, Dayani R, Fard M. Perception of Laypeople and Dental Professionals of Smile Esthetics. J Dent (Tehran). 2016; 13(2):85–91.

12. Armalaite J, Jarutiene M, Vasiliauskas A, Sidlauskas A, Svalkauskiene V, Sidlauskas M, et al. Smile aesthetics as perceived by dental students: a cross-sectional study. BMC Oral Health. 2018; 18(1):225. https://doi.org/10.1186/s12903-018-0673-5 PMID: 30577772

13. Cunningham S, O'Brien C. Quality of Life and Orthodontics. Seminars in Orthodontics. 2007; 13:96–103.

14. Klages U, Bruckner A, Zentner A. Dental aesthetics, self-awareness, and oral health-related quality of life in young adults. Eur J Orthod. 2004; 26(5):507–14. https://doi.org/10.1093/ejo/26.5.507 PMID: 15536839

15. Josefsson E, Bjerklin K, Lindsten R. Factors determining perceived orthodontic treatment need in adolescents of Swedish and immigrant background. Eur J Orthod. 2009; 31(1):95–102. https://doi.org/10.1093/ejo/cjn069 PMID: 19028671

16. Montiel-Company JM, Bellot-Arcis C, Almerich-Silla JM. Validation of the psychosocial impact of dental aesthetics questionnaire (Pidaq) in Spanish adolescents. Med Oral Patol Oral Cir Bucal. 2013; 18(1): e168–73. https://doi.org/10.4317/medoral.18324 PMID: 23229257

17. Tin-Oo MM, Saddki N, Hassan N. Factors influencing patient satisfaction with dental appearance and treatments they desire to improve aesthetics. BMC Oral Health. 2011; 11:6. https://doi.org/10.1186/1472-6831-11-6 PMID: 21342536

18. Sarver DM. Enameloplasty and esthetic finishing in orthodontics-identification and treatment of micro-esthetic features in orthodontics part 1. J Esthet Restor Dent. 2011; 23(5):296–302. https://doi.org/10.1111/j.1708-8240.2011.00446.x PMID: 21977951

19. Van der Geld P, Oosterveld P, Van Heck G, Kuijpers-Jagtman AM. Smile attractiveness. Self-perception and influence on personality. Angle Orthod. 2007; 77(5):759–65. https://doi.org/10.2319/082606-349 PMID: 17685777

20. Bilal R, Arjumand B, Raheem S, Shabir O, Kanwal Q. Smile as perceived by orthodontist and general practitioners. Pakistan Orthodontic Journal. 2010; 2(2):60–5.

21. Pinho S, Ciriaco C, Faber J, Lenza MA. Impact of dental asymmetries on the perception of smile esthetics. Am J Orthod Dentofacial Orthop. 2007; 132(6):748–53. https://doi.org/10.1016/j.ajodo.2006.01.039 PMID: 18068592

22. Kumar S, Gandhi S, Valiathan A. Perception of smile esthetics among Indian dental professionals and laypersons. Indian J Dent Res. 2012; 23(2):295.

23. Alhammadi MS, Halboub E, Al-Mashraqi AA, Al-Homoud M, Wafi S, Zakari A, et al. Perception of facial, dental, and smile esthetics by dental students. J Esthet Restor Dent. 2018; 30(5):415–26. https://doi.org/10.1111/jerd.12405 PMID: 30144369

24. Muth J, Cash T. Body-Image Attitudes: What Difference Does Gender Make? J Appl Soc Psych. 1997; 27(16):1438–52.

25. Gross SM, Gary TL, Browne DC, LaVeist TA. Gender differences in body image and health perceptions among graduating seniors from a historically black college. J Natl Med Assoc. 2005; 97(12):1608–19. PMID: 16396053

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26. Strajnic L, Bulatovic D, Stancic I, Zivkovic R. Self-perception and satisfaction with dental appearance and aesthetics with respect to patients' age, gender, and level of education. Srp Arh Celok Lek. 2016; 144(11–12):580–9. PMID: 29659216

27. Johnston CD, Burden DJ, Stevenson MR. The influence of dental to facial midline discrepancies on dental attractiveness ratings. Eur J Orthod. 1999; 21(5):517–22. https://doi.org/10.1093/ejo/21.5.517 PMID: 10565092

28. Li R, Mei L, Wang P, He J, Meng Q, Zhong L, et al. Canine edge width and height affect dental esthetics in maxillary canine substitution treatment. Prog Orthod. 2019; 20(1):16. https://doi.org/10.1186/s40510-019-0268-y PMID: 30957211

29. Storrer CL, Valverde FK, Santos FR, Deliberador TM. Treatment of gummy smile: Gingival recontouring with the containment of the elevator muscle of the upper lip and wing of nose. A surgery innovation technique. J Indian Soc Periodontol. 2014; 18(5):656–60. https://doi.org/10.4103/0972-124X.142468 PMID: 25425832

30. Pithon MM, Santos AM, Viana de Andrade AC, Santos EM, Couto FS, da Silva Coqueiro R. Perception of the esthetic impact of gingival smile on laypersons, dental professionals, and dental students. Oral Surg Oral Med Oral Pathol Oral Radiol. 2013; 115(4):448–54. https://doi.org/10.1016/j.oooo.2012.04.027 PMID: 23022025

31. Ioi H, Nakata S, Counts AL. Influence of gingival display on smile aesthetics in Japanese. Eur J Orthod. 2010; 32(6):633–7. https://doi.org/10.1093/ejo/cjq013 PMID: 20403956

32. Machado AW. 10 commandments of smile esthetics. Dental Press J Orthod. 2014; 19(4):136–57. https://doi.org/10.1590/2176-9451.19.4.136-157.sar PMID: 25279532

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Article

Patterns of Facial Profile Preference in a Large Sample of Dental Students: A Cross-Sectional Study

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Abstract: The objective of this study was to explore dental students' facial profile preferences in a large sample of students. Nine hundred and nineteen dental students of four dental schools were involved. As part of a larger study on dentofacial esthetics, six photo series consisting of one unaltered and four altered variants of the same female profile were distributed among the students. The altered features were ones that are esthetically significant according to the literature. The students had to indicate the photo in each series that they preferred. The data were analyzed in a regression model in which preference in the given photo series was the dependent variable and gender, grade of studies, and dental school were the factors. Eight hundred and sixty-one students (93.7%) responded. Gender and dental school were not associated with the observed preferences, but the grade of studies was associated for three of the modified parameters: chin prominence, the sagittal position of the maxillary dental arch, and the simultaneous modification of the prominence of the chin and the nose. This study has confirmed several earlier observations, and new observations have also been made. We have demonstrated that the anteroposterior position of the maxillary incisors may be an important determinant of profile esthetics, even if this position does not influence the situation of the soft tissues and if the forehead cannot be used as a reference. We have also shown that the harmony between the nose and the chin overrides the importance of their individual dimensions.

Keywords: dental education; facial esthetics; facial profile

1. Introduction

Since the 1980s, several studies have investigated whether and how dental education (the process of becoming a dental professional) influences one's perception of dental and facial esthetics. Some studies have discussed the outcome, that is the difference between dental professionals and laypersons in this respect [1–3], while others have concentrated directly on the process of dental education [4,5]. Research in this area is important in two ways. First, any potential mismatch between the dentist's and patient's perceptions and expectations in this respect carries the risk of a result that is esthetically unacceptable for the patient. Second, identifying areas of profession-specific esthetic perception that are significantly influenced by dental education can inform dental curricula. Nowadays, there is agreement in the literature that dental professionals and laypersons do differ in their perception of certain aspects of dentofacial esthetics.

Studies in dentofacial esthetics approach their subject predominantly in two aspects: part of the studies discuss "frontal" aspects, such as the esthetics of the teeth, the smile, or the harmony of the face [4–7], while others deal with the "lateral" aspect, that is the facial profile [3,8,9]. Naturally, the results of such studies usually show high geographical/cultural variety, which indicates that they are best used to identify critical parameters or critical areas of perception (i.e., ones that potentially vary to a great degree across laypersons and dental professionals) rather than to find an "esthetic universal". Such factors and areas, then, can be consciously used in either treatment planning or education.

The esthetic perception of facial profile is less often and less deeply studied among dental students than the above-mentioned frontal esthetic aspects. Furthermore, when it is studied in this context, it happens most often in connection with class II/III malocclusion and its correction [3,10–12]. While malocclusion due to the malposition of the mandible is indeed an important clinical problem with a bearing on profile esthetics [13], other—often connected and interacting—factors are also at play: the length of the nose [14], the prominence of the soft tissues of the chin [15], the ratio of the nose to the lips [16], or the inclination of the maxillary incisors [17] have all been reported to influence the perception of profile esthetics by both laypersons and dental professionals.

Between October 2018 and August 2019, our research group conducted a large, cross-sectional multi-site study on the dentofacial mini- and microesthetic preferences of dental students. The study involved 861 students from all five grades of all four of the Hungarian dental faculties [18]. In addition to the main instrument, we distributed six photo series of modified facial profiles among the respondents and asked them to indicate the image they preferred best in each series. Our aim was to determine if the preferences were associated with the respondents' gender, the grade of dental school they attended, or the institution they attended. As this additional assessment was only loosely related to the focus of the main study, we decided to publish the results separately. In the present study, we discuss these results.

2. Materials and Methods

2.1. Subjects and Sampling

All five grades of all four of the dental faculties of Hungary (associated with the universities of Szeged, Debrecen, Pécs, and Budapest) were involved in the study. Printed questionnaires were distributed among the faculties to study the dentofacial mini- and microesthetic preferences of dental students. For details about the development of the questionnaire, please see our previous publication [18]. The album with the profile photo series for rating (see below) was included as a supplement to these questionnaires. Altogether, 1011 questionnaires were distributed to 919 Hungarian-speaking students of the four institutions. The authors were present in person when the questionnaires were administered to ensure adherence to the standard instructions and procedures. Thirty minutes were allocated for answering the questions (including the photo rating). Sampling took place between October 2018 and August 2019.

The study protocol and the applied instruments (including the profile photo album) were approved by the Regional Ethics Committee for Research in Human Medical Biology at the University of Szeged (No. 178/2018-SZTE). Participation was anonymous and voluntary.

2.2. Photo Series

The profile photos for rating were prepared by us. The model was a Caucasian female with normal cephalometric parameters (for Hungary) and without any clinical abnormality that could possibly affect the facial profile. The image was a standard lateral view in portrait orientation showing the lower and middle facial thirds, including the nose, the anterior teeth, the lips, and the chin. The upper edge bordered on the lower rim of the orbit. The photos were taken at a 1.5 m distance from the model, with a Nikon D7000 camera (Nikon Corporatio, Tokyo, Japan) equipped with a Nikon 105 mm F 2.8G VR AF-S

ED.IF Nikkor objective (Nikon Corporatio, Tokyo, Japan). The model was standing with a natural head position while being photographed. The photo shooting session took place on a sunny day, in a room amply and evenly lit by natural light, at noontime.

Six photo series were used. For all six series, the original (unmodified) photo and four modified versions of the photo were used, so all series (defined by the modified feature or features) consisted of five photos (Figure 1). Modifications were always made to the original image (i.e., no modification was generated by further modification of a previously modified version.) For the modifications, Adobe Photoshop CC 2015 (Adobe Systems, San Jose, CA, USA) was used. The 30 photos were arranged in an album in a way that items from the same series were always shown on the same page, in random order (not as shown in Figure 1, where the photos are arranged to ease the interpretation of the results). The respondents were not told which photo was the unmodified version. The modified features were ones that have been reported in the literature to influence facial esthetics. The modifications are summarized in Table 1.

Figure 1. The six series of modified photos. In each series, the unmodified variant is always the middle one. Please note that the photos were not administered to the respondents in this format, but instead were in a photo album, in random order, and without any labeling. This collage was created only as an illustration to ease the interpretation of the results. The numbers in the bottom right corner of the individual images (1 to 6) denote the number of the series. NL: nose length, CP: chin prominence, IOP: occlusal plane inclination, VPM: vertical position of maxillary arch, SPM: sagittal position of the maxillary arch, NC: nose length and chin prominence.

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Table 1. Photo rating: the modified profile features.

Series No.	Item No.	Feature	Description
1	4.1	Nose length (NL)	The length of the nose changes between −2 mm and +2 mm as compared to the original image in 1 mm steps.
2	4.2	Chin prominence * (CP)	The prominence of the chin changes between −2 mm retrusion and +2 mm protrusion as compared to the original image in 1 mm steps.
3	4.3	Occlusal plane inclination (IOP)	The inclination of the occlusal plane changes between 10° downward and 10° upward as compared to the original image in 5° steps. #
4	4.4	Vertical position of maxillary arch (VPM)	The maxillary arch is shifted vertically between −2 mm and +2 mm (downward and upward) as compared to the original image in 1 mm steps.
5	4.5	Sagittal position of the maxillary arch (SPM)	The maxillary arch is shifted sagittally between −2 mm and +2 mm as compared to the original image in 1 mm steps.
6	4.6	Nose length and chin prominence (NC)	The length of the nose and the prominence of the chin change simultaneously between −2 mm and +2 mm as compared to the original image in 1 mm steps.

* Chin prominence was defined as the prominence of the soft tissues of the chin. The position of the mandible was not changed. # Inclination is represented by the angle.

2.3. Statistical Analysis

Statistical analysis was carried out by an independent evaluator (see the Acknowledgements section). The analysis was blind: the evaluator received coded results and was told what analyses to carry out using what coding, without knowledge of the meaning of the codes.

The results were analyzed in SPSS 22.0 (IBM Corp., Armonk, NY, USA). Continuous variables were characterized with means and standard deviations or medians. Categorical variables were described with the number of observed cases and frequencies expressed in percentages. To test the contribution of students' gender, grade, and institution to the variability of their preferences, a multinomial regression model was built, in which students' preferences were entered as the dependent variable, and the said predictors were entered as factors. The reference grade was always Grade 1, and the reference image was always the unmodified image. This analysis was performed for each of the six photo series. The null hypothesis was that none of the factors had significant contribution to the variability of student preferences. The level of significance was $p = 0.05$, unless otherwise indicated.

3. Results

3.1. Subjects

Of the 919 students, 861 (93.7%) responded. Thus, the initial student pool for the photo rating consisted of 861 students. The rating of the profile photos was accomplished by 843 to 855 students, depending on the given photo series (97.9–99.3%). The mean age of the students in the entire sample was 22.85 (±2.49) years. The sample consisted of 560 females (65%) and 301 males (35%), indicating the known feminization tendency within the dental profession in Hungary. The distribution of students across academic institutions was as follows: 296 students (34.4%) attended Semmelweis University (Budapest, Hungary), 206 students (23.9%) attended the University of Debrecen (Debrecen, Hungary), 218 students attended the University of Szeged (Szeged, Hungary) (25.3%),

and 141 students (16.4%) attended the University of Pécs (Pécs, Hungary). These ratios correspond to the relative sizes of the dental schools. The demographic characteristics of the sample broken down by grade are given in Table 2.

Table 2. Demographics by grade for the entire sample ($N = 861$).

Grade	N	Gender (N (%))	Age (Mean $\pm$ SD)
First	187	M: 71 (38%) F: 116 (62%)	19.99 $\pm$ 4.03 years
Second	184	M: 61 (33%) F: 123 (67%)	21.40 $\pm$ 2.96 years
Third	137	M: 41 (30%) F: 96 (70%)	22.23 $\pm$ 5.31 years
Fourth	169	M: 62 (37%) F: 107 (63%)	23.92 $\pm$ 3.33 years
Fifth	184	M: 66 (36%) F: 118 (64%)	24.31 $\pm$ 3.52 years

M: male, F: female.

3.2. Photo Rating

For gender and institution, the null hypothesis was retained for all photo series. The regression analysis indicated a significant effect of grade for photo series 2 (chin prominence, CP, $p < 0.05$), 5 (sagittal position of the maxillary arch, SPM, $p < 0.05$), and 6 (simultaneous modification of nose and chin, NC, $p < 0.01$).

Table 3 shows the preferences for the individual photos in the CP series by grade. According to the results of the regression analysis, students in the fifth (final) grade opted significantly more frequently for the -1 mm modification than the original as compared to the preferences of the first-grade students (odds ratio (OR): 1.998, confidence interval (CI) 95%: 1.078–3.705, $p < 0.05$). In fact, as the table shows, students in the first grade preferred the original image over the -1 mm modification. In the fifth grade, just the opposite was observed.

Table 3. Distribution of preferences across grades regarding chin prominence (CP, photo series No. 2).

			-2 mm	-1 mm	Original	$+1$ mm	$+2$ mm	Total
Grade	1	Count	50	34	45	36	21	186
		% within grade	26.9%	18.3%	24.2%	19.4%	11.3%	100.0%
	2	Count	49	39	45	33	17	183
		% within grade	26.8%	21.3%	24.6%	18.0%	9.3%	100.0%
	3	Count	34	34	37	17	14	136
		% within grade	25.0%	25.0%	27.2%	12.5%	10.3%	100.0%
	4	Count	47	37	43	11	28	166
		% within grade	28.3%	22.3%	25.9%	6.6%	16.9%	100.0%
	5	Count	54	53	35	22	19	183
		% within grade	29.5%	29.0%	19.1%	12.0%	10.4%	100.0%
Total		Count	234	197	205	119	99	854
		% within grade	27.4%	23.1%	24.0%	13.9%	11.6%	100.0%

Preference for a retruded chin was a general tendency: the majority of the choices (>60%) were distributed across the original and the retruded modifications in all grades (approximately evenly, apart from grades 1 and 5). Preference for the original was the lowest in the fifth grade (19.1%) and the highest in the third grade (27.2%), where it was also the most popular choice.

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Table 4 summarizes the preferences for the SPM series. Here, a quite peculiar tendency was observed: the popularity of the +2 mm modification constantly rose from the first through the fifth grade (29% to 41.5%). This was also reflected in the result of the regression analysis: fifth graders opted significantly more frequently for the +2 mm modification than the original as compared to the preferences of the first graders (odd ratio (OR): 1.721, confidence interval (CI) 95%: 0.887–3.338, $p < 0.05$). This gain did not happen at the cost of any single modification. Another minor observation was that second graders opted for the −1 mm modification significantly less frequently than first graders (OR: 0.422, CI 95%: 0.212–0.839, $p < 0.05$).

Table 4. Distribution of preferences across grades regarding the sagittal position of the maxillary arch (SPM, photo series No. 5).

			−2 mm	−1 mm	Original	+1 mm	+2 mm	Total
Grade	1	Count	19	45	27	41	54	186
		% within grade	10.2%	24.2%	14.5%	22.0%	29.0%	100.0%
	2	Count	16	27	38	50	53	184
		% within grade	8.7%	14.7%	20.7%	27.2%	28.8%	100.0%
	3	Count	20	27	22	24	43	136
		% within grade	14.7%	19.9%	16.2%	17.6%	31.6%	100.0%
	4	Count	20	28	24	28	66	166
		% within grade	12.0%	16.9%	14.5%	16.9%	39.8%	100.0%
	5	Count	18	26	22	41	76	183
		% within grade	9.8%	14.2%	12.0%	22.4%	41.5%	100.0%
Total		Count	93	153	133	184	292	855
		% within grade	10.9%	17.9%	15.6%	21.5%	34.2%	100.0%

Preference for the original image was the lowest in the fifth grade (12.0%) and the highest in the second grade (27.2%). In none of the grades was the unmodified image the most popular choice. The overall tendency was an increasing preference for a frontally shifted maxillary arch.

Table 5 gives an overview of the preferences for the NC series. The regression analysis indicated that both fourth graders (odd ratio (OR): 0.422, confidence interval (CI) 95%: 0.212–0.839, $p < 0.05$) and fifth graders (odd ratio (OR): 0.397, confidence interval (CI) 95%: 0.208–0.757, $p < 0.01$) opted significantly less frequently for the +1 mm modification than the original as compared to the preferences of the first-grade students. Furthermore, fifth-grade students also opted significantly less frequently for the +2 mm modification (odd ratio (OR): 0.418, confidence interval (CI) 95%: 0.219–0.798, $p < 0.01$). As for the pattern of preferences: the first grade preferred the two extremes (±2 mm), slightly more than half of the respondents opted for either of these. By the second grade, +2 mm and −1 mm dominated the choices. In grades 3 and 4, the −1 mm modification was the most popular, and in the fifth grade, the original, unmodified image was the most frequently chosen. That is, students' choices appear to have moved from the extremes toward the original from the first through the fifth grades.

Table 5. Distribution of preferences across grades regarding the simultaneous modifications of the nose and chin (NC, photo series No. 6).

			−2 mm	−1 mm	Original	+1 mm	+2 mm	Total
Grade	1	Count	35	30	27	48	46	186
		% within Grade	18.8%	16.1%	14.5%	25.8%	24.7%	100.0%
	2	Count	34	46	30	28	46	184
		% within Grade	18.5%	25.0%	16.3%	15.2%	25.0%	100.0%
	3	Count	19	44	23	31	19	136
		% within Grade	14.0%	32.4%	16.9%	22.8%	14.0%	100.0%
	4	Count	33	50	30	25	28	166
		% within Grade	19.9%	30.1%	18.1%	15.1%	16.9%	100.0%
	5	Count	33	34	48	34	34	183
		% within Grade	18.0%	18.6%	26.2%	18.6%	18.6%	100.0%
Total		Count	154	204	158	166	173	855
		% within Grade	18.0%	23.9%	18.5%	19.4%	20.2%	100.0%

As for the rest of the photo series, no significant effect of any of the predictors could be found, and the choices were remarkably evenly distributed across the image versions.

4. Discussion

This study sought to determine in a large sample of dental students if the students' facial profile preferences were associated with their gender, the grade of dental school they attended, or the institution they attended. As the instrument (the photo series) was administered as a supplement to a larger questionnaire on dentofacial esthetics, only these few background variables could be used, which necessarily resulted in poor explanatory power. However, the large sample size still allows for the identification of patterns, and we have confined our analysis to this aspect. Gender and school were not associated with the observed preferences, but the grade of studies was associated for three of the modified parameters.

The lack of gender effect came as no real surprise, as earlier we made the same observation regarding dentofacial esthetics in the same sample [18]. This is most probably a sample-specific feature. It is known that facial esthetic preferences show high geographical (cultural) variability. For instance, Strajnic and colleagues failed to find gender difference in self-perception and satisfaction with dental appearance in a sample of Serbian patients [19], while Przylipiak and co-workers, working in Poland, found that preferred mean nose size was statistically significantly lower in females in comparison with males [16]. The present study also tested nose size preferences but failed to find significant gender differences. It must be added that most of the data in the literature (including the above cited studies) come from samples of laypersons, which makes one wonder if it is dental education that somehow homogenizes an otherwise gender-dependent preference. To answer this goes far beyond the limits of this discussion, but we propose that this hypothesis could generate an intriguing line of research.

As for the lack of significant difference between the individual dental schools, this is a result that we, in fact, expected. Hungary is a small, culturally homogeneous country, which means that students come from virtually the same background in this respect. The dental profession is a small community in which most professionals, including the faculty of the dental schools, know each other or at least each other's work. This has an immense homogenizing effect on both the material covered and the teaching methodologies. Finally, all dental schools are predominantly state financed. These factors together result in a

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largely undifferentiated dental education, so the findings in this respect are not surprising at all.

Before we turn to the profile-specific findings, it must be emphasized that in this study, white Caucasian students of both sexes and of a homogeneous cultural background rated images of a white Caucasian female; when we talk about facial esthetics or preferred facial features in connection with the results, it is to be understood within these limitations.

The observed preference patterns suggest that progress in one's dental studies does influence one's preferred facial profile features. In this specific sample, this was observed regarding the degree of chin prominence, the sagittal position of the maxillary dental arch, and chin prominence and nose length in combination (i.e., the harmony between the chin and the nose).

A less prominent/slightly retruded chin is a feature generally associated with the female face [20,21]. It is well documented in the literature that observers of various ethnic and cultural backgrounds consider the degree of chin protrusion as a determining feature of facial esthetics. Torsello and colleagues demonstrated in connection with female profiles that, both among laypersons and orthodontists, nose protrusion was more tolerated than a similar amount of chin protrusion [15]. Hongyu and co-workers found that laypersons but not orthodontists put emphasis on chin protrusion when making esthetic judgements about female and male faces [22]. Studying young adult Korean women with a preferred facial appearance (winners of the Miss Korea contest), Kim and colleagues concluded that a retruded chin is a crucial part of what makes a female face perceived as esthetic [23]. Finally, in his study of the esthetic plastic surgical alteration of the chin, Lee recommends that the chin projection should lie ~3 mm posterior to a line drawn in the nose–lip–chin plane (i.e., it should be slightly retruded) [24]. It seems, thus, that a slightly retruded chin is generally considered to be a key component of an esthetic female face, but the cited studies show that sometimes this applies to male faces too. The results of our study support that point.

We also found that an anteriorly shifted maxillary arch gained popularity toward the higher grades. The most probable explanation is that this is the effect of the position of the maxillary incisors, which is documented to have a significant effect on the esthetics of the facial profile [25]. Most studies explain this effect by the varying degrees of soft tissue displacement [26,27]. This, however, cannot really explain our findings, as the modification of the antero-posterior position of the arch was too small to cause readily perceivable soft tissue changes in real life, especially while smiling—so the soft tissues were not modified in our images. What generated this peculiar pattern of preferences if not soft tissue changes? Andrews [28] found that for a Caucasian female profile to be found harmonious, the maxillary incisors need to be positioned anterior to the forehead's facial axis (FFA) point and posterior to glabella. The importance of the maxillary incisor–forehead relation has been shown since then in other populations too [29]. Unfortunately, our images were cropped at the lower rim of the orbit, so it was impossible for our respondents to observe these relations. Our results corroborate those of other studies in terms of the importance of the anteroposterior position of the maxillary incisors, but they also show that this feature can have a significant influence on esthetic judgements even if neither soft tissue changes nor the forehead can be used as a reference. It also seems that dental students gradually develop a preference for an anteriorly shifted maxillary arch during their studies. These appear to be hitherto undocumented aspects of facial profile esthetics, which we cannot satisfactorily explain. A study involving laypersons, dentists, and orthodontists would be desirable to learn more about this pattern.

To interpret the results regarding the simultaneous modification of the nose and the chin, let us first see what was observed when these areas were modified separately. As for the chin, we have earlier established that a retruded chin was preferred by most of the respondents. As for the length of the nose, we found no association with any of the background variables (i.e., the preferences were homogeneous in the entire sample). This is apparently in contradiction with studies that found that a shorter nose is perceived as

more esthetic than a longer one [14,16]. However, once again, these studies analyzed the preferences of laypersons, so their results are not entirely comparable to ours. Unfortunately, the few available studies that dealt with the facial profile preferences of dental students [3,30] did not discuss the role of the nose, so it is difficult to tell if a relative indifference to the dimensions of the nose is a general characteristic of dental students or just a sample-specific finding. However, what happens when the modifications to the nose and chin are linked? If the prominence of the chin is the dominant feature of the two (as the results suggest), one would expect that the shorter modifications would also dominate in this case. This is not what our results show. As we noted before, students' choices appear to have moved from the extremes toward the original from the first through the fifth grades. This should not be interpreted in an over-simplifying manner, such as by saying that by the fifth grade of dental school students had seen enough to be able to safely judge what is normal. A glance at the distribution of choices in the fifth grade (Table 5) tell us just the opposite: the distribution is stunningly homogeneous, and the unmodified variant stands out by mere 8%. In our opinion, this shows that (a) the chin and the nose are linked in terms of facial profile esthetics, and (b) any modification to either the prominence of the chin or the nose may be perceived as esthetic if it is accompanied by the same degree of modification to the other. To put it simply, the harmony between the nose and the chin overrides the importance of their individual dimensions. The practical consequence of this observation is that any intervention that potentially modifies the prominence of the nose or the chin should take both structures into consideration.

Finally, the studied factors did not have a significant effect on the preferences for three parameters. Of these, we have already discussed nose length. As for the inclination of the occlusal plane and the vertical position of the maxillary arch, these parameters are usually regarded as important determinants of smile esthetics [31–33]. Unfortunately, no studies are available on how they influence the esthetic perception of the facial profile. Our results suggest no significant effect, but we do not wish to draw conclusions from a single observation, even if it has been made in a large sample.

5. Conclusions

To our knowledge, no previous study has examined the perception of facial profile esthetics in a similarly large sample of dental students. This study has confirmed several earlier observations made in smaller samples and also resulted in new observations. We have demonstrated that the anteroposterior position of the maxillary incisors may be an important determinant of profile esthetics, even if this position does not influence the situation of the soft tissues and if the forehead cannot be used as a reference. We have also shown that the harmony between the nose and the chin overrides the importance of their individual dimensions. Focused studies are needed to learn if the same patterns may be found in other populations.

References

1. Brisman, A.S. Esthetics: A comparison of dentists' and patients' concepts. *J. Am. Dent. Assoc.* **1980**, *100*, 345–352. [CrossRef] [PubMed]
2. Kokich, V.O.; Kokich, V.G.; Kiyak, H.A. Perceptions of dental professionals and laypersons to altered dental esthetics: Asymmetric and symmetric situations. *Am. J. Orthod. Dentofac. Orthop.* **2006**, *130*, 141–151. [CrossRef] [PubMed]
3. Tufekci, E.; Jahangiri, A.; Lindauer, S.J. Perception of profile among laypeople, dental students and orthodontic patients. *Angle Orthod.* **2008**, *78*, 983–987. [CrossRef]
4. Armalaite, J.; Jarutiene, M.; Vasiliauskas, A.; Sidlauskas, A.; Svalkauskiene, V.; Sidlauskas, M.; Skarbalius, G. Smile aesthetics as perceived by dental students: A cross-sectional study. *BMC Oral Health* **2018**, *18*, 225. [CrossRef] [PubMed]
5. Alhammadi, M.S.; Halboub, E.; Al-Mashraqi, A.A.; Al-Homoud, M.; Wafi, S.; Zakari, A.; Mashali, W. Perception of facial, dental, and smile esthetics by dental students. *J. Esthet. Restor. Dent.* **2018**, *30*, 415–426. [CrossRef]
6. Chen, Y.H.; Cheng, Y.L.; Cheng, H.; Yu, H. Comparison of smile esthetics among celebrities, dentists, and dental students in a Han Chinese population. *J. Prosthet. Dent.* **2020**, *123*, 845–849. [CrossRef]
7. Espana, P.; Tarazona, B.; Paredes, V. Smile esthetics from odontology students' perspectives. *Angle Orthod.* **2014**, *84*, 214–224. [CrossRef] [PubMed]
8. Aldhorae, K.; Alqadasi, B.; Altawili, Z.M.; Assiry, A.; Shamalah, A.; Al-Haidari, S.A. Perception of Dental Students and Laypersons to Altered Dentofacial Aesthetics. *J. Int. Soc. Prev. Community Dent.* **2020**, *10*, 85–95. [CrossRef]
9. Jung, G.H.; Jung, S.; Park, H.J.; Oh, H.K.; Kook, M.S. Factors Influencing Perception of Facial Attractiveness: Gender and Dental Education. *J. Craniofacial Surg.* **2018**, *29*, e170–e175. [CrossRef]
10. von Bremen, J.; Erbe, C.; Pancherz, H.; Ruf, S. Facial-profile attractiveness changes in adult patients treated with the Herbst appliance. *J. Orofac. Orthop.* **2014**, *75*, 167–174. [CrossRef]
11. Ng, D.; De Silva, R.K.; Smit, R.; De Silva, H.; Farella, M. Facial attractiveness of skeletal Class II patients before and after mandibular advancement surgery as perceived by people with different backgrounds. *Eur. J. Orthod.* **2013**, *35*, 515–520. [CrossRef]
12. Cochrane, S.M.; Cunningham, S.J.; Hunt, N.P. A comparison of the perception of facial profile by the general public and 3 groups of clinicians. *Int. J. Adult Orthod. Orthognath. Surg.* **1999**, *14*, 291–295.
13. Huang, P.; Cai, B.; Zhou, C.; Wang, W.; Wang, X.; Gao, D.; Bao, B. Contribution of the mandible position to the facial profile perception of a female facial profile: An eye-tracking study. *Am. J. Orthod. Dentofac. Orthop.* **2019**, *156*, 641–652. [CrossRef] [PubMed]
14. Khosravanifard, B.; Rakhshan, V.; Raeesi, E. Factors influencing attractiveness of soft tissue profile. *Oral Surg. Oral Med. Oral Pathol. Oral Radiol. Endod.* **2013**, *115*, 29–37. [CrossRef] [PubMed]
15. Torsello, F.; Graci, M.; Grande, N.M.; Deli, R. Relationships between facial features in the perception of profile attractiveness. *Prog. Orthod.* **2010**, *11*, 92–97. [CrossRef]
16. Przylipiak, M.; Przylipiak, J.; Terlikowski, R.; Lubowicka, E.; Chrostek, L.; Przylipiak, A. Impact of face proportions on face attractiveness. *J. Cosmet. Dermatol.* **2018**, *17*, 954–959. [CrossRef]
17. Naini, F.B.; Manouchehri, S.; Al-Bitar, Z.B.; Gill, D.S.; Garagiola, U.; Wertheim, D. The maxillary incisor labial face tangent: Clinical evaluation of maxillary incisor inclination in profile smiling view and idealized aesthetics. *Maxillofac. Plast. Reconstr. Surg.* **2019**, *41*, 31. [CrossRef] [PubMed]
18. Romsics, L.; Segatto, A.; Boa, K.; Becsei, R.; Rozsa, N.; Szanto, I.; Nemes, J.; Segatto, E. Dentofacial mini- and microesthetics as perceived by dental students: A cross-sectional multi-site study. *PLoS ONE* **2020**, *15*, e0230182. [CrossRef] [PubMed]
19. Strajnic, L.; Bulatovic, D.; Stancic, I.; Zivkovic, R. Self-perception and satisfaction with dental appearance and aesthetics with respect to patients' age, gender, and level of education. *Srpski Arhiv Za Celokupno Lekarstvo* **2016**, *144*, 580–589. [CrossRef]
20. Kościński, K. Facial attractiveness: General patterns of facial preferences. *Anthr. Rev.* **2007**, *70*, 45–79. [CrossRef]
21. Marcinkowska, U.M.; Dixson, B.J.; Kozlov, M.V.; Prasai, K.; Rantala, M.J. Men's Preferences for Female Facial Femininity Decline with Age. *J. Gerontol. B Psychol. Sci. Soc. Sci.* **2017**, *72*, 180–186. [CrossRef]
22. Hongyu, R.; Xin, C.; Yongqing, Z. Correlation between facial attractiveness and facial components assessed by laypersons and orthodontists. *J. Dent. Sci.* **2021**, *16*, 431–436. [CrossRef]
23. Kim, S.Y.; Bayome, M.; Park, J.H.; Kook, Y.A.; Kang, J.H.; Kim, K.H.; Moon, H.B. Evaluation of the facial dimensions of young adult women with a preferred facial appearance. *Korean J. Orthod.* **2015**, *45*, 253–260. [CrossRef] [PubMed]
24. Lee, E.I. Aesthetic alteration of the chin. *Semin. Plast. Surg.* **2013**, *27*, 155–160. [CrossRef]
25. Maddalone, M.; Losi, F.; Rota, E.; Baldoni, M.G. Relationship between the Position of the Incisors and the Thickness of the Soft Tissues in the Upper Jaw: Cephalometric Evaluation. *Int. J. Clin. Pediatr. Dent.* **2019**, *12*, 391–397. [CrossRef] [PubMed]

26. Hernandez-Alfaro, F. Upper incisor to Soft Tissue Plane (UI-STP): A new reference for diagnosis and planning in dentofacial deformities. *Med. Oral Patol. Oral Cir. Bucal* **2010**, *15*, e779–e781. [CrossRef]
27. Kim, H.H.; Lee, J.W.; Cha, K.S.; Chung, D.H.; Lee, S.M. Three-dimensional assessment of upper lip positional changes according to simulated maxillary anterior tooth movements by white light scanning. *Korean J. Orthod.* **2014**, *44*, 281–293. [CrossRef]
28. Andrews, W.A. AP relationship of the maxillary central incisors to the forehead in adult white females. *Angle Orthod.* **2008**, *78*, 662–669. [CrossRef]
29. Gidaly, M.P.; Tremont, T.; Lin, C.P.; Kau, C.H.; Souccar, N.M. Optimal antero-posterior position of the maxillary central incisors and its relationship to the forehead in adult African American females. *Angle Orthod.* **2019**, *89*, 123–128. [CrossRef]
30. Soh, J.; Chew, M.T.; Wong, H.B. A comparative assessment of the perception of Chinese facial profile esthetics. *Am. J. Orthod. Dentofac. Orthop.* **2005**, *127*, 692–699. [CrossRef]
31. Batwa, W.; Hunt, N.P.; Petrie, A.; Gill, D. Effect of occlusal plane on smile attractiveness. *Angle Orthod.* **2012**, *82*, 218–223. [CrossRef] [PubMed]
32. Corte, C.C.; Silveira, B.L.; Marquezan, M. Influence of occlusal plane inclination and mandibular deviation on esthetics. *Dent. Press J. Orthod.* **2015**, *20*, 50–57. [CrossRef] [PubMed]
33. Menezes, E.B.C.; Bittencourt, M.A.V.; Machado, A.W. Do different vertical positions of maxillary central incisors influence smile esthetics perception? *Dent. Press J. Orthod.* **2017**, *22*, 95–105. [CrossRef] [PubMed]