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Effectiveness of two distraction strategies in reducing preoperative anxiety in children in China: A randomized controlled trial

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ABSTRACT

Purpose: Music and animation are the most common and affordable distraction strategies to reduce preoperative anxiety in children; however, their effects are inconsistent. This study aimed to examine the effectiveness of two distraction strategies (music or animation) in reducing preoperative anxiety in children.
Design and methods: In this randomized controlled trial, 183 children who underwent surgery were divided into music, animation, and control groups using a single-blind block randomized design. Children in the control group underwent routine preoperative visits. Meanwhile, the children in the intervention groups could choose their favorite music and cartoons as intervention content. Study outcomes included anxiety levels, degree of cooperation, heart rate, and blood pressure. Data were collected before entering the operating room, entering the operating room, and before the induction of anesthesia; only the degree of cooperation was collected before the induction of anesthesia.
Results: Only animation significantly reduced preoperative anxiety in the children ($P < 0.05$) upon entering the operating room. Both music and animation reduced the level of preoperative anxiety before induction of anesthesia; however, there was no significant difference between them ($P > 0.05$). The induction compliance score was significantly lower in the music and animation groups than in the control group ($P < 0.05$). Heart rates differed significantly between the three groups from before entering the operating room to before induction of anesthesia. Children in the control group had the highest systolic blood pressure upon entering the operating room ($P < 0.05$).
Conclusions: Music and animation strategies can significantly reduce preoperative anxiety in children and improve surgical cooperation during anesthesia induction.
Trial Registration: Clinical.Trials.gov NCT05285995.

Background

Surgery, as a threatening stressor, often leads to strong psychological stress reactions in surgical patients before surgery, the most typical of which is anxiety (Takenaka & Hirose, 2020). Children are often afraid and nervous before surgery because they are separated from their parents and face the unfamiliar environment of the operating room alone (Santiago et al., 2014; Schneemilch et al., 2006). They react to this experience with behaviors typical of their age by being resistant and fearful of unfamiliar surroundings and individuals, crying, and refusing to enter the operating room(Bozkurt, 2007). According to previous studies, >60% of children experience severe anxiety during anesthesia induction (Aydin et al., 2008; Zutter & Frei, 2011). Furthermore, preoperative anxiety in children is significantly related to adverse postoperative physiological and psychological changes, such as delirium during recovery from anesthesia, postoperative pain, and sleep disturbance, and has a serious negative impact on their study and life (e.g., timidity, nocturia, among others), even for several years (Kain et al., 2004). Therefore, effective interventions to reduce preoperative anxiety in children are urgently required.

Currently, most studies have adopted different interventions to improve preoperative anxiety in children. For example, Robin (Eijlers et al., 2019) conducted a virtual reality exposure (VRE) before elective day surgery to reduce children's anxiety and pain through a randomized, single-blind trial. The results showed no differences between the VRE and control groups in self-reported anxiety, pain, emergence

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delirium, or parental anxiety. Moreover, several studies have explored the efficacy of psychological interventions in reducing preoperative anxiety in children undergoing surgery (Kumar et al., 2019; Meletti et al., 2019). Vagnoli (Vagnoli et al., 2019) adopted relaxation-guided imagery to reduce both preoperative anxiety and postoperative pain in a sample of 60 children (6–12 years old) undergoing minor surgery, and the results suggested that relaxation-guided imagery reduces preoperative anxiety and postoperative pain in children. Through toys and video games, researchers (Kumar et al., 2019) verified the effects of psychological preparation on perioperative stress, anxiety, and mood in children undergoing cardiac surgery, implying that providing video games and toys preoperatively can reduce postoperative stress and anxiety and improve mood in children. In addition, researchers have evaluated specialized games (Wang et al., 2018), interest induction (Gao et al., 2013), and child-focused and diversified nursing methods (Deng, 2016; Ding et al., 2015) to relieve preoperative anxiety in children. Although these interventions have achieved certain effects, their delivery requires specialists with particular training. In addition, they are time-consuming, labor-intensive, and have limited audiences, in particular, during the peak operation period.

Attention distraction is an emotion regulation strategy commonly used in daily life (Brans et al., 2013) that actively separates an individual's attention from negative emotions and points to neutral or positive stimuli. Music or animation are the most common and affordable distraction strategies to reduce preoperative anxiety in children (Aytekin et al., 2016); however, their effects are inconsistent. Some researchers believe active and passive music interventions can effectively reduce preoperative anxiety (Atak & Ozyazicioglu, 2021; Millett & Gooding, 2018). However, one study has shown that music interventions have no obvious effect on young children (Kuhlmann et al., 2020). Meanwhile, Chow (Chow et al., 2016) demonstrated that the effect of the combination of audio and video is better than that of music intervention. Moreover, previous studies have confirmed that when a mental image is experienced, an associated emotion connects the feeling state with the mind and body, leading to a physiological change (Beizaee et al., 2018; Jallo et al., 2014).

Therefore, this study aimed to use two distraction strategies (music or animation) in pediatric surgery patients to compare the effects of the two strategies on preoperative anxiety level, anesthesia induction cooperation, and vital signs, and to explore effective methods to improve preoperative anxiety in children.

Methods

Design and methods

This study was a single-blind, randomized controlled trial. The researchers recruited pediatric patients from a general tertiary hospital in Changsha, Hunan Province, China. All patients were screened by the researchers for eligibility and then enrolled in the study if they were eligible and their parents provided consent. This study was conducted according to the CONSORT guidelines (Schulz et al., 2010), the guidelines are seen in Supporting Information Appendix S1.

Participants

According to the data of the surgery center, the main types of surgeries performed on children are adenoidectomy, tonsillectomy, and pediatric concealed penile surgery. The literature shows that children aged 4–12 years commonly undergo tonsillectomy and adenoidectomy (Mitchell et al., 2019), and those aged 3–12 years commonly undergo concealed penile surgery (Abbas et al., 2007). Therefore, the inclusion criteria for the patients were as follows: (1) age between 3 and 12 years; (2) typical mental, psychological, and intellectual development (based on the medical history data); (3) general anesthesia surgery; and (4) the parents of the children agreed to participate in the study. The exclusion criteria were as follows: (1) children undergoing emergency surgery (2) children with unstable vital signs or critical illnesses and (3) children with visual or auditory impairment. Prior to the preoperative visit, members of the research team communicated with the parents of children who met the inclusion and exclusion criteria. They introduced the study's purpose, significance, benefits, and their rights to parents. Parents who volunteered to participate in the study were asked to sign an informed consent form.

The samples were analyzed using the PASS module of the NCSS software. We obtained the effect values $\mu1 = 33.65$, $\mu2 = 54.20$, $\sigma = 20.55$, and $\alpha = 0.05$, $\beta = 0.90$ from the related literature (Ding et al., 2015). The sample size was calculated to be 57 patients per group and was increased to 60 participants per group, allowing for dropouts and withdrawals from the study.

Randomization and blinding

The participants were divided into three groups: animation, music, and control. First, according to the 1:1:1 balance of the three groups, the statistician set the block length to three and performed a random design of the single-blind block group. Then, according to the sequence of children entering the study, each group of three children was randomly divided into three participants in each block according to the random number table.

The blind copy was kept by the unit personnel, who had nothing to do with the experiment. The statistician saved the randomization plan, and the researcher only had the number of each participant. After opening the envelope according to the number, they knew whether the participant was in the control or intervention group. Investigators involved in the intervention were not included in the study data analysis.

Intervention

Before implementing the intervention, we established an intervention team and clarified the specific division of labor among team members. The team consisted of seven members, including one pediatrician (Deputy Chief Physician), one anesthesiologist (chief physician), and five nurses (two had master's degrees, and three had bachelor's degrees). Pediatricians and anesthesiologists were responsible for the entire construction process of the intervention plan. The nurses were responsible for implementing the entire intervention and for data collection.

The animation or music library was established through a preoperative visit survey, literature review, and expert discussion, and the intervention plan of this study was then determined. The animation library included Peppa Pig, Bears, Paws, Ultraman, and Cinderella. The music library included two categories: Bandari Light Music (Snow Dreams, New Morning, Moonglow, among others) and nursery Songs (Baby Bus, Bewa Nursery Songs, among others).

Control group

In the control group, one day before surgery, nurses from the operating room conducted routine preoperative visits, communicated with the children and their families, and conducted psychological counseling. The visit lasted for nearly 30 min.

On the day of surgery, the children were admitted to a special waiting room for children 0.5 h in advance, and a circuit nurse performed venipuncture. During this period, the child was also accompanied by a parent in the waiting room to wait for surgery. Colorful cartoon patterns were depicted on the walls of the waiting room, and various toys for children were placed indoors. After entering the operating room, a parent accompanied the child into the waiting room to wait for surgery, as in the intervention group. During this period, a nurse from the research group provided routine psychological comfort and preoperative guidance and answered questions about anesthesia and

surgery raised by the children over 30–40 min. Before anesthesia induction, each child was brought into the operating room for anesthesia induction and surgery by an operating room nurse, anesthesiologist, and surgeon, while the child's parents left the waiting room and waited outside the operating room.

Intervention group

The same routine preoperative visit was conducted on the day before surgery, which lasted nearly 30 mins. On the day of surgery, the children were admitted to a special waiting room for children 0.5 h in advance, and a circuit nurse performed venipuncture. During this period, the child was accompanied by a parent in the waiting room to wait for surgery. Based on routine preoperative care in the music group, the preferred music was selected from the music library as the intervention content on the day of surgery according to the children's preference during the 1-day preoperative visit. If there was no preference, music was played randomly. During the intervention, the same multimedia audio system (Wanderer EDIFIER R1700BT) was used to play music for 30–40 min; the volume was controlled at 35–80 dB and adjusted in time according to the feedback of the children. The children in the animation group also chose their favorite cartoons as intervention content based on preoperative care. The same pad (Lenovo TB3-850F) was used to play pre-selected cartoons and volumes as the music group, which also lasted 30–40 min. During the intervention period, the children in the intervention group were accompanied by a nurse who was also responsible for implementing and maintaining the intervention program. The child's parents left the waiting room and waited outside the operating room before anesthesia induction.

Data collection

The data were collected between June and October 2019. Data collection was performed by three nursing undergraduates. The researchers assessed the children's anxiety status and recorded their heart rate and blood pressure at three-time points: before entering the operating room (baseline T0), entering the operating room (T1), and before anesthesia induction (T2). The degree of cooperation during anesthesia induction was measured only before the induction of anesthesia (T2).

Before data collection, researchers who conducted data collection were trained in the measurement tools. The training contents mainly included: (1) explaining the purpose, meaning, and scoring method of the measurement tools; (2) scoring the child's anxiety through pictures at three-time points, discussing the reasons for consistent or inconsistent results, and repeating the measurement until the coefficient of agreement, $\kappa \geq 0.8$, was obtained.

Outcome measures

At baseline, data on the participants' demographic information and clinical characteristics were collected using a demographic information sheet designed by the researchers, including age, sex, American Society of Anesthesiologists' classification of surgical risk, surgical grade, blood pressure, and heart rate.

The primary outcome was anxiety, which was measured using the Modified Yale Preoperative Anxiety Scale-Short Form (mYPAS-SF).

The secondary outcomes were the cooperation of the children during anesthesia induction and vital sign measurements. The children's cooperation during anesthesia induction was measured using the induction compliance checklist. The vital signs were the heart rate and blood pressure.

Modified yale preoperative anxiety scale-short form

The scale was developed by Kain et al. (Kain et al., 1995) in 1995 and modified to be called mYPAS in 1997 (Kain et al., 1997). It can be used to describe the anxiety state of children aged 2–12 years during the perioperative period. Moreover, it is an observational behavioral, medical scale that can be used in children undergoing surgery to assess the preoperative anxiety level at four-time points: the preoperative waiting period, entering the operating room, arriving in the operating room, and the anesthesia induction period. The mYPAS includes five parts (mental state, language, emotional expression, arousal state, and dependence on parents). Jenkins (Jenkins et al., 2014) simplified the scale in 2014, deleting the dependent part on parents, and arriving at a simplified version of the mYPAS (mYPAS-SF) with four parts and 18 items. The measurement time points were also changed from four to two: the preoperative waiting period and anesthesia induction period. Chinese scholar Dai (Dai et al., 2019) translated the mYPAS-SF into Chinese and tested the translated version's reliability and validity. The results showed that Cronbach's alpha coefficient was 0.935. The Cronbach's alpha of the Chinese version in this study was 0.877.

Induction compliance checklist (ICC)

The scale was developed by Kain (Kain et al., 1998) in 1998 to assess the degree of children's cooperation during anesthesia induction. There were 11 items in total, with scores ranging from 0 to 10 points. A score of 0 indicated that the induction was successful without any uncooperative behavior; 10 points indicated that the induction failed; that is, the child was completely passive, and the degree of cooperation was very poor. If the child had the same condition as the item on the scale, the child could obtain 1 point, and the points were added to obtain the final total score—the lower the total score, the better the cooperation. The scale has high internal consistency (0.998) and external consistency (0.987). In addition, the scale has excellent reliability ($k = 0.995–0.998$), and validity ($r = 0.978$) (Kain et al., 2007).

Vital signs

Vital signs such as heart rate and blood pressure were evaluated using the same portable electronic sphygmomanometer (OMRON HEM-7124). In addition, vital signs in the operating room were measured using the same ECG monitor (Minray BeneView T8).

Ethical considerations

The study protocol was approved by the Institutional Review Board of the hospital. Since the participants in this study were children, we obtained informed consent from their parents before conducting the study, and they had the right to withdraw from the study at any time without any implications for further care. This study was classified as a minimal risk investigation for the children participating. All participants' information was confidential to the research team and was only available to those directly involved in this study. It will be destroyed during central follow-up.

Data analysis

Data were analyzed using IBM SPSS 20.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to describe the background characteristics, including frequencies, percentages, ranges, means, and standard deviations. Repeated measures analysis of variance was used to evaluate the effect of the intervention on preoperative anxiety, degree of cooperation in anesthesia induction, heart rate, and blood pressure in children. A Mauchly spherical symmetry test was performed. If spherical symmetry was not satisfied, the degrees of freedom were corrected using the Greenhouse–Geisser for the F-boundary. Multiple

comparisons were used to compare differences between groups at different times and at each time point in the same group. Statistical significance was considered at *P*-values of <0.05 (two-tailed).

Findings

Participant characteristics

A total of 181 children were recruited. Of the 181 children, the music, animation, and control groups had 61 (33.8%), 60 (33.1%), and 60 (33.1%) children, respectively. Fig. 1 presents a flowchart of the study. The mean age of all children was 7.29 (2.195, range: 3–12) years. Males accounted for 70.5% of the music group and 71.7% of the control group. Most children were between grades 1–3. Most children in the three groups had no history of surgery (control group, 90%; music group, 78.7%; and animation group, 86.7%). There was no significant difference between the three randomization groups at the baseline assessment (Table 1). No serious intervention-related adverse events were observed during this study.

Table 1
Socio-demographic and clinical characteristics of children at baseline.

Variable	Control group ($n = 60$)		Music group ($n = 61$)		Animation group ($n = 60$)		*χ2/t-Test*	
	n/¯X	%/ SD	n/¯X	%/SD	n/¯X	%/SD	*χ2/F*	*P value*
Age(years)	7.63	2.314	6.97	2.338	7.28	1.887	1.399	0.249
Sex								
Male	43	71.7	43	70.5	46	76.7	0.657	0.720
Female	17	28.3	18	29.5	14	23.3		
Education level								
Preschool	12	20.0	19	31.1	14	23.3	2.727	0.604
Grades 1–3	35	58.3	30	49.2	36	60.0		
Grades 4–6	13	21.7	12	19.7	10	16.7		
Surgical history								
No	54	90.0	48	78.7	52	86.7	3.227	0.199
Yes	6	10.0	13	21.3	8	13.3		
Surgical level								
Level 1	0	0	0	0	0	0	0.894	0.639
Level 2	44	73.3	49	80.3	47	78.3		
Level 3	16	26.7	12	19.7	13	21.7		
Level 4	0	0	0	0	0	0		
ASA classification								
Level 1	14	23.3	14	23.0	10	16.7	2.938	0.568
Level 2	46	76.7	47	77.0	49	81.7		
Level 3	0	0	0	0	1	1.7		
Level 4	0	0	0	0	0	0		

Effects of interventions on anxiety and cooperation

The results showed that the intervention and time effects of the mYPAS-SF score were significant ($P < 0.05$) (Table 2).

The analysis of the mYPAS-SF scores of the children in each group at different time points showed significant differences ($P < 0.05$) in the three groups at T1 and T2. Pairwise comparisons showed that when entering the operating room (T1), only the mYPAS-SF score of the animation group was lower than that of the control group, and the difference between the animation group and the music group was insignificant ($P > 0.05$); before the induction of anesthesia (T2), the scores of the music group and the animation group were both lower than those of the control group; however, there was no significant difference ($P > 0.05$) between them (Table 3). The analysis of mYPAS-SF scores in each group at the three-time points showed that the scores of the three groups of children increased significantly ($P < 0.05$). The three groups had the highest mYPAS-SF score at T2, and there were differences ($P < 0.05$) among the three groups in pairwise comparisons; however, the mYPAS-SF scores of the music and the animation groups were both lower than those of the control group (Table 4).

Although the ICC scores showed significant differences ($P < 0.05$) among the groups, the animation group had the lowest score. Further pairwise comparisons showed that the ICC scores of the music and animation groups were significantly ($P < 0.05$) lower than those of the control group; however, there was no significant ($P > 0.05$) difference between the groups.

Effects of two distraction interventions on vital signs of children

The results showed that there was no significant difference among the groups on vital signs ($P > 0.05$), except for the time effect on heart rate. Furthermore, there was no significant difference ($P > 0.05$) in the other vital signs, except for the systolic blood pressure of the control group, which was significantly ($P < 0.05$) higher than that of the music group at T1 and T2. Moreover, systolic blood pressure in the control group was significantly ($P < 0.05$) different at T0 vs. T1 and at T1 vs. T2. However, there was no obvious fluctuation in systolic blood pressure between the two groups (Table 4).

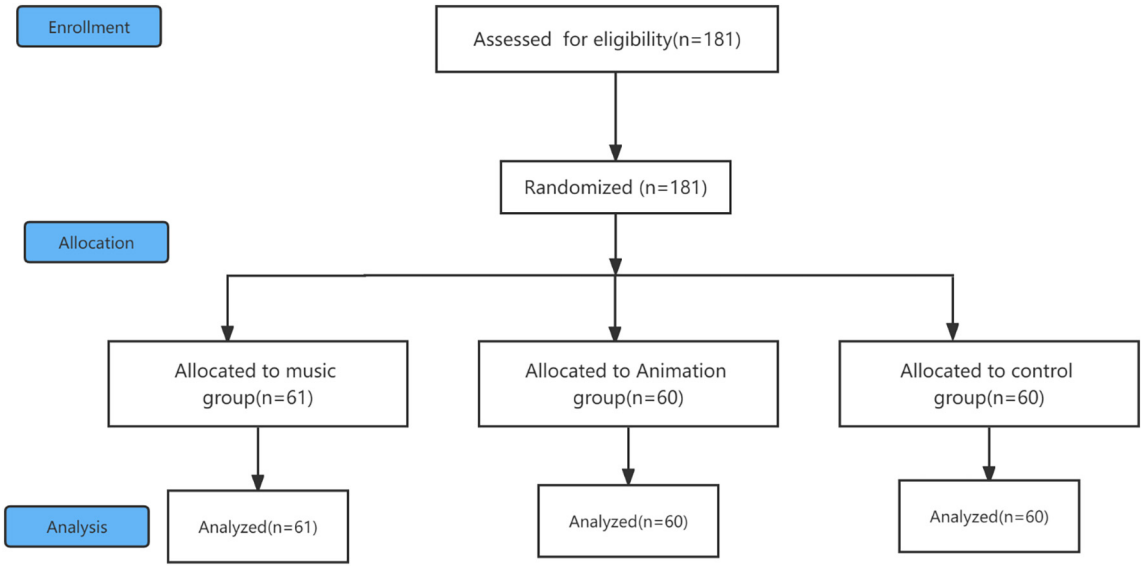

Fig. 1. Flow diagram of participants through the trial.

Table 2
Repeated measures analysis of variance for each variable ($\bar{x} \pm s$).

Variable /Time	Group			*The effect of intervention*		*The effect of time*		*The effect of interaction*	
	Control group ($n = 60$)	music group ($n = 61$)	animation group ($n = 60$)	*F*	*P*	*F*	*P*	*F*	*P*
mYPAS-SF				3.27	0.040 *	219.04	0.000 * *	2.49	0.053
T0	34.9 ± 10.3	33.2 ± 8.3	34.5 ± 8.5						
T1	48.9 ± 12.4	45.6 ± 11.0	43.3 ± 12.0						
T2	54.8 ± 12.3	49.2 ± 12.8	49.8 ± 10.1						
heart rate				0.47	0.627	3.67	0.028 *	0.20	0.932
T0	91.1 ± 12.5	92.3 ± 14.4	90.6 ± 11.6						
T1	89.5 ± 14.7	91.8 ± 12.1	88.7 ± 12.6						
T2	92.5 ± 16.6	93.2 ± 12.9	92.0 ± 14.2						
systolic blood pressure				3.21	0.043	3.18	0.053	2.24	0.078
T0	106.0 ± 12.4	104.9 ± 10.2	107.8 ± 11.4						
T1	111.7 ± 10.8	105.1 ± 9.7	108.4 ± 12.4						
T2	108.9 ± 9.5	104.9 ± 9.2	106.5 ± 13.1						
diastolic blood pressure				0.26	0.768	2.00	0.140	0.26	0.889
T0	66.0 ± 10.8	64.6 ± 12.2	66.9 ± 9.0						
T1	67.2 ± 8.5	67.5 ± 9.0	67.9 ± 11.6						
T2	65.7 ± 10.4	65.9 ± 8.7	66.3 ± 14.9						

Note: $^{*}P<0.05$, $^{**}P<0.01$.
The effect of intervention refers to that because the intervention, the variable differs between the three groups.
The effect of time refers to that the variable differs between the three groups from T0 to T2.
The effect of interaction refers to the interactions between intervention and time, it presented the variable differ in intervention effect over time.

Outcomes stratified by age

The children were divided into preschool- and school-age based on their clinical stages. The results showed that the mYPAS-SF scores of the preschool- and school-aged children were statistically ($P < 0.05$) different in terms of time effect, and there was an interaction effect of intervention and time on the mYPAS-SF scores of school-aged children (Tables 5 and 6). This indicates that the two distraction interventions can reduce the anxiety levels of preschool- and school-age children at T1 and T2. However, there was no statistical difference between both groups regarding vital signs such as heart rate and systolic blood pressure ($P > 0.05$).

Discussion

The results of the study showed that only animation intervention significantly reduced preoperative anxiety levels in children when entering the operating room. Before the induction of anesthesia, both music and animation distraction interventions reduced the level of preoperative anxiety; however, there was no significant difference between them.

Due to their young age, preschool- and school-age children cannot understand the purpose and meaning of surgery, which, coupled with unfamiliar environments, fear of pain, and separation from their families, results in varying degrees of anxiety, tension, stress, and even shock response (Sadhasivam et al., 2009). This study combined attention and distraction strategies to intervene according to the characteristics of the children during this period. A cross-sectional electronic survey aimed to evaluate media access/children's use of television, computers, mobile phones, and iPad/tablet, and observed that 57.9% of children who used new media were aged 5 years and below. The use of mobile phones, pads, computers, and TV was more common in younger children (Dinleyici et al., 2016). Therefore, the pad-based animation distraction intervention in this study was more consistent with the daily relaxation method of most children. In this study, the method of interest induction was also incorporated into the design of the intervention strategy, and the music and animation in which the children were interested were selected as the distraction strategy, which was effective and achieved good results.

Music intervention, one of the more economical and accessible non-drug interventions, has been widely used in clinical practice and is more suitable for efficient operation in the operating room. This study showed that music intervention could effectively reduce the anxiety level of

Table 3
Repeated measures analysis of variance between groups at each time point ($\bar{x} \pm s$).

Variable /Time	Control group ($n = 60$)	Music group ($n = 61$)	Animation group ($n = 60$)	*F*	*P*	*Pairwise comparison [A,B,C]*
mYPAS-SF						
T0	34.9 ± 10.3	33.2 ± 8.3	34.5 ± 8.5	0.56	0.571	0.313,0.818,0.437
T1	48.9 ± 12.4	45.6 ± 11.0	43.3 ± 12.0	3.34	0.038*	0.132,0.011*,0.288
T2	54.8 ± 12.3	49.2 ± 12.8	49.8 ± 10.1	4.09	0.018*	0.010*,0.022*,0.776
heart rate						
T0	91.1 ± 12.5	92.3 ± 14.4	90.6 ± 11.6	0.26	0.775	0.626,0.838,0.488
T1	89.5 ± 14.7	91.8 ± 12.1	88.7 ± 12.6	0.88	0.417	0.355,0.724,0.201
T2	92.5 ± 16.6	93.2 ± 12.9	92.0 ± 14.2	0.10	0.908	0.803,0.852,0.663
Systolic blood pressure						
T0	106.0 ± 12.4	104.9 ± 10.2	107.8 ± 11.4	1.00	0.371	0.618,0.374,0.165
T1	111.7 ± 10.8	105.1 ± 9.7	108.4 ± 12.4	5.44	0.005*	0.001**,0.108,0.096
T2	108.9 ± 9.5	104.9 ± 9.2	106.5 ± 13.1	2.14	0.120	0.041*,0.222,0.409
diastolic blood pressure						
T0	66.0 ± 10.8	64.6 ± 12.2	66.9 ± 9.0	0.68	0.509	0.493,0.641,0.249
T1	67.2 ± 8.5	67.5 ± 9.0	67.9 ± 11.6	0.06	0.939	0.856,0.724,0.863
T2	65.7 ± 10.4	65.9 ± 8.7	66.3 ± 14.9	0.05	0.952	0.924,0.759,0.832
ICC	1.9 ± 1.5	1.3 ± 1.6	1.3 ± 1.1	3.64	0.028*	0.023*,0.018*,0.912

Note: A: Control group vs. Music group, B: Control group vs. Animation group, C: Music group vs. Animation group; $^{*}P<0.05$, $^{**}P<0.01$.

Table 4
Repeated measures analysis of variance at different time points within each group ($\bar{x} \pm s$).

Variable /Time	Control group ($n = 60$)	Music group ($n = 61$)	Animation group ($n = 60$)
mYPAS-SF			
T0	34.9 ± 10.3	33.2 ± 8.3	34.5 ± 8.5
T1	48.9 ± 12.4	45.6 ± 11.0	43.3 ± 12.0
T2	54.8 ± 12.3	49.2 ± 12.8	49.8 ± 10.1
F	106.96	56.07	66.06
P	0.000	0.000	0.000
Pairwise comparison *[DEF]*	0.000**, 0.000**, 0.000**	0.000**, 0.000**, 0.000**	0.000**, 0.000**, 0.002**
heart rate			
T0	91.1 ± 12.5	92.3 ± 14.4	90.6 ± 11.6
T1	89.5 ± 14.7	91.8 ± 12.1	88.7 ± 12.6
T2	92.5 ± 16.6	93.2 ± 12.9	92.0 ± 14.2
F	1.70	0.36	2.11
P	0.187	0.696	0.126
Pairwise comparison [DEF]	0.281,0.403,0.089	0.743,0.649,0.342	0.237,0.412,0.039*
Systolic blood pressure			
T0	106.0 ± 12.4	104.9 ± 10.2	107.8 ± 11.4
T1	111.7 ± 10.8	105.1 ± 9.7	108.4 ± 12.4
T2	108.9 ± 9.5	104.9 ± 9.2	106.5 ± 13.1
F	6.73	0.62	0.01
P	0.005	0.541	0.964
Pairwise comparison [DEF]	0.003**,0.091,0.004**	0.742,0.479,0.224	0.926,0.991,0.829
diastolic blood pressure			
T0	66.0 ± 10.8	64.6 ± 12.2	66.9 ± 9.0
T1	67.2 ± 8.5	67.5 ± 9.0	67.9 ± 11.6
T2	65.7 ± 10.4	65.9 ± 8.7	66.3 ± 14.9
F	0.56	1.83	0.35
P	0.548	0.178	0.703
Pairwise comparison [DEF]	0.432,0.867,0.216	0.566,0.768,0.428	0.102,0.485,0.063

Note: D: T0 vs.T1 , E:T0 vs.T2 , F:T1 vs.T2 ; *$P<0.05$, **$P<0.01$.

children before anesthesia induction, which is consistent with the results of a meta-analysis (van der Heijden et al., 2015). However, this study's results were inconsistent with Li's research (Li et al., 2011), which showed that music intervention could reduce parents' anxiety but had a limited effect on children's anxiety before anesthesia induction. In this study, the two groups had the companionship of their parents during the anesthesia induction period; hence, the effect of music intervention was different. Furthermore, both distraction strategies mobilized children's positive emotions, turned individual attention to neutral or positive stimuli, and distracted attention from surgery and anesthesia to reduce psychological fear and anxiety; therefore, the difference was insignificant. However, considering the single auditory stimulus of music, the effect of animation combined with the dual sensory dimensions of image and sound was more obvious. A systematic review (Chow et al., 2016) also showed that videos, multilevel interventions, and interactive games were more effective than music therapy and web-based interventions.

The anxiety level of the children in each group changed significantly at the three-time points (T0, T1, and T2), among which the level of anxiety before induction of anesthesia increased most significantly. The reason may be that during the induction period of anesthesia, children had to face the operating room full of instruments and operating staff, and their tension increased. Studies have also shown that the induction of anesthesia is the most threatening and painful stage throughout the perioperative period (Moseley et al., 2021). However, the music and animation groups showed smaller changes in preoperative anxiety levels than the control group. After further matching the children by age stage, we observed that the two distraction interventions could reduce the anxiety level of preschool- and school-aged children when entering the operating room and before anesthesia induction.

During anesthesia induction, the ICC score also showed that the cooperation between the music and animation groups was significantly higher than that of the control group, suggesting that the use of music or animation distraction strategy can reduce surgery stimulation and anesthesia induction to put the child in a relaxed state and reduce anxiety and the stress response to anesthesia and surgery. In addition, they can also improve the degree of cooperation to anesthesia induction in children.

This study showed that the systolic blood pressure of the music group was significantly lower than that of the control group at T1 and T2, and the systolic blood pressure of the children in the control group increased significantly at the two-time points while the animation and music groups showed no significant fluctuations. Bradt (Bradt et al., 2013) conducted a systematic review of adult surgical patients and observed that music intervention could reduce preoperative anxiety levels and patients' heart rate and blood pressure fluctuations. Other authors

Table 5
Repeated measures analysis of variance for each variable in preschool age ($\bar{x} \pm s$).

Variable /Time	Group			*The effect of intervention*		*The effect of time*		*The effect of interaction*	
	Control group ($n = 11$)	Music group ($n = 19$)	Animation group ($n = 12$)	*F*	*P*	*F*	*P*	*F*	*P*
mYPAS-SF				2.57	0.090	53.39	0.000**	0.61	0.602
T0	40.5 ± 10.4	32.2 ± 9.0	35.2 ± 10.4						
T1	58.9 ± 15.3	49.1 ± 9.5	48.4 ± 13.6						
T2	61.1 ± 14.4	55.7 ± 16.1	52.3 ± 13.1						
heart rate				0.16	0.855	3.24	0.057	0.32	0.818
T0	92.6 ± 15.7	95.4 ± 14.4	93.8 ± 10.1						
T1	94.6 ± 15.4	95.8 ± 10.5	95.2 ± 15.3						
T2	101.3 ± 20.2	101.2 ± 13.4	96.4 ± 15.1						
Systolic blood pressure				0.16	0.851	1.80	0.182	1.00	0.400
T0	98.9 ± 8.3	102.0 ± 10.2	101.8 ± 11.9						
T1	106.3 ± 6.7	102.2 ± 8.7	105.2 ± 17.1						
T2	105.7 ± 9.5	101.5 ± 8.3	101.3 ± 13.6						
diastolic blood pressure				0.17	0.845	1.36	0.263	0.65	0.600
T0	60.4 ± 8.5	59.4 ± 12.2	63.6 ± 9.6						
T1	63.0 ± 7.7	64.0 ± 9.7	63.8 ± 14.8						
T2	67.7 ± 10.7	62.8 ± 8.6	63.3 ± 20.1						

Note: *$P<0.05$, **$P<0.01$.
The effect of intervention refers to that because the intervention, the variable differs between the three groups.
The effect of time refers to that the variable differs between the three groups from T0 to T2.
The effect of interaction refers to the interactions between intervention and time, it presented the variable differ in intervention effect over time.

Table 6
Repeated measures analysis of variance for each variable in school age ($\bar{x} \pm s$).

Variable /Time	Group			*The effect of intervention*		*The effect of time*		*The effect of interaction*	
	Control group ($n = 49$)	Music group ($n = 42$)	Animation group ($n = 48$)	*F*	*P*	*F*	*P*	*F*	*P*
mYPAS-SF				2.14	0.121	164.54	0.000 **	4.04	0.005**
T0	33.6 ± 9.9	33.6 ± 8.1	34.28 ± 8.02						
T1	46.6 ± 10.6	44.0 ± 11.4	42.0 ± 11.4						
T2	53.4 ± 11.5	46.2 ± 9.8	49.1 ± 9.3						
heart rate				0.07	0.930	2.40	0.093	0.68	0.605
T0	90.8 ± 11.9	90.9 ± 14.4	89.8 ± 11.9						
T1	88.4 ± 14.4	89.9 ± 12.5	87.1 ± 11.4						
T2	90.6 ± 15.3	89.6 ± 11.0	90.9 ± 14.0						
Systolic blood pressure				2.20	0.115	1.81	0.173	1.69	0.165
T0	107.5 ± 12.7	106.2 ± 10.1	109.3 ± 10.8						
T1	112.9 ± 11.2	106.4 ± 10.0	109.2 ± 11.0						
T2	109.6 ± 9.4	106.4 ± 9.3	107.8 ± 12.8						
diastolic blood pressure				0.28	0.756	2.24	0.112	0.22	0.919
T0	67.2 ± 10.9	67.0 ± 11.6	67.7 ± 8.8						
T1	68.2 ± 8.5	69.1 ± 8.4	68.9 ± 10.6						
T2	65.2 ± 10.4	67.3 ± 8.4	67.1 ± 13.5						

Note: *$P<0.05$, **$P<0.01$.
The effect of intervention refers to that because the intervention, the variable differs between the three groups.
The effect of time refers to that the variable differs between the three groups from T0 to T2.
The effect of interaction refers to the interactions between intervention and time, it presented the variable differ in intervention effect over time.

(Karakul & Bolışık, 2018) showed that music intervention could reduce postoperative pulse rate, systolic blood pressure, diastolic blood pressure, and respiratory rate in adolescent patients. The results of these previous studies are consistent with those of this study. Organ development in preschool- and school-age children is not yet complete, and their mental and cognitive developments are on-going. Moreover, children show psychological rejection when faced with unfamiliar things and environments in the operating room, and it is easy to produce emotions such as fear, anxiety, and tension, which, in turn, cause physical changes (Dwairej et al., 2020). Through beautiful melodies or vivid images, music and animation can relieve tension in children, stabilize and maintain their blood pressure and heart rate, and reduce their fluctuations in the perioperative period.

Implications for nursing practice

Music or animation distraction strategies helped reduce preoperative anxiety and improve surgical cooperation during anesthesia induction. These distraction strategies could also provide a reference for nursing managers in mainland China and other countries with similar needs who want to perform patient-centered, accessible assistance to improve children's anxiety and surgical cooperation during surgery.

Limitations

In this study, a randomized controlled trial was conducted to compare the effects of two distraction strategies (music or animation) on alleviating preoperative anxiety in children, which provides a reference strategy for similar studies. This study also has some limitations. First, although we tried to recruit children randomly and to minimize bias by using a single-blinded design, further studies, such as multi-site randomized clinical or cluster trials, are recommended. In addition, music intervention has certain requirements for environmental settings and sound equipment; if children can truly enter the musical mood during the intervention, the effect of the intervention will increase; further research should consider how to make children truly enter the musical mood and improve the effectiveness of the intervention. Finally, there were differences in the surgical categories of children included in this study, which may have biased the results. Future research should include children in the same surgical category and age group.

Conclusions

This randomized controlled study confirmed that music and animation, which are relatively economical and accessible distraction strategies, can significantly reduce preoperative anxiety in children and improve surgical cooperation during anesthesia induction. In addition, both intervention methods are easy to operate in clinical practice, and the feedback showed that animation intervention was welcomed by most children.

Author contributions

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Ethics approval

This study was approved by Institutional Review Board (IRB) of the Third Xiangya Hospital, Central South University (CSU) (Changsha, Hunan province, China) before data collection. NO:2019-S506

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pedn.2022.10.013.

References

Abbas, M., Liard, A., Elbaz, F., & Bachy, B. (2007). Outcome of surgical management of concealed penis. *Journal of Pediatric Urology*, 3(6), 490–494. https://doi.org/10.1016/j.jpurol.2007.04.006.

Atak, M., & Ozyazicioglu, N. (2021). The effect of different audio distraction methods on Children's postoperative pain and anxiety. *Journal of Perianesthesia Nursing*, *36*(1), 75–80. https://doi.org/10.1016/j.jopan.2020.06.028.

Aydin, T., Sahin, L., Algin, C., Kabay, S., Yucel, M., Hacioglu, A., ... Kilicoglu, A. (2008). Do not mask the mask: Use it as a premedicant. *Paediatric Anaesthesia*, *18*(2), 107–112. https://doi.org/10.1111/j.1460-9592.2007.02381.x.

Aytekin, A., Doru, O., & Kucukoglu, S. (2016). The effects of distraction on preoperative anxiety level in children. *Journal of Perianesthesia Nursing*, *31*(1), 56–62. https://doi.org/10.1016/j.jopan.2014.11.016.

Beizaee, Y., Rejeh, N., Heravi-Karimooi, M., Tadrisi, S. D., Griffiths, P., & Vaismoradi, M. (2018). The effect of guided imagery on anxiety, depression and vital signs in patients on hemodialysis. *Complementary Therapies in Clinical Practice*, *33*, 184–190. https://doi.org/10.1016/j.ctcp.2018.10.008.

Bozkurt, P. (2007). Premedication of the pediatric patient - anesthesia for the uncooperative child. *Current Opinion in Anaesthesiology*, *20*(3), 211–215. https://doi.org/10.1097/ACO.0b013e328105e0dd.

Bradt, J., Dileo, C., & Shim, M. (2013). Music interventions for preoperative anxiety. *Cochrane Database of Systematic Reviews*, *6*, D6908. https://doi.org/10.1002/14651858.CD006908.pub2.

Brans, K., Koval, P., Verduyn, P., Lim, Y. L., & Kuppens, P. (2013). The regulation of negative and positive affect in daily life. *Emotion.*, *13*(5), 926–939. https://doi.org/10.1037/a0032400.

Chow, C. H., Van Lieshout, R. J., Schmidt, L. A., Dobson, K. G., & Buckley, N. (2016). Systematic review: Audiovisual interventions for reducing preoperative anxiety in children undergoing elective surgery. *Journal of Pediatric Psychology*, *41*(2), 182–203. https://doi.org/10.1093/jpepsy/jsv094.

Dai, Y., Zheng, X. L., Shu, L. L., Zheng, Q. Y., Xu, X. L., & Ouyang, R. X. (2019). Study on translation of the modified Yale preoperative anxiety scale – Short form and its reliability and validity. *Nursing Research*, *33*(15), 2596–2599 (In Chinese).

Deng, K. X. (2016). Effect of funny nursing on anesthesia induction cooperation for preschool children. *The Journal of Nursing*, *31*(10), 56–58 [In Chinese].

Ding, M. S., Yu, X. Y., & Wang, D. D. (2015). The effectiveness of diversified interventions on preoperative anxiety in preschool children. *Chinese Nursing Education.*, *12*(08), 619–622 (In Chinese).

Dinleyici, M., Carman, K. B., Ozturk, E., & Sahin-Dagli, F. (2016). Media use by children, and Parents' views on Children's media usage. *Interactive Journal of Medical Research*, *5*(2), Article e18. https://doi.org/10.2196/ijmr.5668.

Dwairej, D. A., Obeidat, H. M., & Aloweidi, A. S. (2020). Video game distraction and anesthesia mask practice reduce children's preoperative anxiety: A randomized clinical trial. *Journal for Specialists in Pediatric Nursing*, *25*(1), Article e12272. https://doi.org/10.1111/jspn.12272.

Eijlers, R., Dierckx, B., Staals, L. M., Berghmans, J. M., van der Schroeff, M. P., Strabbing, E. M., ... Utens, E. M. W. J. (2019). Virtual reality exposure before elective day care surgery to reduce anxiety and pain in children: A randomised controlled trial. *European Journal of Anaesthesiology*, *36*(10), 728–737. https://doi.org/10.1097/EJA.0000000000001059.

Gao, X. L., Liu, Y., Tian, S., Zhang, D. Q., & Wu, Q. P. (2013). Effect of interested play on reducing children's preoperative anxiety. *Chinese Journal of Nursing*, *48*(01), 27–29 (In Chinese).

van der Heijden, M. J., Oliai, A. S., van Dijk, M., Jeekel, J., & Hunink, M. G. (2015). The effects of perioperative music interventions in pediatric surgery: A systematic review and Meta-analysis of randomized controlled trials. *PLoS One*, *10*(8), Article e133608. https://doi.org/10.1371/journal.pone.0133608.

Jallo, N., Ruiz, R. J., Elswick, R. J., & French, E. (2014). Guided imagery for stress and symptom management in pregnant african american women. *Evidence-based Complementary and Alternative Medicine*, *2014*, 840923. https://doi.org/10.1155/2014/840923.

Jenkins, B. N., Fortier, M. A., Kaplan, S. H., Mayes, L. C., & Kain, Z. N. (2014). Development of a short version of the modified Yale preoperative anxiety scale. *Anesthesia and Analgesia*, *119*(3), 643–650. https://doi.org/10.1213/ANE.0000000000000350.

Kain, Z. N., Caldwell-Andrews, A. A., Maranets, I., McClain, B., Gaal, D., Mayes, L. C., ... Zhang, H. (2004). Preoperative anxiety and emergence delirium and postoperative maladaptive behaviors. *Anesthesia and Analgesia*, *99*(6), 1648–1654. https://doi.org/10.1213/01.ANE.0000136471.36680.97.

Kain, Z. N., MacLaren, J., McClain, B. C., Saadat, H., Wang, S. M., Mayes, L. C., & Anderson, G. M. (2007). Effects of age and emotionality on the effectiveness of midazolam administered preoperatively to children. *Anesthesiology.*, *107*(4), 545–552.

Kain, Z. N., Mayes, L. C., Cicchetti, D. V., Bagnall, A. L., Finley, J. D., & Hofstadter, M. B. (1997). The Yale preoperative anxiety scale: How does it compare with a "gold standard"? *Anesthesia and Analgesia*, *85*(4), 783–788. https://doi.org/10.1097/01.anes.0000281895.81168.c3.

Kain, Z. N., Mayes, L. C., Cicchetti, D. V., Caramico, L. A., & Rimar, S. (1995). Measurement tool for preoperative anxiety in young children: The Yale preoperative anxiety scale. *Child Neuropsychology*, *1*(3), 203–210. https://doi.org/10.1080/09297049508400225.

Kain, Z. N., Mayes, L. C., Wang, S. M., Caramico, L. A., & Hofstadter, M. B. (1998). Parental presence during induction of anesthesia versus sedative premedication: Which intervention is more effective? *Anesthesiology.*, *89*(5), 1147–1156 9A-10A. https://doi.org/10.1097/00000542-199811000-00015.

Karakul, A., & Bolışık, Z. B. (2018). The effect of music listened to during recovery period after day surgery on anxiety state and vital signs of child and adolescent. *The Journal of Pediatric Researc.*, *5*(2). https://doi.org/10.4274/jpr.24892.

Kuhlmann, A., van Rosmalen, J., Staals, L. M., Keyzer-Dekker, C., Dogger, J., de Leeuw, T. G., ... van Dijk, M. (2020). Music interventions in pediatric surgery (the music under surgery in children study): A randomized clinical trial. *Anesthesia and Analgesia*, *130*(4), 991–1001. https://doi.org/10.1213/ANE.0000000000003983.

Kumar, A., Das, S., Chauhan, S., Kiran, U., & Satapathy, S. (2019). Perioperative anxiety and stress in children undergoing congenital cardiac surgery and their parents: Effect of brief intervention-a randomized control trial. *Journal of Cardiothoracic and Vascular Anesthesia*, *33*(5), 1244–1250. https://doi.org/10.1053/j.jvca.2018.08.187.

Li, Z. Q., Xu, Q., Zhou, T., & Wang, L. (2011). Effect of music on induction of anesthesia on parental presence. *Journal of Huazhong University of Science and Technology (Medical Edition).*, *40*(06), 750–752 (In Chinese).

Meletti, D. P., Meletti, J., Camargo, R., Silva, L. M., & Mdolo, N. (2019). Psychological preparation reduces preoperative anxiety in children. Randomized and double-blind trial. *Jornal de Pediatria*, *95*(5), 545–551. https://doi.org/10.1016/j.jped.2018.05.009.

Millett, C. R., & Gooding, L. F. (2018). Comparing active and passive distraction-based music therapy interventions on preoperative anxiety in pediatric patients and their caregivers. *Journal of Music Therapy*, *54*(4), 460–478. https://doi.org/10.1093/jmt/thx014.

Mitchell, R. B., Archer, S. M., Ishman, S. L., Rosenfeld, R. M., Coles, S., Finestone, S. A., ... Nnacheta, L. C. (2019). Clinical practice guideline: Tonsillectomy in children (update)-executive summary. *Otolaryngology and Head and Neck Surgery*, *160*(2), 187–205.

Moseley, S. L., Heine, C., Valente, T., Stone, D., Levy, D. A., Downs, J. B., ... Clemmens, C. (2021). Effects of parental presence during induction of anesthesia on operative and perioperative times in pediatric patients undergoing adenotonsillectomy. *International Journal of Pediatric Otorhinolaryngology*, *140*, Article 110515. https://doi.org/10.1016/j.ijporl.2020.110515.

Sadhasivam, S., Cohen, L. L., Szabova, A., Varughese, A., Kurth, C. D., Willging, P., ... Gunter, J. (2009). Real-time assessment of perioperative behaviors and prediction of perioperative outcomes. *Anesthesia and Analgesia*, *108*(3), 822–826. https://doi.org/10.1213/ane.0b013e318195c115.

Santiago, A. E., Issy, A. M., & Sakata, R. K. (2014). Effects of preoperative intravenous clonidine in patients undergoing cataract surgery: A double-blind, randomized trial. *Journal of Ophthalmology*, *2014*, 346549. https://doi.org/10.1155/2014/346549.

Schneemilch, C. E., Bachmann, H., Ulrich, A., Elwert, R., Halloul, Z., & Hachenberg, T. (2006). Clonidine decreases stress response in patients undergoing carotid endarterectomy under regional anesthesia: A prospective, randomized, double-blinded, placebo-controlled study. *Anesthesia and Analgesia*, *103*(2), 297–302. https://doi.org/10.1213/01.ane.0000223673.68072.42.

Schulz, K. F., Altman, D. G., & Moher, D. (2010). CONSORT 2010 statement: Updated guidelines for reporting parallel group randomized trials. *BMC Medicine*, *8*, 18. https://doi.org/10.1186/1741-7015-8-18.

Takenaka, S., & Hirose, M. (2020). Preoperative anxiety and intraoperative nociception in patients undergoing thoracic surgery. *The Journal of Surgical Research*, *249*, 13–17.

Vagnoli, L., Bettini, A., Amore, E., De Masi, S., & Messeri, A. (2019). Relaxation-guided imagery reduces perioperative anxiety and pain in children: A randomized study. *European Journal of Pediatrics*, *178*(6), 913–921. https://doi.org/10.1007/s00431-019-03376-x.

Wang, W. J., Zhou, Y. Q., He, S. B., Yang, Q. S., & Yang, Y. C. (2018). Application of specialized game intervention in perioperative nursing for preschool children patients in ophthalmology. *Chinese Journal of Nursing*, *53*(12), 1429–1433 (In Chinese).

Zutter, A., & Frei, F. J. (2011). Uncooperative children during induction of anesthesia: Theory and practice. *Anaesthesist.*, *60*(8), 743–750. https://doi.org/10.1007/s00101-011-1918-8.