Comparison of active versus passive audiovisual distraction tools on children's behaviour, anxiety and pain in paediatric dentistry: a randomised crossover clinical trial

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Abstract

Aim To determine the effect of active distraction when playing PlayStation® video games, compared to passive distraction when watching a cartoon with audiovisual eyeglasses, on parental perception of patients' anxiety, and children's anxiety, pain, behaviour and heart rate during restorative procedures in paediatric dentistry.

Materials and methods Study design: Randomised crossover clinical trial. There were 34 patients in the cartoon film group (passive distraction) and 34 in the Playstation® video game group (active distraction), aged 6–8 years, who required a minimum of 2 visits for restorative treatment. Rimax® iVision 5.0 eyeglasses were used in both groups. Parental perception of patients' anxiety (Modified Corah Dental Anxiety Scale), and children's anxiety (Venham Picture Test), pain (Wong-Baker Faces Scale), behaviour (Frankl Scale) and heart rate were evaluated at each of the treatment visits. Preference for and satisfaction with the audiovisual product were also assessed.

Results There were significant differences in self-reported pain between control (P=0.016) and experimental (P=0.013) visits in both groups, with lower values in the Playstation® video game group. No significant differences were found (P>0.05) in the other variables evaluated with the use of active distraction. A significant increase in heart rate was recorded at each treatment visit (P=0.0001) when the anaesthetic was injected. All the patients wanted to continue watching or playing their chosen cartoon or Playstation® video game during subsequent visits.

Conclusion The use of PlayStation® video games for active audiovisual distraction, compared with passive distraction with a cartoon, improved self-reported pain but did not reduce parents' perception of patients' anxiety, pain, global behaviour, or heart rate. Both distraction methods were accepted by paediatric patients.

KEYWORDS Anxiety; Audiovisual distraction; Behaviour; Child management; Pain.

Introduction

The aetiology of dental fear and anxiety in children is multifactorial and can be influenced by different risk factors such as personality type, previous negative experiences, sex, and age, as well as parental fear. These factors may predict to some extent the way children behave in the dental chair [Strøm al., 2015; Merdad and El-Housseiny, 2017].

The main objective of behaviour management techniques is to treat paediatric patients in a safe and effective way, in order to ensure successful treatment. Dentists have a wide variety of techniques available to assist them in management of children [AAPD, 2018], such as tell-show-do, relaxation, distraction, systematic desensitisation, modelling, audio analgesia, hypnosis, and behaviour rehearsal. Among these techniques, traditional behaviour management techniques such as papoose board and hand-over-mouth techniques can be successful, but the attitude of parents and dental professionals towards these techniques is changing [Luis de Leon et al., 2010; Peretz et al., 2013; Boka et al., 2014;], and their acceptance is reduced. Nowadays, nonaversive techniques like distraction are becoming more popular.

Distraction techniques are applied in clinical paediatric dentistry with the intent of withdrawing children's conscious attention away from oral noxious stimuli (or selective attention) [El-Sharkawi et al., 2012; Al-Khotani et al., 2016]. Distraction is based on the assumption that children perceive pain when their brain is concentrated on a specific painful stimulus inside their mouth. Thus, diverting attention away from a concurrent nociceptive painful procedure results in an analgesic effect, with at least 33% pain reduction, compared with standard care and other forms of cognitive distraction [Farrar et al., 2000]. The technique can be performed with no contraindications with respect to patient age [Sullivan et al., 2000]. Distraction techniques for behaviour management during medical and dental treatments are categorised into active, interactive and passive distraction. Interactive distraction requires cognitive engagement with a distracting stimulus, while passive distraction requires only visual or auditory ability to observe the distracting stimulus [Wohlheiter and Dahlquist, 2013; Asvanund et al., 2015]. Distraction techniques include: music (passive) [Parkin, 1981; Aitken et al., 2002]; cartoons projected on a monitor (passive) [Guinot et al., 2014; Ghadimi et al., 2018]; storytelling (passive) [Stark, 1989]; audio presentation through headphones or presentation of audiovisual stories on a television (passive) [Venham et al., 1981; Ingersoll et al., 1984]; use of external interventional stimuli, including tools such as a multisensory adapted dental environment that features a partially dimmed room with lighting effects (passive) [Shapiro et al., 2007]; audio analgesia (passive) [Baghdadi, 2000]; and immersion in virtual reality (active) [Sullivan et al., 2000]. More recently, audiovisual video eyeglasses (passive) [El-Sharkawi et al., 2012; Asvanund et al., 2015; Mitrakul et al., 2015; Nuvvula et al., 2015; Al-Khotani et al., 2016; Bagattoni et al., 2018; Garrocho-Rangel et al., 2018; Shetty et al., 2019] have been introduced as a promising technique for distraction. A final method described in the literature is the use of an iPad video game (active) [Attar and Baghdadi, 2015].

There is evidence from medical treatment that passive distraction, such as watching a film, is not as effective as active distraction, such as playing a video game [Lacquiere and Courtman, 2011; McQueen et al., 2012], but there is little evidence of the use of active distraction in dentistry. Attar and Baghdadi [2015] concluded that active distraction by playing games on an iPad showed better performance and acceptance than passive distraction, in which children wore audiovisual glasses to watch a film during dental treatment. Therefore, methods of active distraction that involve the use of new technologies seem to offer a promising alternative for managing anxious patients [Nuyyula et al., 2015; Al-Khotani et al., 2016].

The aim of the present study was to determine the effect of active distraction by playing PlayStation® video games, compared with passive distraction watching a cartoon with audiovisual eyeglasses, on parental perception of patients' anxiety, and children's anxiety, pain, behaviour and heart rate during restorative procedures in paediatric dentistry.

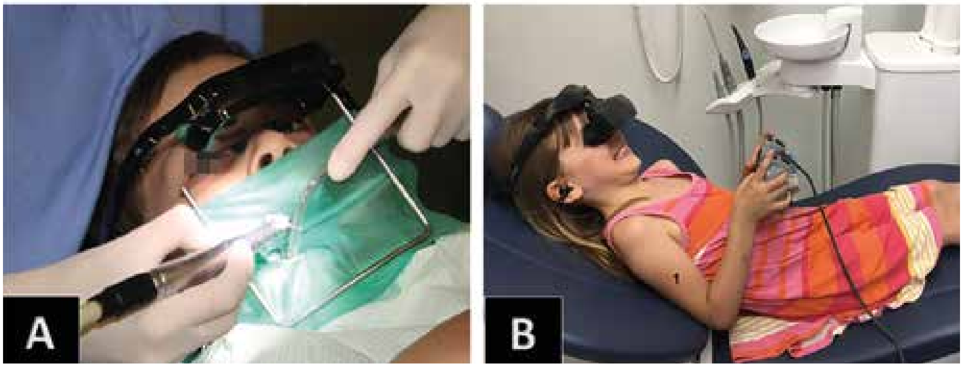
Materials and methods

A non randomised crossover trial was conducted between February 2018 and December 2019 at the Department of Paediatric Dentistry of the Faculty of Dentistry of the Universitat Internacional de Catalunya, Barcelona, Spain. The project was evaluated and approved by the Ethics Committee of the Universitat Internacional de Catalunya, Barcelona, Spain (Approval Reference: D-06-LBD-10). The study design was carried out according to the CONSORT 2010 statement 25-item checklist. The present report is part of a larger study, which has been registered at ClinicalTrials.gov (Identifier: NCT02180386). The study was carried out in compliance with the Declaration of Helsinki as well as the International Conference on Harmonization Guidelines for Good Clinical Practice. The parameters used for the calculation of sample size were 95% confidence interval (CI), 80% statistical power, standard deviation (SD) of 2.90 points [Hoge et al., 2012, Guinot et al., 2014], and minimal difference of 2 points in the self-reported pain score detected between treatment visits. A minimum of 34 patients in each study group was determined. This number was increased to 42 to make up for cases that might be lost to follow-up (-20%). Thus, 84 healthy (ASA 1) and cooperative patients aged 6–8 years (43 boys and 41 girls) were recruited and randomly distributed into sex- and age-matched groups: the cartoon film group or Playstation® video game group. Each child required a minimum of 2 visits for dental treatment (composite filling or pulpotomy) in a mandibular quadrant with an alveolar nerve block, and had undergone previous restorative dental treatment in the above-mentioned department. The study itself comprised a control visit and an experimental visit. The order of the visits was selected by flipping a coin. All parents or guardians of the children participating in the study gave their informed consent before recruitment. All of those chosen agreed to participate in the study. All patients were free to withdraw from the study at any time without affecting their dental treatment. Prior to starting the study parents and children were informed that, in one of the two visits, they would either use the Playstation® video game or watch a cartoon. Patients with reduced audiovisual capabilities and psychological disorders were excluded from the study.

Data were collected and corroborated by 2 paediatric dentists, who were trained to apply the Frankl Behaviour Rating Scale [Frankl et al., 1962] by the same dentist who calibrated this scale in the first part of the study [Guinot et al., 2014]. This was accomplished by performing 50 observations of children (who did not participate in the study) in the clinic over the course of 1 month (κ statistic = 0.87). Each visit lasted approximately 35 minutes and the maximum time between the 2 treatment sessions was 2 weeks. This time interval between dental procedures was established as a washout period to promote children's cooperation and to avoid possible changes in the severity of carious lesions. Each patient was treated by the same dentist for both visits. Before the start of each treatment session, as a part of the standard procedure for a paediatric dental visit, children were given an explanation of what the visit would comprise, with the aim of interrupting the treatment as little as possible. The parents were not present in the operating room during the treatment. Once the patients had been assigned to a study group, they were asked to choose the cartoon that they wanted to watch or the video game that they wanted to play during the experimental treatment visit. The available selection comprised 25 cartoons and 10 Playstation® video games that were suitable for all audiences.

Parents were asked to fill in the Modified Corah Dental Anxiety Scale [Corah et al., 1978] during the control visit to assess their perception of patients' anxiety before their children entered the operating room. A score of 4 indicated the lowest possible level of anxiety and a score of 20 the highest. After treatment, the children completed the Venham Picture Test [Venham and Gaulin-Kremer, 1979] to evaluate their perceived anxiety during treatment. The score ranged from 0 (not anxious) to 8 (extremely anxious). The Wong-Baker Faces Scale [Wong and Baker, 1988] was also completed by the children at the end of the control visit to register self-reported pain during treatment. The Wong-Baker Faces Scale is a 6-point scale ranging from 0 (no pain) to 10 (worst pain). For the scores to be as exact as possible, detailed explanations were given to the children about the significance of each drawing on the scales. Heart rate was measured with a digital Onyx® pulseoximeter (NONIN, Plymouth, MN, USA) clipped to the finger of the left hand (for right-handed patients) throughout the visits at the following time points: during the 3 minutes before application of topical anaesthesia; during application of topical anaesthesia; during injection of local anaesthesia; during placement of the clamp and rubber dam; and during onset of caries removal with rotary instruments. A dental assistant ensured that the children did not move by gently holding the patients' hand, if needed. Mean heart rate was calculated for each period by averaging all values of beat-to-beat heart rate within the period. The data described were registered on a sheet to enable collection of information. Heart rate was used as an objective measure to assess the degree of anxiety of the children. Once the visit was over, the operator filled in the Frankl Behaviour Rating Scale [Frankl et al., 1962] to assess the global behaviour of the patients from 1 (worst

FIG. 1 Photographs of a child in the audiovisual distraction setup. A. Rimax® iVision 5.0 glasses watching a cartoon film. B. PlayStation® adapted to the video eyewear Rimax® iVision 5.0 glasses



behaviour) to 4 (best behaviour). The methodology used in the present investigation was the same as that described previously [Guinot et al., 2014].

During the experimental visit, all the test conducted during the control visit were also applied. The patients' heart rates were also measured. Heart rate was measured in the same way as during the control visit, and the values were recorded on the data collection sheet. The audiovisual device used during the experimental visit was the Rimax® iVision 5.0 (Rimax International Ltd., London, UK), which is a new multimedia eyeglass system that partially occludes the environment and enables children to watch and listen to a cartoon or TV programme, or play a video game. The glasses have built-in head phones that enable the sound to be heard.

During the experimental visit the cartoon/Playstation® video game was turned on 3 minutes before application of topical anaesthesia and turned off at the end of the treatment. The Rimax® iVision 5.0 glasses were placed in a position that was comfortable for the patients and convenient for the operators, so as not to interfere with the treatment process (Fig. 1). The volume of the cartoon or video game was such that the children could hear it correctly, while at the same time, the operators could give the patients necessary instructions. For this purpose, earphones were used. Given the nature of the study design, blinding was impossible. During the treatment visit, the operators had no access to the results of the measurements obtained at the other treatment visit.

After the experimental visit, the children were asked to answer the following questions to determine their degree of acceptance of the product: "Did you enjoy playing a video game/watching a cartoon during the dental visit?" (Yes/No); and "Would you like to continue playing video games/watching cartoons during your next visits?" (Yes/No).

The statistical data were analysed using Statgraphics® Plus version 5.1 (Statpoint Technologies, Warrenton, VA, USA). To assess the normality of the sample with respect to age, the Shapiro-Wilk test was applied and with respect to sex, the proportion test. The repeated measures analysis of variance (ANOVA) test was used to determine the visit factor, and the 1-way ANOVA test was used to analyse the results obtained in the different treatment visits between the study groups. For the study of the results obtained between the two groups for the age and sex factors of each of the evaluated variables, the 2-way ANOVA test was applied. For comparison of patient satisfaction in receiving dental treatment by watching cartoon films or playing video games, and the patients' willingness to receive future dental treatment by watching cartoon films or playing video games, the proportion test was used for dichotomous variables of independent samples.

$P \leq 0.05$ was considered statistically significant.

	Cartoon film group		PlayStation® video game group		Comparision between groups (mean±SD)	
Variable	Control visit (mean±SD)	Experimental visit (mean±SD)	Control visit (mean±SD)	Experimental visit (mean±SD)	Control visits	Experimental visits
Modified Corah Dental Anxiety Scale	7.2±3.40	6.97±2.56	6.85±2.35	7.38±2.79	P=0.17 NS	P=0.53 NS
Comparison between visits	P=0.86 NS		P=0.26 NS			
Venham Picture Test	0.52±1.30	0.38±1.45	0±0.35	0±0.15	P=0.52 NS	P=0.41 NS
Comparision between visits	P=0.32 NS		P=0.19 NS			
Wong-Baker Faces Scale	1.11±1.57	0.94±1.41	0±0.35	0±0.26	P=0.016*	P=0.013*
Comparison between visits	P=0.49 NS		P=0.55 NS			
Frankl Behaviour Rating Scale	3.05±0.69	3.26±0.66	4±3.41	4±3.50	P=0.06 NS	P=0.19 NS
Comparison between visits	P=0.10 NS		P=0.49 NS			
Heart rate	99.67±8.99	96.31±10.40	91.69±2.49	92.52±1.32	P=0.007*	P=0.17 NS
Comparision between visits	P=0.03*		P=0.63 NS			
*Statistically significant (P<0.05). NS = Nonsignificant value (P>0.05).						

TABLE 1 Means, SD, and ANOVA for each variable measured in the study.

Results

Participants

Sixteen of the 84 patients were excluded because they did not attend the corresponding appointments, leaving a study sample of 68 patients aged 6–8 years: 34 in the cartoon film group (17 girls and 17 boys) and 34 in the video game (PlayStation®) group (17 girls and 17 boys). The mean age was similar in the two groups: 7.03 ± 0.76 years in the cartoon film group and 7.02 ± 0.83 years in the video game group, thus there were no significant differences for the age variable (P=0.29). There were no significant differences in sex since both groups had the same number of boys and girls (P=1.0).

Table 1 shows the mean and SD for each variable measured during the control and experimental visits in both groups.

Parental perception of patients' anxiety

No significant differences (P≥0.05) were observed between the control and experimental visits of the cartoon film and video game groups, or between the control and experimental visits of both groups with regard to parental perception of patients' anxiety, as determined by the Modified Corah Dental Anxiety Scale. Significant differences were observed with regard to age or sex (P= 0.000). The boys in both study groups showed a higher score than the girls, both in the control and in experimental visits with children aged 8 years having a lower score than those aged 6–7 years.

Self-reported anxiety measures

No significant differences (P≥0.05) were observed between the control and experimental visits of the cartoon film and video game groups, or between the control and experimental visits of both groups with regard to self-reported anxiety measures, as determined by the Venham Picture Test, although the mean score for the experimental visit was lower than for the control visit. No significant differences were observed with regard to age (P=0.107), or sex (P=0.163), although in the cartoon film group, the boys showed a higher score than the girls, and in the video game group, the higher score was obtained by the girls.

Self-reported pain measures

There were significant differences in self-reported pain measures, using the Wong-Baker Faces Scale, between control (P=0.016) and experimental (P=0.013) visits in both study groups, with the higher score in the cartoon film group. No significant differences (P≥0.05) were observed between the control and experimental visits of the cartoon film and video game groups, although the mean score in the experimental visit was lower than in the control visit in both groups. With respect to age, significant differences were found in both study groups (P=0.002), with children aged ≥7 years having a higher score than those aged 6–8 years. No significant differences were observed with regard to sex (P≥0.05).

Global behaviour measures

No significant differences (P≥0.05) were observed between the control and experimental visits of the cartoon film and video game groups, and between the control and experimental visits of both study groups with regard to global behaviour of the patients, as determined by the Frankl Scale. Nevertheless, the results were higher in the video game group in both visits. With respect to age, significant differences were found in both study groups (P=0.000), with children aged 6 years having a lower score than those aged 7–8 years. No significant differences were observed with regard to sex (P≥0.05).

Heart rate

There were significant differences in heart rate between control visits (P=0.007) in both study groups, with low scores recorded in the video game group and between the control and experimental visits of the cartoon film group (P=0.03). No significant differences (P≥0.05) were observed between the experimental visits of both study groups, although heart rate was lower in the video game group. With regard to the different times at which heart rate was recorded, for both groups there was a significant increase at the time of administration of the anaesthetic (P=0.001) (Fig. 2). Significant differences were observed with regard to sex (P= 0.000). The girls in both study groups showed a higher score than the boys, both in the control and in experimental visits. There was a significant difference related to age during injection of anaesthetic in the experimental visit of both study groups (P=0.001), with the youngest children registering a higher heart rate (Fig. 3).

Postoperative questions

On the question of whether the patients had enjoyed watching cartoon films or playing video games during the visit, in the cartoon film group an affirmative response was recorded for all 34 patients in both groups. The same result was obtained for the question of whether they would like to continue watching cartoons or playing video games during subsequent visits.

Discussion

This study was conducted to compare the effect of active versus passive distraction techniques during paediatric dental treatment. It has been stated that the ideal distractor ought to have various features such as visual, auditory and kinaesthetic modalities (i.e., physical movements) to provide the full capacity to harness children's concentration and attention, and in turn to minimise their anxiety [Sharar et al., 2007; Al-Khotani et al., 2016]. For this reason, the Playstation® video game group was formed to establish whether active distraction involving multiple sensory modalities (hearing, seeing, kinaesthetic and active

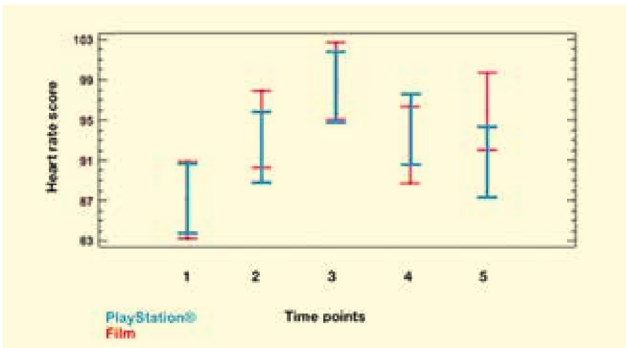


FIG. 2 Plot of heart rate measured using the pulse oximeter at each time point throughout the control and experimental visits for the two study groups. 1) 3 minutes before application of topical anaesthesia; 2) application of topical anaesthesia; 3) injection of local anaesthesia; 4) placement of the clamp and rubber dam; 5) onset of caries removal with rotary instruments.

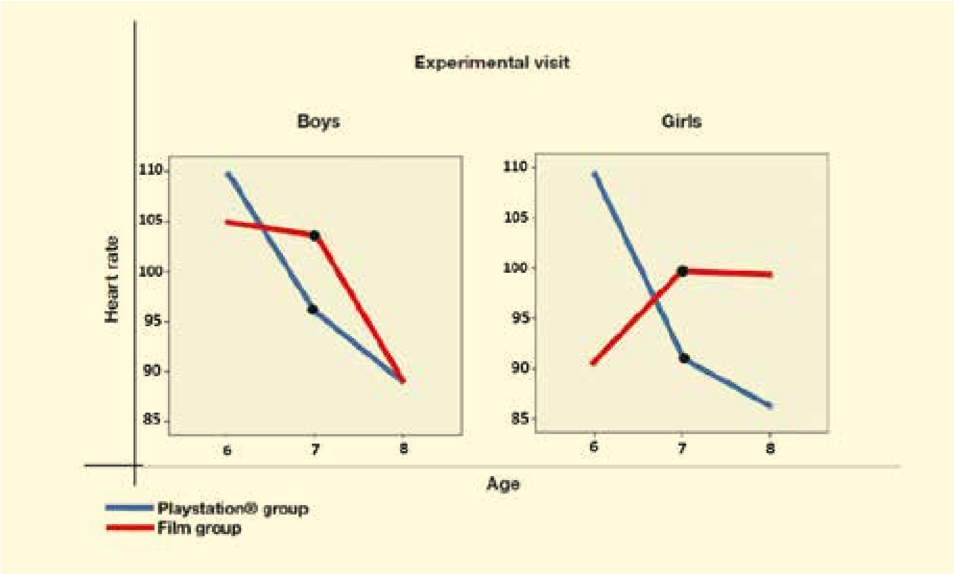


FIG. 3 Statistical analysis of interaction of heart rate modified for age and sex of the two groups (video games and cartoon films) during injection of anaesthetic in the experimental visit.

emotional involvement of the child) was more effective than passive distraction.

The Rimax® iVision 5.0 audiovisual device was chosen as a distraction method on the basis that other authors have indicated that the video eyeglass technique is a powerful distraction tool [El-Sharkawi et al., 2012; Asvanund et al., 2015; Attar and Baghdadi, 2015; Mitrakul et al., 2015; Nuvvula et al., 2015; Al-Khotani et al., 2016; Bagattoni et al., 2018; Garrocho-Rangel et al., 2018; Shetty et al., 2019]. The Rimax® iVision 5.0 can be connected to several devices including DVD players, gaming systems like Sony Play Station Pro, Microsoft X-BOX, Nintendo WII, etc., or a satellite box. At the same time, it successfully isolates the patient at least partially from the sights and sounds of unfriendly medical environments. Furthermore, with developments in technology, video eyeglasses have become lighter, wireless, and more user-friendly, and are available at an affordable price. Video eyeglasses reduce the negative influence of unpleasant noises while maintaining the ability to communicate partially with patients and to monitor their facial expressions. These advantages are clear, particularly during anaesthetic injection and removal of caries tissue, which are the most stressful stages for patients and dentists [Bagattoni et al., 2018].

The present study was designed as a crossover study to eliminate any difference in pain and anxiety, where every patient was compared with themselves in control and experimental visits, in order to reduce the effects of confounding factors. The advantages of a crossover design is that each participant can serve as his/her own control [Aitken el at., 2002; Ram et al., 2010; Mitrakul et al., 2015; Bagattoni et al., 2018]. However, one of our inclusion criteria was to have a previous dental experience that may have affected future treatment outcomes; also known as a carry-over effect [Ram et al., 2010; Mitrakul et al., 2015]. A carry-over effect is defined as the memorised experience from the first visit that might affect the experience of the following visit [Asvanund et al., 2015]. The randomness of the visits and their cumulative effect, as well as clinicians' ability to manage patients' behaviour may have conditioned the results of the measures. If the first visit is the control treatment visit, it is possible to develop a positive relationship and trust between child and dentist, as a result of direct contact between them based on conventional behaviour management techniques. As a result, the second dental treatment with audiovisual distraction may be more successful, due to confidence in and knowledge of the treatment steps acquired by the children. In contrast, use of a distraction technique during the first visit compounds a loss of a direct communication, which could reduce the child's cooperation and increase the operator's stress [Bagattoni et al., 2018]. For this reason, the order of visits (control or experimental) was randomised in the present study.

Children's comprehension of pain and anxiety varies considerably with age and level of cognition, which can influence their behaviour during dental treatment. Preschool compared to school-age children have been shown to have a higher level of fear and anxiety, reflected in disruptive and difficult behaviour control [Laquiere and Courtman, 2011]. Several studies [Dahlquist et al., 2009; Hoge et al., 2012; Attar and Baghdadi, 2015] have also suggested that distraction is more effective in older age groups due to the lower level of anxiety and dental fear, which yields more benefits with methods of distraction than in younger children. For that reason, as in Al-Khotani et al. [2016], school-age children were chosen for our study, since the use of distraction requires a low level of dental fear and anxiety. Furthermore, different age groups have different cognitive and behavioural actions towards audiovisual distraction. Another reason for choosing school-age children is that younger age groups exhibit more uncooperative and disruptive behaviour that is hard to control [Al-Khotani et al., 2016]. Additionally, Nuvvula et al. [2015] have suggested that the use of audiovisual eyeglasses in children aged <7 years is contraindicated.

The Modified Corah Dental Anxiety Scale was used to measure the parental perception of patients' dental anxiety because it is a short-form instrument and is easy to apply. Additionally, it has high levels of reliability and validity, and is useful for planning interventions aimed at reducing anxiety [Corah et al., 1978; Aartman et al., 1998; Guinot et al., 2011]. Like Aitken et al. [2002] or Attar y Baghdadi [2015] using a similar scale, no significant differences were found between the different treatment visits in the two study groups, and the values obtained in all visits were low. This may have been related to the high level of acceptance of audiovisual distraction obtained for both study groups. All 34 of the children in the cartoon film and PlayStation® video game groups preferred the visit in which they were distracted, and replied that they would like to continue watching cartoons or playing video games on future dental visits. Some patients attended dental visits more than 30 minutes in advance due—according to their parents—to the desire and enthusiasm they had for being able to watch the cartoon or play the video game that they had chosen while receiving dental treatment. This may have led parents, when scoring on the Modified Corah Dental Anxiety Scale, to decide to give a low score prior to the start of the control and experimental visits of each study group. The high acceptance of the different distraction methods used in this study was similar to that obtained in previous investigations [Guinot et al., 2014; Nuvvula et al., 2015; Bagattoni et al., 2018], demonstrating that state-of-the-art audiovisual products are attractive for paediatric patients.

In relation to self-reported anxiety, no significant differences were obtained between the control and experimental visits of the cartoon film and video game groups, and between the two control and experimental visits of the two study groups. These results coincide with those of similar studies [Ingersoll et al., 1984; Sullivan et al., 2000; Aitken et al., 2002; Guinot et al., 2014; Al-Khotani et al., 2016] in which the application of an audiovisual product as a method of distraction did not reduce self-reported anxiety. By contrast, our results differ from those obtained by Parkin [1981], who found a decrease in childhood anxiety through the use of music as a means of distraction. However, in the Parkin study, there were a number of significant limitations. Patients were only exposed to music for 5 minutes. Subsequently, they were evaluated by means of a silent videotape used by operators blinded to the study. These operators compared 60 seconds of music with 60 seconds of music-free treatment for each patient using an analogous visual scale. There was no control group or baseline measurements of the patients.

There are many different self-reporting scales used to measure pain intensity in children. Most commonly used are faces scales, numerical rating scales, visual analogue scales, and the Wong-Baker Faces Scale [Ram et al., 2010; Tomlinson et al., 2010; Guinot et al., 2014]. Like Attar and Baghdadi [2015], the use of a PlayStation® video game as an active distraction method resulted in a decrease in the perception of self-reported pain compared to a passive distraction method, although the records of the cartoon film group were also low.

Global behaviour, measured using the Frankl scale, showed no significant differences, although the results were more favourable for both visits in the PlayStation® group. Ram [2010] found that the global behaviour of the patients in the visits with audiovisual distraction was excellent in 70% of the cases and poor in only 5% according to the scale of Houmpt. Al-Khotani et al. [2016] found better and significant scores in the group treated with audiovisual distraction when applying the MVARS scale (Modified Venham's Clinical Ratings of Anxiety and Cooperative Behavior Scale). Attar and Baghdadi [2015] found behaviour improvement measured using the North Carolina Behaviour Rating Scale when using an iPad as an active distraction method.

Our initial values of self-reported anxiety, self-reported pain, and global behaviour indicate that our 2 groups of patients had few problems in managing behaviour during dental treatment. It is difficult to find significant differences when the values prior to the application of the audiovisual distractions are low or global behaviour is positive. The Venham Picture Test, Wong–Baker Scale, and Frankl Scale were applied after the treatment ended, so it is possible that previous experience could have influenced the anxiety and pain perception felt by children and the operators' objective vision. Alternatively, the children might have been influenced by the feeling of having completed the dental visit, having forgotten what happened when the scale was applied. In light of the foregoing, it might be advisable to apply the scales at specific times during a dental visit; for example, immediately after administration of local anaesthesia or after placement of the clamp and rubber dam, as in similar studies [Baghdadi, 2000; El-Sharkawi et al., 2012; Asvanund et al., 2015; Attar and Baghdadi, 2015; Mitrakul et al., 2015; Nuvvula et al., 2015; Al-Khotani et al., 2016; Garrocho-Rangel et al., 2018]. However, we believe that stopping the visit at intervals to apply the different scales could have altered the rhythm of the dental treatment. It was therefore decided to carry out a final evaluation of each of the scales used, as in Ghadini et al. [2018] and Shetty et al. [2019]. Each treatment session could also have been recorded and an external observer could have evaluated the overall behaviour objectively. As a consequence, the results for 3 variables (self-reported anxiety, pain measures and global behaviour) could have been more precise. However, due to limitations of time and resources, this avenue was rejected.

In the present study, heart rate was considered as an objective measure of anxiety. The physiological measurements of pulse rate and oxygen saturation of arterial haemoglobin are related to pain/anxiety perception; thus, they are considered methods for objective evaluation of behaviour in children [Porrit et al., 2013; Asvanund et al., 2015; Nuvvula et al., 2015; Garrocho-Rangel et al., 2018; Ghadini et al., 2018]. Approximately 14% of children aged 4–11 years are anxious when attending a dental clinic, and their strongest fears are associated with injections [Versloot et al., 2005]. With regard to the different times of treatment at which heart rate was recorded, the results for the two study groups agreed with those presented by other authors [Stark et al., 1989; Sullivan et al., 2000; Aitken et al., 2002; Guinot et al., 2014; Nuvvula et al., 2015]. These authors found that injection of local anaesthetic is the time at which the greatest increase in heart rate occurs, regardless of the use of different audiovisual distraction methods. Inadequate pain control could lead to a negative dental experience that might develop into dental fear and anxiety, and eventual avoidance of dental treatment in future [Versloot et al., 2005; El-Sharkawi et al., 2012; Asvanund et al., 2015]. Therefore, it is important to use specific interventions to distract children from the treatment procedures [Nuvvula et al., 2015].

The individual choice of distraction method can provide a sense of a familiar situation during dental treatment as a means of increasing the child's control over unpleasant stimuli and reducing the likelihood of uncooperative behaviour [Filcheck et al., 2004; Attar and Baghdadi, 2015]. Normally, children have no control over what occurs when they are in the dental chair; hence, having control over the music and/or film can be beneficial. Therefore, in most recent studies [El-Sharkawi et al., 2012; Guinot et al., 2014; Asvanund et al., 2015; Attar and Baghdadi, 2015; Mitrakul et al., 2015; Nuvvula et al., 2015; Al-Khotani et al., 2016; Bagattoni et al., 2018; Garrocho-Rangel et al., 2018; Shetty et al., 2019], children were able to choose their favourite cartoon or video game. The only recent study in which there was no patient choice of the audiovisual product was made by children aged 4 and 5 years [Ghadini et al., 2018].

Audiovisual methods also have some disadvantages. Children with high levels of anxiety do not respond well to this type of distraction [Dahlquist et al., 2009]. The design of video eyeglasses does not eliminate complete visual access to the surrounding environment, thus patients might not be completely distracted from the dental procedures [Al-Khotani et al., 2014; Shetty et al., 2019]. Also, some children do not know how to play Playstation® video games so they must first be instructed on how to do so.

Conclusions

The use of PlayStation® video games as an active method of audiovisual distraction improved the self-reported pain of children aged 6–8 years but did not reduce their parents' perception of patients' anxiety, pain, global behaviour, or heart rate, according to the measurement scales used, compared to a method of passive distraction (cartoon film). Injection of local anaesthetic was the time at which the greatest increase in heart rate was detected in the two study groups, in both the control and experimental visits. Both types of product (cartoons and PlayStation® video games) were widely accepted among paediatric patients. They were also easy to apply and may enhance positive attitude towards dental experiences in children.

Conflict of interest

The authors declare no conflict of interest.

References

› Aartman IH, van Everdingen T, Hoogstraten J, Schuurs AH. Self-report measurements of dental anxiety and fear in children: a critical assessment. ASDC J Dent Child 1998;65:252-8, 29-30.
› Aitken JC, Wilson S, Coury D, Moursi AM. The effect of music on pain, anxiety and behavior in pediatric dental patients. Pediatr Dent 2002;24:114–118.
› Al-Khotani A, Bello LA, Christidis N. Effects of audiovisual distraction on children's behaviour during dental treatment: a randomized controlled clinical trial. Acta Odontol Scand 2016;74(6):494-501.
› American Academy of Pediatric Dentistry Reference Manual. Behavior Guidance for the Pediatric Dental Patient. Pediatr Dent 2018;40(6):254–267.
› Asvanund Y, Mitrakul K, Juhong RO, Arunakul M. Effect of audiovisual eyeglasses during local anesthesia injections in 5- to 8-year-old children. Quintessence Int 2015;46(6):513-521.
› Attar RH, Baghdadi ZD. Comparative efficacy of active and passive distraction during restorative treatment in children using an iPad versus audiovisual eyeglasses: a randomised controlled trial. Eur Arch Paediatr Dent 2015;16:1–8.
› Bagattoni S, Piana G, Alessandro GD, Sadotti A, Alkhamis N. Effects of audiovisual distraction in children with special healthcare needs during dental restorations: a randomized crossover clinical trial. Int J Paediatr Dent 2018; 28(1):111–120.
› Baghdadi ZD. Evaluation of audio analgesia for restorative care in children treated using electronic Dental anesthesia. J Clin Pediatr Dent 2000;1:9-12.
› Boka V, Arapostathis K, Vretos N, Kotsanos N. Parental acceptance of behaviour-management techniques used in paediatric dentistry and its relation to parental dental anxiety and experience. Eur Arch Paediatr Dent 2014;15:333–339.
› Corah NL, Gale EN, Illig SJ. Assessment of a dental anxiety scale. J Am Dent Assoc 1978;97:816-819.
› Dahlquist LM, Weiss KE, Clendaniel LD. Effects of video game distraction using a virtual reality type head-mounted display helmet on cold pressor pain in children. J Pediatr Psychol 2009;34:574–584.
› El-Sharkawi HF, El-Housseiny AA, Aly AM. Effectiveness of new distraction technique on pain associated with injection of local anesthesia for children. Pediatr Dent 2012;34:142-145.
› Farrar JT, Portenoy RK, Berlin JA, Kinman JL, Strom BL. Defining the clinically important difference in pain outcome measures. Pain 2000;88:287-294.
› Filcheck HA, Allen KD, Ogren H, Darby JB, Holstein B, Hupp S. The use of choice-based distraction to decrease the distress of children at the dentist. Child Fam Behav Ther 2004;26:59–68.
› Frankl SN, Shreve FR, Fogels HR. Should the parent remain within the dental operatory? J Dent Child 1962;29:150-163.
› Garrocho-Rangel A, Ibarra-Gutiérrez E, Rosales-Bérber M, Esquivel-Hernández R, Esparza-Villalpando V, Pozos-Guillén A. A video eyeglasses/earphones system as distracting method during dental treatment in children: A crossover randomised and controlled clinical trial. Eur J Paediatr Dent 2018;19(1):74-79.
› Ghadimi S, Estaki Z, Rahbar P, Shamshiri AR. Effect of visual distraction on children's anxiety during dental treatment: a crossover randomized clinical trial. Eur Arch Paediatr Dent 2018;19(4):239-244.
› Guinot F, Yuste S, Cuadros C, Lorente A, Mercadé M. Objective and subjective measures for assessing anxiety in paediatric dental patients. Eur J Paediatr Dent 2011;12(4):239-244.
› Guinot F, Mercadé M, Cuadros C, Lorente A, Llopis J, Boj JR. Effect of audiovisual distraction on children's behaviour, anxiety and pain in the dental setting. Eur J Paediatr Dentistry 2014;15(3):297-302.
› Hoge MA, Howard MR, Wallace DP, Allen KD. Use of video eyewear to manage distress in children during restorative dental treatment. Pediatr Dent 2012;34:378-382.
› Ingersoll BD, Nash DA, Gamber C. The use of contingent audiotaped material with pediatric dental patients. J Am Dent Assoc 1984;109:717-719.
› Lacquiere DA, Courtman S. Use of the iPad in paediatric anaesthesia. Anaesthesia 2011;66:629–630.
› León JL De, Jimeno FG, Dalmau LJB. Acceptance by Spanish parents of behaviour-management techniques used in Paediatric Dentistry. Eur Arch Paediatr Dent 2010;11(4):175-178.
› McQueen A, Cress C, Tothy A. Using a tablet computer during pediatric procedures: a case series and review of ''Apps''. Pediatr Emerg Care 2012;28:712–714.
› Merdad L, El-Housseiny AA. Do children' s previous dental experience and fear affect their perceived oral health- related quality of life (OHRQoL)?. BMC Oral Health 2017;17(1):47
› Mitrakul K, Asvanund Y, Arunakul M. Effect of audiovisual eyeglasses during dental treatment in 5-8 year-old children. Eur J Paediatr Dent 2015;16(3):239–245.
› Nuvvula S, Alahari S, Kamatham R, Challa R. Effect of audiovisual distraction with 3D video glasses on dental anxiety of children experiencing administration of local analgesia: a randomised clinical trial. Eur Arch Paediatr Dent 2015;16:43–50.
› Parkin SF. The effect of ambient music upon the reactions of children undergoing dental treatment. J Dent Child 1981;48:430-436.
› Peretz B, Kharouba J, Blumer S. Pattern of Parental Acceptance of Management Techniques Used in Pediatric Dentistry. J Clin Pediatr Dent 2013;38(1):27–30.
› Porrit J, Buchanan H, Hall M, Gilchrist F, Marshman Z. Assessing children's dental anxiety: A systematic review of current measures. Community Dent Oral Epidemiol 2013;41;130-142.
› Ram D, Shapira J, Holan G, Magora F, Cohen S, Davidovich E. Audiovisual video eyeglass distraction during dental treatment in children. Quintessence Int 2010;41:673-679.
› Shapiro M, Mehmed RN, Sgan-Cohen HD, Eli I, Parush S. Behavioural and physiological effect of dental environment sensory adaptation on children's dental anxiety. Eur J Oral Sci 2007;115:470–483.
› Sharar SR, Carrougher GJ, Nakamura D, Hoffman H, Blough DK, Patterson DR. Factors influencing the efficacy of virtual reality distraction analgesia during postburn physical therapy: Preliminary results from 3 ongoing studies. Arch Phys Med Rehabil 2007;88:S43-49.
› Shetty V, Suresh LR, Hegde AM. Effect of Virtual Reality Distraction on Pain and Anxiety During Dental Treatment in 5 to 8 Year Old Children. J Clin Pediatr Dent 2019;43(2):97-102.
› Sullivan C, Schneider PE, Musselman RJ, Dummett CO Jr, Gardiner D. The effect of virtual reality during dental treatment on child anxiety and behavior. ASDC J Dent Child 2000;67(3):193-196.
› Stark LJ. Distraction: its utilization and efficacy with children undergoing dental treatment. J Appl Behav Anal 1989;3(3):297–307.
› Strøm K, Rønneberg A, Skaare AB, Espelid I, Willumsen T. Dentists' use of behavioural management techniques and their attitudes towards treating paediatric patients with dental anxiety. Eur Arch Paediatr Dent 2015;16:349–355.
› Tomlinson D, von Baeyer CL, Stinson JN, Sung L. A Systematic Review of Faces Scales for the Self-report of Pain Intensity in Children. Pediatrics 2010;126:1168-1198.
› Venham LL, Gaulin-Kremer E. A self-report measure of situational anxiety for young children. Pediatr Dent 1979;1:91-96.
› Venham LL, Goldstein M, Gaulin-Kremer E, Peteros K, Cohan J, Fairbanks J. Effectiveness of a distraction technique in managing young dental patients. Pediatr Dent 1981;3:7-11.
› Versloot J, Veerkamp JS, Hoogstraten J. Computerized anesthesia delivery system vs. traditional syringe: comparing pain and pain-related behavior in children. Eur J Oral Sci 2005;113:488–493.
› Wohlheiter KA, Dahlquist LM. Interactive versus passive distraction for acute pain management in young children: the role of selective attention and development. J Pediatr Psychol 2013;38(2):202-212.
› Wong DL, Baker CM. Pain in children: comparison of assessment scales. Pediatr Nurs 1988;14(1):9-17.