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Randomized multi-centre study on the effect of training on tooth shade matching

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ABSTRACT

Objectives: The aim of this study was to find out whether Toothguide Trainer, TT, and Toothguide Training Box, TTB, show any training effects, independent of the shade guide chosen.

Methods: Students from four dental schools ($N = 78$) were included in this study. The participants were randomized into a study, 42 students (age range: 19–27 years; 69% female, 31% male) and a control group of 36 students (age range: 19–30 years; 57% female, 43% male). The study group started with a double blind introduction test, followed by the TT and TTB training, finishing with the final test. The control group only passed the introduction and – after a break – the final test. Eight randomly chosen samples, seven of the Vita classical and one of the 3D-Master colour scale, were marked by barcodes. Colour matching was arranged by the Vita classical scale.

Results: The results of the pre- and final tests of both groups were combined. For every sample, the value ΔE was determined. The summation of all eight samples from the introduction and final tests offered a summarized ΔE value. The differences between introduction and final tests revealed the individual learning success. 47.6% of the study group showed statistically significant better results than the control group, 33% ($p = 0.031$).

Conclusion: TT and TTB show a positive effect of training on tooth shade matching independent of the colour scale used.

Clinical significance: Visual shade taking is the most frequent clinical method for shade determination. To increase better results in visual colour matching, TT and TTB training is used. This is the first study examining the training effect of TT and TTB using Vita classical scale.

1. Introduction

Visual and electronic tools can be used for tooth shade determination to enable the communication between practices and laboratories.[1–6] A study which included a survey of European students of dentistry in 2011 showed that visual shade determination with Vitapan Classical (17–67%) and the "VITA" 3D-Master (0–47%) was the most frequently taught method of shade taking. Only a minority of the students (2–47%)

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was introduced into digital shade taking.[7] The examination of Paravina et al.[2] exhibited that Vitapan Classical and ''VITA'' 3D-Master were the most popular shade guides.

Several surveys on teaching colour have been accomplished in the last 40 years.[2,8–10] The percentage of programmes with courses on ''colour'' or ''colour in dentistry'' has increased over the years.[2,8–10]

Previous studies had demonstrated a training effect in shade differentiation.[11,12] On one hand there are various training systems, with pure colour training exercises.[1] On the other hand, there are training programmes that are based directly on a specific shade taking system, such as the shade curriculum developed at the University of Leipzig.[2,13] This shade curriculum has been an element of preclinical training in Leipzig since 2004.[13] The universities of Berlin, Greifswald, Heidelberg, Halle (Saale), Budapest, Beirut and Passo Fundo for example, have also integrated this programme into their curricula. The programme has been developed especially for the 3-step shade matching method and includes TT software program and TTB. TT displays a virtual VITA 3D-Master on the monitor. Students learn the use of VITA 3D-Master in three steps (1st lightness, 2nd chroma, 3rd hue). The training is performed under standardized lighting conditions using the TTB with a real colour scale. Independently conducted studies showed that the training of participants lead to improvement in colour matching results.[14,15] Moreover, in a study on the simulation of colour blindness, improvement could be achieved for participants with colour vision deficiency subsequent to the training with TT and TTB.[16] Fact is that Vitapan and its derivations were probably the most commonly used shade guides[1] and used in dental training. It was also the aim to examine the effect of training with TT and TTB on shade taking using the Vitapan Classical. The objective of this multicentre study was to prove, that visual shade differentiation might be learned using TT and TTB independent of the colour scale used. The specific hypothesis was that training with TT and TTB resulted in an improvement of visual shade determination using Vitapan Classical.

2. Materials and methods

Students ($N = 78$) of four international universities (Berlin ($N = 43$), Leipzig ($N = 25$), Greifswald ($N = 5$) (all Germany), Olomouc ($N = 5$) (Czech Republic)) participated in the study at Science Day in Berlin 2011. The participants were students of the first preclinical semester and had been educated in colour differentiation at their universities before this examination began. The test series were performed independently of the TT and TTB curriculum. The students had not obtained any training in visual tooth shade determination until that date. They participated voluntarily. The study protocol had been approved by both dental schools of Berlin and Leipzig on the basis of research results. All students gave informed consent prior to their participation in the study. At the beginning, an Ishihara Test was performed to exclude students with impaired colour vision. The group test consisted of 24 illustrations, which were projected by a calibrated beamer. Participants with more than two errors were excluded.[17] Afterwards students were randomly divided into two groups: a study group and a control group. The study group consisted of 42 students: 31% ($N = 13$) of them were male and 69% ($N = 29$) were female. The average age was 22.4 years (19–27 years). The control group consisted of 36 students: 57% ($N = 21$) were female and 43% ($N = 15$) were male. The average age was 24.4 years (19–30 years).

Each participant of the study group and the control group had undergone a double-blind initial and final test. In random order, the participants received eight shade tabs. Seven of the eight tabs were taken from the Vitapan Classical shade guide (B4, A1, C4, C2, D3, A3, C3), and one tab was taken from the 3D shade guide (3M3). The shade tabs were marked with bar codes so that they could not be classified by the participants neither the recorder. The original Vitapan Classical shade guide (A-to-D arrangement) was used for shade determination with the instruction ''select the best match''. The participant identified the tab he had received using the Vitapan Classical codes, while the recorder entered the value into a table. Numerical codes were used for anonymisation of the participants. Shade matching was conducted under defined lighting conditions. The participants used hand help lamps (5500 K, shade-taking lamps, System Eickhorst, Hamburg, Germany) under natural surrounding light conditions (daylight).

After the initial test, the study group completed the training programme with TT and TTB. 90 min later there was the final test. The control group did not receive any training. The final test was done after a break of 90 min between initial and final test. The lists with the results of the initial and final tests were calculated and the distance in the colour space (ΔE) was determined for each shade tab. Colour difference between task tab and selected tab was computed as follows[18]:

$$\Delta E = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2}$$

On the basis of $L^*a^*b^*$ values provided by the manufacturer it was possible to denote differences in lightness, chroma and hue, ΔL^*, Δa^*, Δb^*. For the shade tab of the 3D shade guide, the smallest possible colour distance of the determination process was set to 0 by subtracting the amount. Thereby it was possible to compare the results of 3M3 shade tab with the other shade tabs of this study.

As a result, a summarized ΔE value was obtained for all shade tabs of the initial and final test. The change in the sums of the differences between initial and final test represented the extent of the individual learning success to be assessed. In case the sum of the final test was smaller than the one of the initial test, a personal training effect for the participant could be proven. Positive differences indicated an improvement between the initial and the final test. The higher the positive value the larger the degree of improvement. An advancement of ΔE at more than 2 was classified as clinically relevant. Negative values indicated deterioration. The summation of the ΔE data had been adopted in previous similar studies with TTB.[16,19,20] It is therefore possible to compare the results among each other. The control group and the study group were stratified (same number, age and sex).

Means and standard deviation were calculated. Student's T-test and Mann–Whitney U-test were used for statistical analysis of the data ($\alpha = 0.05$).[21] Data analysis was performed using SPSS 10.0 for Windows (SPSS, Chicago, IL).