

Original Article

Evaluation effect of color in dental office and dentist's uniform while using two different distraction techniques on injection anxiety of 6–9 years' old children referring to Hamedan Dental School: Randomized clinical trial

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ABSTRACT

Background: The management of children's anxiety in dental offices is still a challenge for the treatment team. The most important factors which affect children's dental anxiety are the clinician-related factors and the physical factors of the dental operatory. Color is an environmental factor whose relationship with the perceptive and emotional factors of children has been reported. On the other hand, distraction is essential factors in a treatment environment that can be used to manage children's anxiety.

Materials and Methods: In this randomized clinical trial study, from 132 6 to 9 years of age children, 52.3% were male, and 47.7% were female, with a mean age of 7.45 ± 1.1 years. The children's anxiety levels were determined using the Venham Picture Test and pulse oximetry before and after the administration of local anesthesia. The children were randomly assigned to two groups ($n = 66$): Group 1, music, and Group 2, animated cartoons. The data were analyzed with SPSS 25, using descriptive statistics and the statistical tests consisting of one-way analysis of variance (ANOVA), *t*-test, and repeated-measures ANOVA, followed by Tukey honestly significant difference tests. Statistical significance was set at $P < 0.05$.

Results: The anxiety levels were the lowest in the blue and pink environments and the highest in the black and red. Anxiety levels between different colors in terms of physiologic markers and the questionnaire in each distraction technique at different intervals was significantly different.

Conclusion: The use of blue, pink, green, and yellow for dentists' attire, and the interior design of the dental operatory decreased the child patients' anxiety.

Key Words: Anxiety, clothing, color, injections

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INTRODUCTION

The management of children's anxiety during dental procedures is one of the most essential and first factors for the success of treatment. Dental anxiety

leads to a low rate of follow-up and sometimes, a lack of dental visits for dental procedures.^[1] Anxiety might

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be defined as a complicated response, consisting of an internal feeling of fear and the relevant pressure associated with symptomatic physiologic stimulation.^[2]

Dental anxiety is determined with the use of behavioral, self-reporting (questionnaires), and physiologic techniques. Biological markers, including pulse rate, and oxygen saturation (SpO₂), determine the patient's real physiological condition and evaluate the possible changes in anxiety levels during the dental procedures more accurately than subjective tools.^[3] One of the self-reporting techniques is the use of a questionnaire. One of the useful questionnaires in this field is Venham Picture Test. The advantage of this tool is that it is easy to implement, and the child does not need to read anything to complete it. It is especially useful for young children.^[4] Subjective tools rely on children's ability to express what they are feeling, which might be difficult. Therefore, a combination of subjective and objective techniques provides the best picture of the patient for the management of anxiety.^[5]

The dentist's attire is the first clinical communication pathway between the patient and the dentist. Therefore, color preference might be evaluated to determine its effect on the level of anxiety of child patients and their satisfaction with the environment.^[6] Children can classify colors based on different criteria, the most important of which is whether or not a specific color can positively affect them.^[7]

Administration of local anesthesia is an important etiologic factor for anxiety, which is due to a high level of pain perception. Perception of pain is an important psychological factor in terms of the level of attention to the pain stimulus and the factors that modify it.^[8] Therefore, if it is possible to establish a relationship between specific colors and the patients' anxiety levels, especially in young children, it would be possible to help children attain tranquility.

The distraction technique involves strategies to decrease anxiety, which limits the patient's capacity for attention. Therefore, these techniques distract the patients' attention from the unpleasant process. These techniques might be active or passive. The active techniques require activities that require the child's direct involvement; in contrast, passive techniques rely on the use of music or videos.^[9] Evidence indicates that listening to music during some procedures helps reduce dental anxiety.^[10] Audiovisual

distraction, too, has been used to a great deal. This technique results in the involvement of the patient's attention, the distraction of the patients' vision from the dental treatment field, resulting in a comforting dental experience.^[11]

Limited studies have been undertaken on the effect of music, the operatory environment, and the colorful attire of the dentist as effective methods to decrease dental anxiety in children. Therefore, the present study was designed to evaluate the effect of colors in designing the environment and dentists' attire and two different distraction techniques (audio and audiovisual) on the anxiety resulting from the administration of local anesthesia in children.

MATERIALS AND METHODS

A total of 132 children aged 6–9 years, referring to the Hamadan Faculty of Dentistry, were selected and evaluated in this randomized clinical trial study (IRCT20110109005570N10r). The children had no history of dental treatment and were able to communicate, were not color-blind, and had no systemic condition and anxiety disorders. After gaining informed consent from the parents, the children's demographic data, including age and gender, were recorded using a checklist. Due to the informed consent and the absence of unnecessary and harmful intervention, the study had no particular moral limitations.

The VPT¹ questionnaire and a pulse oximeter were used to evaluate the children's anxiety before and after the administration of local anesthesia. The children were randomly assigned to two groups ($n = 66$). The stochastic method is stratified block (for distraction technique and color type). The children in one group listened to music using headphones, and those in the other group watched an animated cartoon; the sound of the cartoon was muted to prevent interference with the children in the other group who were listening to music. The children in each group were randomly assigned to six subgroups in terms of color (six colors), the dentist's attire, and the operatory's curtains. For the blinding purpose, a different operator submitted the questionnaires to the children before and after the procedures. This operator sat behind a colored curtain with no knowledge about the color of the environment and the dentist's attire for evaluating the pulse oximeter marker. Besides, the operator used a headphone to avoid hearing the noises and voices in the environment.

1 Venham Picture Test

The data were analyzed with SPSS 25 (IBM, New York, USA) using descriptive statistics and statistical tests, including the one-way analysis of variance, *t*-test, repeated-measures analysis of variance, and Tukey honestly significant difference tests. Statistical significance was set at $P < 0.05$.

RESULTS

Of 132 children selected for this study, 69 (52.3%) were male, and 63 (47.7%) were female. The mean age of the children was 7.45 ± 1.1 , with an age range of 6–9 years. Table 1 results related to the comparison of anxiety levels in terms of each variable (VPT questionnaire, pulse rate, and SpO₂ levels) at different intervals of the study between the different color groups and distraction techniques simultaneously [Table 1]. Descriptions of each variable are provided in the following sections.

Table 2 presents the results related to the comparison of children's anxiety in terms of heart rate (HR) in each study group before, during, and after treatment in terms of distraction and color [Table 2].

The pulse rates in the green, pink, and blue groups were lower in both distraction techniques compared to

the other colors. The black and red colors exhibited the highest HRs, respectively. The results showed significant differences in anxiety levels between the different colors [Table 2]. Besides, comparison of anxiety levels in terms of HR at different intervals between the two distraction techniques (i.e., audio and audiovisual) with the *t*-test showed no significant differences between the two distraction techniques with any of the colors [Table 2].

Comparison of anxiety levels in terms of HR at different study intervals between the different colors and distraction techniques simultaneously showed significant differences between the different colors at different study intervals in terms of the effect of the distraction technique, indicating that the effect of color was significant ($P < 0.001$), with the lowest anxiety levels in blue and pink colors. However, the effect of distraction technique on the stress level was not significant (0.337). In addition, the cumulative effect of color and distraction technique was not significant ($P = 0.525$). Furthermore, the results showed significant changes in mean HRs over time, with the maximum effect during the treatment procedure ($P < 0.001$) [Table 1 and Figure 1].

The SpO₂ levels before treatment in the yellow, pink, and blue groups in both distraction techniques were higher compared to other colors, with the black and red colors exhibiting the least SpO₂ levels. In all the cases, there were significant differences in anxiety levels in different colors [Table 3].

In addition, comparison of anxiety levels in terms of SpO₂ levels in each color before, during, and after treatment between the two distraction techniques with the use of *t*-test showed no significant differences between any of the colors at each time interval between the two distraction techniques [Table 3].

Table 1: The results of repeated-measures analysis of variance between the study groups over time

| Effects | Variable (<i>P</i>) | | |
|---------------------|-----------------------|--------|----------------|
| | VPT | HR | O ₂ |
| Time | <0.001 | <0.001 | <0.001 |
| Time×color | 0.878 | 0.012 | 0.002 |
| Time×cheating | 0.477 | <0.001 | 0.865 |
| Time×color×cheating | 0.001 | 0.007 | 0.669 |
| Color | <0.001 | <0.001 | <0.001 |
| Cheating | 0.075 | 0.337 | 0.137 |
| Color×cheating | 0.119 | 0.525 | 0.105 |

HR: Heart rate; VPT: Venham Picture Test

Table 2: Comparison of the children's anxiety levels in terms of heart rate in each group before, during, and after the procedure (separately in terms of the distraction technique and color)

| Color | Mean±SD | | | | | | <i>P</i> -value (comparing distraction technique)** | | |
|------------------------------------|-------------|-------------|-------------|-------------|-------------|-------------|---|--------|-------|
| | Sound | | | Sound-video | | | Before | During | After |
| | Before | During | After | Before | During | After | | | |
| Yellow | 86.38±15.33 | 94.19±19.96 | 90.75±11.76 | 81.57±19.38 | 106.29±22.2 | 82.29±15.28 | 0.530 | 0.210 | 0.161 |
| Blue | 76.67±6.18 | 84.22±5.91 | 79.78±3.89 | 74.00±3.00 | 83.00±5.43 | 77.87±4.67 | 0.168 | 0.611 | 0.315 |
| Red | 87.54±8.05 | 98.85±8.32 | 93.54±6.96 | 86.89±10.57 | 103.56±8.30 | 90.22±16.52 | 0.872 | 0.207 | 0.523 |
| Black | 94.00±4.26 | 99.45±8.81 | 96.91±5.33 | 93.33±7.14 | 106.56±14.5 | 98.78±9.94 | 0.792 | 0.194 | 0.597 |
| Pink | 73.56±5.34 | 82.56±8.45 | 76.44±5.98 | 74.79±3.40 | 81.71±5.12 | 76.71±4.15 | 0.505 | 0.768 | 0.899 |
| Green | 75.75±6.90 | 85.75±13.52 | 80.63±10.41 | 81.58±9.72 | 96.58±15.40 | 89.83±11.76 | 0.161 | 0.124 | 0.090 |
| <i>P</i> -value (comparing color)* | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | | | |

*One-way ANOVA, ***t*-test. SD: Standard deviation, ANOVA: Analysis of variance

Comparison of anxiety levels in terms of SpO₂ levels at different study intervals between different colors and distraction techniques simultaneously showed significant differences at different intervals in terms of the distraction techniques; in addition, the effect of color on the anxiety level was significant ($P < 0.001$). However, the effect of distraction technique on the anxiety level was not significant ($P = 0.137$). Furthermore, the cumulative effect of color and distraction technique was not significant ($P = 0.105$). Besides, the results showed that mean changes in the SpO₂ levels were generally significant, with the lowest levels during treatment ($P < 0.001$) [Table 1 and Figure 2].

The minimum anxiety levels before and after treatment were recorded in the blue group, with the pink, green, and yellow colors ranking the second, third, and fourth. The maximum anxiety levels were recorded with black and red colors. The results showed significant differences in anxiety levels between different colors [Table 4]. Although the anxiety levels before and after treatment in the green, blue, and pink groups with the audio distraction technique were less than those with the audiovisual distraction technique, the results of *t*-test showed no significant differences in any of the colors at the study intervals between the two distraction techniques [Table 4].

Comparison of stress in terms of the VPT questionnaire at different study intervals between different color groups and distraction techniques showed significant differences between the different colors at different study intervals in terms of the distraction techniques; besides, the effect of color on anxiety level was significant ($P < 0.001$). However, the effect of distraction technique on the anxiety level was not significant ($P = 0.075$). Besides, the

cumulative effect of color and distraction technique was not significant (0.119). Furthermore, the results

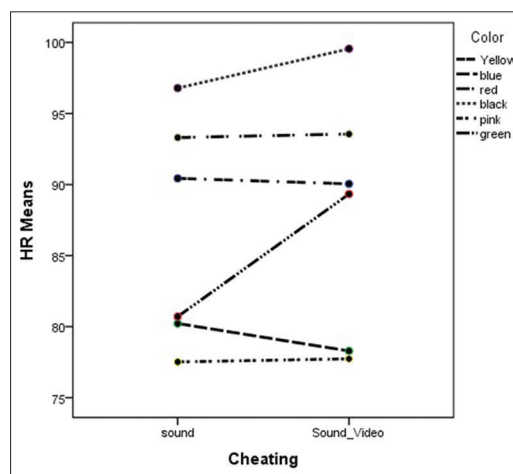


Figure 1: Comparison of anxiety levels in terms of heart rate at different study intervals between different color groups and different distraction techniques.

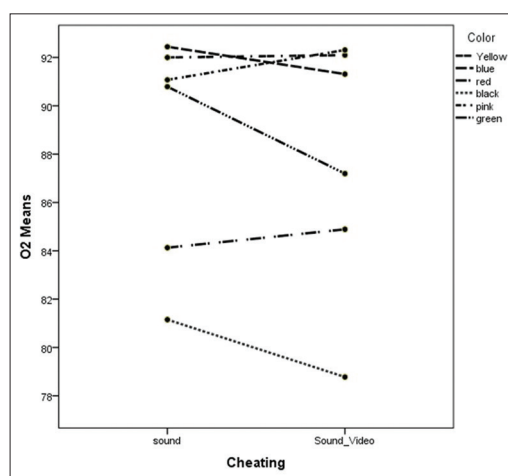


Figure 2: Comparison of anxiety levels in terms of oxygen saturation levels at different study intervals between the different color groups and different distraction techniques.

Table 3: Comparison of children’s anxiety levels in terms of oxygen saturation levels in each group before, during, and after treatment, separately for each distraction technique and color

| Color | Mean±SD | | | | | | P-value (comparing distraction technique)** | | |
|----------------------------|------------|------------|------------|-------------|------------|------------|---|--------|--------|
| | Sound | | | Sound-video | | | Before | During | After |
| | Before | During | After | Before | During | After | | | |
| Yellow | 94.00±4.74 | 89.69±6.95 | 92.31±4.43 | 94.43±3.45 | 89.29±8.38 | 92.57±4.79 | 0.833 | 0.906 | 0.901 |
| Blue | 93.33±4.18 | 91.67±3.12 | 92.33±2.12 | 92.93±3.45 | 89.93±5.37 | 91.07±3.08 | 0.802 | 0.390 | 0.290 |
| Red | 85.62±2.78 | 82.69±2.35 | 84.08±2.59 | 87.00±2.59 | 83.11±2.36 | 84.56±2.92 | 0.253 | 0.687 | 0.690 |
| Black | 84.45±4.76 | 79.09±3.53 | 79.91±1.75 | 83.78±4.14 | 76.89±2.08 | 75.67±4.61 | 0.742 | 0.117 | 0.0110 |
| Pink | 93.89±2.08 | 88.44±5.22 | 90.89±2.80 | 93.36±2.89 | 91.00±2.07 | 92.57±2.34 | 0.640 | 0.113 | 0.134 |
| Green | 94.00±5.37 | 87.13±5.86 | 91.25±4.62 | 89.83±4.30 | 83.67±3.49 | 88.08±3.87 | 0.070 | 0.114 | 0.114 |
| P-value (comparing color)* | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | | | |

*One-way ANOVA, **t-test. SD: Standard deviation, ANOVA: Analysis of variance

Table 4: Comparison of children's anxiety levels in terms of the VPT questionnaire in each group before and after treatment separately for each distraction technique and color

| Color | Mean±SD | | | | P-value (comparing distraction technique)** | |
|----------------------------|-----------|-----------|-------------|-----------|---|-------|
| | Sound | | Sound-video | | Before | After |
| | Before | After | Before | After | | |
| Yellow | 4.06±2.88 | 2.31±1.88 | 3.43±2.93 | 3.29±1.97 | 0.635 | 0.274 |
| Blue | 0.44±0.72 | 0.00 | 2.13±1.55 | 0.33±0.61 | 0.006 | 0.123 |
| Red | 6.23±1.36 | 4.31±1.84 | 4.78±1.56 | 4.56±1.23 | 0.031 | 0.729 |
| Black | 7.91±0.30 | 5.64±1.69 | 7.67±0.50 | 5.56±1.66 | 0.196 | 0.916 |
| Pink | 1.44±1.01 | 0.56±0.88 | 2.93±0.99 | 0.43±0.51 | 0.002 | 0.666 |
| Green | 1.25±1.28 | 2.55±1.06 | 3.42±1.56 | 1.33±0.88 | 0.004 | 0.458 |
| P-value (comparing color)* | <0.001 | <0.001 | <0.001 | <0.001 | | |

*One-way ANOVA, **t-test, SD: Standard deviation, ANOVA: Analysis of variance

showed that the changes in the mean anxiety level in terms of the VPT questionnaire were significant over time, decreasing after treatment ($P < 0.001$) [Table 1 and Figure 3].

DISCUSSION

The present study was aimed to determine the effect of color on designing the environment, the dentist's attire, and two different techniques of distraction (audio and audiovisual) on the anxiety resulting from the administration of local anesthetic agents in 6–9-year-old children referring to the Hamadan Faculty of Dentistry. A total of 132 children, aged 6–9 years, with no history of dental visits, were selected for the evaluation of the effect of color in designing the environment, dentists' attire, and two different distraction techniques on anxiety levels due to the administration of local anesthesia.

Management of dental anxiety in children in dental offices is a significant challenge facing the treatment team. Several factors in the dental office affect children's dental anxiety, which is categorized as dentist-related factors and physical factors related to the environment.^[12] Clinical psychologists have proposed theories on the emotional importance of color for the past several years. Therefore, the use of colors in the present study might help both the children and staff feels more comfortable in the dental environment. The use of colorful equipment, too, is useful.^[13]

In the present study, the SpO₂ levels before treatment in the yellow, pink, and blue groups were higher compared to the other groups. In line with these results, general evidence shows that light, and relatively soft-shadeless colors such as pink, blue, gray, and yellow, which are used in nurses' clothing,

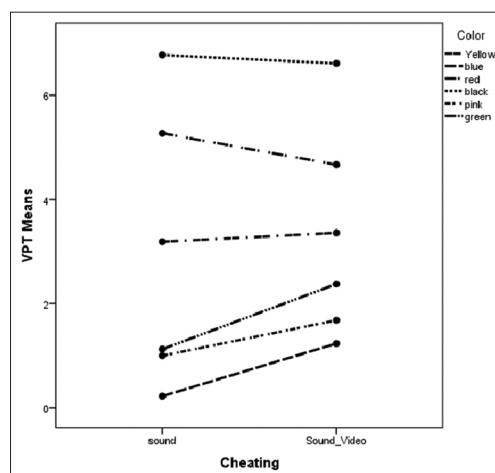


Figure 3: Comparison of anxiety levels in terms of the VPT questionnaire at different study intervals between different colors and distraction techniques.

cause the secretion of sedative hormones— serotonin, endorphins, and dopamine. These colors help children resist violence and prevent anger. However, bright colors stimulate the sensory nerves and secrete cortisol and epinephrine, which cause feelings of anxiety and stress, resulting in HR and increase blood pressure in patients.^[14] Annamary study showed that colors such as blue and pink in the dental environment can enhance a positive attitude, whereas black and red evoke a negative outlook.^[15]

In addition, there were significant differences between the three groups before, during, and after treatment. The HRs before treatment in the green, pink, and blue groups were lower than those in the other groups; besides, there were significant differences between the three groups before, during, and after treatment. The decision to determine only the HRs and SpO₂ levels in the present study was based on the fact that placing several pieces of recording equipment

on a child might itself increase fear and physiologic reactions.^[16] In addition, evaluation of anxiety levels before and after the administration of local anesthesia with the use of the VPT questionnaire showed the minimum anxiety level before and after treatment in the blue group, followed by the pink and green groups, respectively, consistent with the results of a study by Parvizi and Rafatjou, who evaluated the relationship between the color selected to paint the operatory environment and the dental equipment and the 6–12-year-old children's dental anxiety (using the standard MCDAS questionnaire).^[17]

Bubna *et al.* used the Corah dental anxiety scale to evaluate 6–12-year-old children and did not report any significant difference in the selection of color between two groups of children with and without dental anxiety. Both groups exhibited great interest in the yellow color to express a feeling of happiness. In both groups, children selected the red color at a high rate to express a feeling of discomfort.^[7] A study by Hotwan and Sharma showed that blue was the boys' favorite color, whereas girls preferred red at a higher rate. In contrast, red and dark colors were the least favorable colors of boys and girls, respectively. Significant differences were reported in the selection of color combinations between the two genders.^[18] Pakseresht *et al.* showed that children encountering nurses with pink uniforms exhibited less anxiety compared to when they encountered nurses with blue uniforms.^[19] Furthermore, Albert reported a lower level of anxiety and a higher rate of positive feelings when children encountered nurses wearing pink and blue uniforms.^[20]

Goethe introduced a colorful wheel in 1840, which was used to evaluate the psychological effect of different colors, reporting that yellow was associated with happiness and a positive emotional state. Blue was associated with security, calmness, and comfort; black was associated with depression or anxiety; orange was associated with stress; red had both positive and negative effects; and green induced fear and tranquility.^[21]

In a study by Yahyaoglu *et al.*, there was a relationship between anxiety and dental caries, and a small change in the dentist's appearance decreased the children's anxiety.^[22] In the present study, although the anxiety levels before and after the administration of local anesthesia were higher in girls, there was no significant relationship between the children's age

and gender and dental anxiety during the injection of local anesthetic agents. In a study by Parvizi, the age group that selected a green color for the environment was younger than that selecting blue. Boys and girls selected yellow for the environment, and yellow and pink for happy emojis.^[17] Some well-established hormonal processes affect gender-related behaviors.^[23] However, some studies on gender have not reported the effect of gender on appearance preference of the dentist, that is., the attire.^[24] It should be noted that in the present study, the effect of these two variables (color and distraction technique) cannot be separated.

In a study by Rafatjou *et al.*, MCDAS and VPT questionnaires were used to determine stress levels, reporting that generally, during children's first visit, aggressive treatments, such as tooth extraction and restorative procedures, should be avoided. The anxiety levels in female children were higher than those in male children. Therefore, girls need more attention in this respect. Finally, they reported that mothers' awareness of orodental hygiene had a crucial role in decreasing their children's dental anxiety.^[25]

In the present study, there was no significant difference in decreasing anxiety levels between the two distraction techniques, and in general, distraction did not decrease anxiety. Navidian study and other studies did not report any significant change in anxiety levels by listening to music.^[11,26,27] Gupta concluded that music did not decrease pain, anxiety, or unfavorable behaviors significantly.^[28] The heterogeneity in audio and audiovisual distraction results may be due to the different forms and types of equipment used, different types of content played, and the volume. It is possible that the audio may not be enough to mask some sounds in the dental operatory (eg, high-speed handpiece, and the saliva ejector), as the volume must allow the patient to hear the dentists' commands and explanations.^[29]

However, Jindal and Florella *et al.*, and Kaur *et al.*, in contrast to the present study, reported that listening to music was effective in decreasing anxiety.^[30-32] In addition, music helped decrease the unfavorable sound of the handpiece and other anxiety-inducing stimuli. This advantage, in association with the effect of selecting a piece of music by the child (due to playing his/her favorite song or music), helps them regain their control in the face of unfavorable stimuli, feeling that they are in a familiar environment.^[33,34]

Liu *et al.* carried out a systematic review and reported a significant decrease in children's dental anxiety with the use of the audiovisual distraction techniques,^[35] consistent with the results of the present study and some other studies. Although the use of audio and audiovisual distraction technique is clinically simple and safe and requires some short preparatory instructions by the clinician, it still has some disadvantages. For example, audiovisual instruments have been designed for adults and are not suitable for children with small faces. In addition, the cost-effectiveness of these techniques should be considered because some of the tools used in previous studies are expensive.^[36]

CONCLUSION

The use of blue and pink colors above all, then green and yellow, respectively, for dentists' attire and the interior design of the operatory gave rise to a decrease in children's dental anxiety; moreover, red and black have a negative effect on children's dental anxiety.

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Conflicts of interest

The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or nonfinancial in this article.

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