

Effectiveness of Active Distraction Tools in Reducing Anxiety and Pain Perception in Preschool Children During Dental Procedures

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Abstract: ***Background:** Dental anxiety is a common barrier to effective pediatric dental care, particularly in children aged 3–5 years, who often struggle with fear and cooperation due to developmental limitations. Active distraction techniques have shown promise in improving the dental experience by redirecting attention away from fear-inducing stimuli. **AIM:** To evaluate the efficacy of thumb light and talking back cactus toy as active distraction techniques in reducing dental anxiety and pain perception in young children during local anesthetic procedures. **Materials and Methods:** A randomized clinical study was conducted on 24 children aged 3–5 years, divided into three groups: Thumb Light (Group A), Talking Back Cactus (Group B), and Control (Group C). Anxiety was assessed using the Facial Anxiety Scale and physiological changes were monitored via pulse oximeter. **RESULTS:** Both intervention groups showed significant reductions in pulse rate post-intervention (Thumb Light: 138.13 to 120.75 bpm, $p = 0.002$; Talking Back: 137.00 to 119.50 bpm, $p < 0.001$), indicating reduced anxiety levels. No significant differences were found between the intervention groups. Anxiety scores did not differ significantly among groups, suggesting a more prominent physiological rather than behavioral impact. **Conclusion:** Thumb Light and Talking Back Cactus are effective, non-pharmacological tools for reducing physiological anxiety during pediatric dental procedures. These child friendly, active distraction techniques can enhance patient cooperation and comfort, and may be valuable adjuncts in pediatric dental practice.*

Keywords: Pediatric dentistry; Dental anxiety; Active distraction techniques; Thumb light; Talking back toy; Physiological anxiety; Facial Anxiety Scale; Non-pharmacological behavior management

1. Introduction

Fear and anxiety related to dentistry affect a large percentage of young children. Dental fear and anxiety refer to the emotional distress children experience related to dental visits and treatments. Dental fear is a normal, unpleasant reaction to perceived threats during dental treatment, while dental anxiety is a more excessive and unreasonable negative emotional state about dental procedures. These terms are often used interchangeably to describe strong negative emotions in children and adolescents toward dental treatment.

Persistent dental fear and anxiety can lead to long-term consequences. Children may avoid or delay dental appointments, which increases their risk for dental caries and other oral health problems. This avoidance behavior can also extend into adulthood, fostering a lifelong aversion to dental treatment and potentially worsening oral health outcomes.

Dental fear and anxiety are two independent yet overlapping phenomena that significantly impact a child's ability to cooperate during dental procedures and can adversely affect overall oral health outcomes³. These emotional responses are particularly prevalent in younger children, who are more prone to experiencing fear and anxiety in clinical settings¹. Research indicates that approximately 61% of children exhibiting dental fear and anxiety also demonstrate behavior management issues during treatment, further complicating the delivery of effective dental care.

Treating young children aged three to five years involves special challenges: Because of their developmental stage, children in this age range frequently exhibit inadequate comprehension and cooperation skills.

Ineffective behaviour management may make dental treatments challenging or impossible due to their fear, anxiety, or uncooperative behaviour. A child's reaction to dental treatment may be influenced by the fear and actions of their parents. Behaviour during dental appointments is also influenced by the child's temperament, prior dental experiences, and parenting styles.

In pediatric dentistry, behaviour management is vital because it ensures that the child stays calm and cooperative during dental procedures, which is critical for both the child's safety and the treatment outcome. Effective behaviour management also minimises the child's fear and anxiety, which lessens the trauma of the dental procedure and promotes a favourable attitude towards future dental treatment. This positive attitude is critical for long-term oral health as it encourages frequent dental visits and cooperation with the dental treatments.

Non-pharmacological behavior management techniques are essential in pediatric dentistry to help children cope with anxiety and pain during dental procedures. Distraction techniques are particularly effective and widely used among these non pharmacological behavior management techniques. Distraction works by diverting the child's attention away from the dental procedure and towards a more engaging or pleasant stimulus. This reduces the focus on potentially unpleasant sensations, thereby lowering both anxiety and the perception of pain. The psychological basis for distraction is rooted in the understanding that pain perception has a significant cognitive component when attention is shifted away from the noxious stimulus, the perceived intensity of pain decreases.

Distraction techniques in pediatric dentistry can be broadly classified into three categories based on the level of child engagement. Active distraction involves the child's direct participation in activities such as playing video games, using

interactive toys, or engaging in guided imagery. In contrast, passive distraction requires minimal involvement, with the child simply observing or listening to stimuli like cartoons, music, or immersive experiences through virtual or augmented reality. A third category, contingent distraction, is used as a behavioral reinforcement strategy, where engaging stimuli are offered as a reward for cooperative behavior during treatment. Commonly used distraction modalities include audiovisual aids (e.g., cartoons, movies, virtual reality), music therapy, interactive mobile apps or games, guided imagery and relaxation exercises, humor, and storytelling. These techniques are safe, easy to implement, and can be tailored to suit a child's developmental stage and personal preferences, making them highly effective tools for managing anxiety in pediatric dental settings.

Thumb lights and talking back toys are innovative, active distraction tools which use effective, child-friendly active distraction tools in pediatric dentistry to manage anxiety and improve cooperation in young children during dental procedures.

Thumb lights have direct evidence supporting their use in reducing anxiety during dental procedures in young children. While talking back toys are supported by broader evidence favoring active, interactive distraction methods. Both tools help create a more positive and manageable dental experience for young patients.

This need for the study is because it addresses a critical difficulty in pediatric dentistry: managing anxiety and pain perception in young children (3–5 years old) during dental treatments. At this developmental stage, children frequently lack the cognitive maturity to comprehend dental treatments, resulting in fear and anxiety, resistance towards dental treatment. For safe, effective treatment and to promote long-term, favourable attitudes towards dental care, effective distraction techniques are essential.

Despite the growing use of distraction techniques, there is limited research regarding the effectiveness and patient acceptance of specific active distractions in young children during dental procedures. This can help identify the most effective distraction strategies for this preoperational stage, which is child friendly that improve cooperation and better dental outcomes in early childhood.

This study intends to highlight how child-centered, interactive distraction devices, such as talking back toys and thumb lights, may revolutionise childhood dental treatment by improving cooperation, lowering anxiety, and reducing pain perception.

2. Methodology

Samples were collected according to inclusion criteria from the outpatient Department of Pedodontics and Preventive Dentistry. Parents were informed about the study and written consent was obtained from them. Children was categorized according to the facial anxiety scale. Pulse rate of the child was checked before the intervention using a pulse oximeter. The selected children were divided into 3 groups– The thumb light group, Talking back cactus group and the control group.

GROUP A (Thumblight group) - The thumb light device is worn on the thumb of the operator which could be activated accordingly. In thumblight group, A thumb sleeve or acrylic device with an embedded LED light activated by pressure or manual control. The light appears and disappears magically through operator manipulation by releasing pressure on hidden battery contacts. Light is intermittently activated during local anesthesia administration to distract the child

GROUP B (Talking back cactus group) - The toy is displayed in front of the child patient during the treatment procedure. In talking back cactus group, Soft plush cactus with embedded electronics. This records and repeats speech in a humorous tone and moves side-to-side through an internal pulley/belt mechanism. The toy is positioned within the child's direct line of sight and activated intermittently during dental procedures. Child talks to the toy, triggering voice playback and dancing movements and lights maintain continuous engagement.

GROUP C (Control group without any distraction) - Pulse rate of the child was checked again during the treatment while the child is being distracted using the techniques. All the readings was noted and entered in the excel spreadsheet. Data was collected and statistically analyzed.

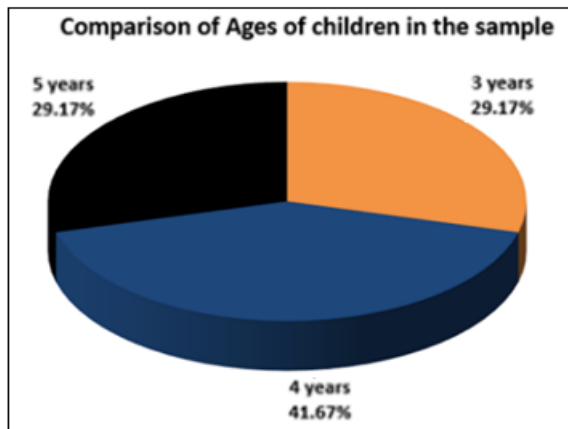


3. Results

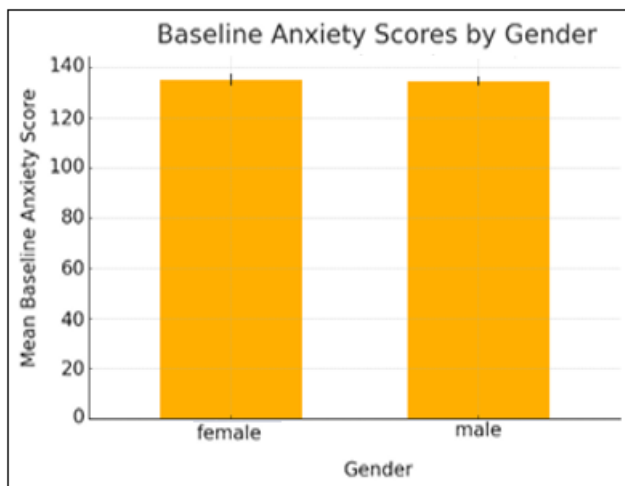
At baseline, Age distribution was also assessed using the chi-square test. The children were distributed as follows: 3 years (29.2%), 4 years (41.7%), and 5 years (29.2%), with no significant difference in age distribution among the groups ($\chi^2 = 1.371$, $p = 0.849$). This homogeneity further strengthens the study's internal validity by ensuring that age-related factors did not confound the results.



This suggests that at baseline, anxiety levels did not differ by gender. (Bar graph shows nearly identical mean baseline anxiety scores for females and males, each around 135–136)



Comparison of anxiety levels using pretreatment pulse rates between groups:



Group	Number	Mean	SD
Thumb Light	8	138.13	6.198
Talking Back	8	137.00	7.856
Control	8	134.63	7.190

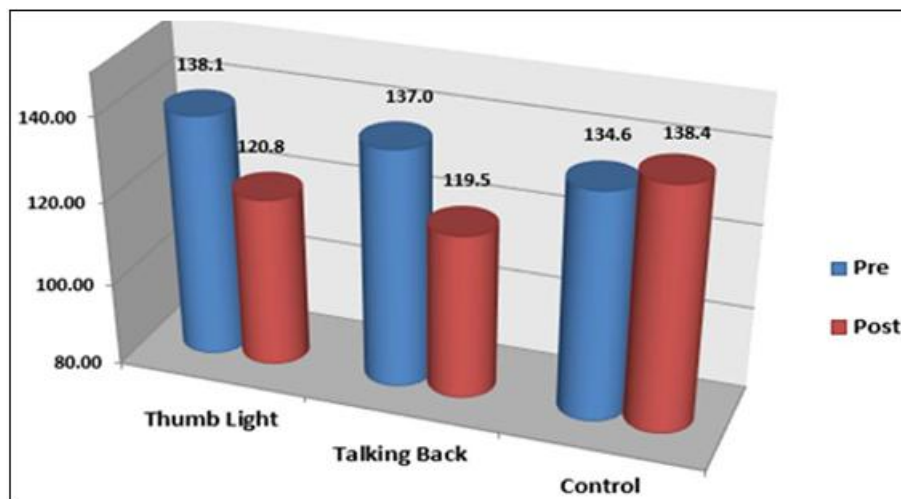
This table depicts the baseline mean pulse rates among the three groups: Thumb Light (138.13 bpm, SD = 6.20), Talking Back (137.00 bpm, SD = 7.86), and Control (134.63 bpm, SD = 7.19).

Comparison of anxiety levels using pulse rates During the Procedure Between Groups:

Group	Number	Mean	SD
Thumb Light	8	120.75	9.377
Talking Back	8	119.50	6.302
Control	8	138.38	12.118

The mean pulse rates observed after the intervention were: Thumb Light (120.75 bpm, SD = 9.38), Talking Back (119.50 bpm, SD = 6.30), and Control (138.38 bpm, SD = 12.12). ANOVA revealed a highly significant difference ($F = 9.74$, $p = 0.001$), indicating that the intervention groups experienced a marked reduction in physiological arousal compared to the control group.

Comparison of anxiety levels between three groups (Pretreatment vs Posttreatment pulse rates):



In the Thumb Light group, pulse rates decreased significantly from 138.13 bpm before the procedure to 120.75 bpm during the procedure ($t = 4.66$, $df = 7$, $p = 0.002$). Similarly, the Talking Back group saw a significant reduction from 137.00 bpm to 119.50 bpm ($t = 6.436$, $df = 7$, $p < 0.001$). But in contrast, the Control group showed no significant change, with pulse rates increasing slightly from 134.63 bpm to

138.38 bpm ($t = 1.301$, $df = 7$, $p = 0.235$). These results demonstrate the physiological benefit of distraction techniques in managing procedural anxiety.

4. Discussion

Dental fear and anxiety (DFA) in children range from mild uneasiness to severe phobia, often expressed as crying, resistance, or physical distress. Fear is an immediate reaction to a perceived threat, anxiety is anticipatory, and phobia represents irrational avoidance. DFA develops from painful dental experiences (conditioning), observing anxious parents, or a lack of coping skills. Preschoolers (3–5 years), with limited reasoning and strong imaginations, are especially vulnerable. Bright lights, loud instruments, and unfamiliar settings can trigger distress. However, their natural responsiveness to play and distraction makes them ideal candidates for non-pharmacological behavior management.

Distraction as Behavior Management Distraction shifts attention away from dental procedures toward engaging, non-threatening activities. It can be passive (stories, cartoons, music) or active (toys, games). For preschool children, distraction doubles as desensitization, gradually familiarizing them with the environment while easing fear. Toys like Thumb Light (visual–tactile stimulation) and Talking Back Cactus (interactive humor and voice mimicry) work particularly well, harnessing children’s imagination and playfulness to reduce anxiety.

Study Findings In our study of 3–5-year-olds, baseline anxiety was high, especially among 4-year-olds, who are aware enough to anticipate discomfort but lack coping strategies. Separation anxiety and egocentric thinking (perceiving treatment as punishment) further worsened distress. Gender did not significantly affect DFA, as both boys and girls showed nearly identical anxiety scores, confirming that temperament and prior experience play a larger role.

Physiological indices supported the effectiveness of distraction.

Thumb Light group: pulse rate dropped from 138.13 to 120.75 bpm ($p = 0.002$).

Talking Back Cactus group: pulse rate decreased from 137.0 to 119.5 bpm ($p < 0.001$).

Control group: significantly higher anxiety; both distraction groups showed lower pulse rates ($p = 0.001$). No significant difference was found between the two distraction tools, confirming both as equally effective.

Psychological and Developmental Basis Distraction works through established theories:

- **Cognitive Behavioral Theory (Piaget):** redirecting attention disrupts anxious thoughts, supporting emotional regulation.
- **Classical Conditioning:** pairing dental treatment with enjoyable stimuli builds positive associations.
- **Social Learning Theory:** children model calm behavior when they see peers/caregivers engaging with the tools.
- **Language & Social Interaction Theory:** interactive toys like Talking Back Cactus create companionship and trust.
- **Play Theory:** play helps children process stressful experiences, transforming treatment into a tolerable activity.

- **Attention & Engagement Theory:** toys capture limited cognitive capacity, leaving fewer resources for fear.

Both Thumb Light and Talking Back Cactus proved highly effective in reducing dental anxiety in preschoolers undergoing procedures with local anesthesia. By blending play, sensory engagement, and interaction, these tools not only lowered physiological stress but also fostered cooperation and positive dental experiences.

The limitations of this study highlights significant concern, the novelty effect which is the initial excitement caused by the Thumb Light or Talking Back Cactus may only provide short-term distraction. As noted, this effect could diminish over time, particularly in repeated dental visits or among older children who may quickly lose interest or view such tools as overly childish. Nonetheless, individual differences in temperament and personal preferences also play a role, not all children may find these techniques engaging or calming, especially those with heightened baseline anxiety or specific sensory sensitivities. Although these methods seem especially effective for preschool-aged children, their age-specific appeal may limit their application in older age groups. Furthermore, for some children, particularly those more prone to sensory overload, such interactive distractions could potentially cause overstimulation, inadvertently increasing anxiety rather than reducing it. There is also a risk of measurement bias, as the study predominantly relies on subjective measures such as observer ratings and self-reports, which may be influenced by observer expectations or children’s desire to please adults. Moreover, while the study captures immediate physiological and behavioral responses, it does not address whether these distraction techniques have any lasting impact on long-term dental anxiety or cooperative behavior in future visits. Finally, the findings may be influenced by contextual factors such as the specific clinical or cultural setting in which the research was conducted, which could affect the broader generalizability of the results across different populations or dental environments.

The scope of this clinical study reveals that the use of distraction tools such as the Thumb Light and Talking Back Cactus during the administration of local anesthesia offers a promising, child-centered approach to managing dental anxiety in young patients. These tools are particularly effective for preschool-aged children as they align with their developmental stage, where imaginative play holds more sway than rational explanation. By creating a playful and “magical” atmosphere, such distractions successfully shift the child’s focus away from the procedure, reducing fear and fostering a sense of comfort. This not only eases anxiety but also enhances cooperation, helping to build trust between the child and the dental practitioner. Moreover, these interventions are practical, they are low-cost, non-invasive, and easy to integrate into routine dental practice. Beyond their immediate calming effect, the findings suggest potential for wider application in other medical contexts and across different age groups. Additionally, this approach supports the development of more standardized methods for evaluating pediatric patient cooperation, emotional response, and overall treatment experience, paving the way for more empathetic and effective care in pediatric dentistry.

5. Conclusion

The present study demonstrated that both Thumb Light and Talking Back Cactus are highly effective distraction techniques for reducing anxiety in children aged 3 to 5 years undergoing dental procedures. This effectiveness is based by a significant reduction in pulse rates during the procedure in both intervention groups, as compared to the control group, while initial pulse rates were comparable across all groups. Pairwise comparisons confirmed that both Thumb Light and Talking Back Cactus significantly lowered physiological signs of anxiety, with no significant difference between the two techniques, indicating that both are equally beneficial. The promising results of this study opens scope for broader implementation of such non-pharmacological, child-friendly distraction techniques in dental and other medical settings. Future research with larger sample sizes, diverse age groups, and varied clinical procedures can further validate these findings. Furthermore, exploring the integration of these techniques with other behavioral management strategies may enhance overall patient cooperation and comfort. Ultimately, the widespread adoption of engaging, interactive distraction tools like Thumb Light and Talking Back Cactus has the potential to transform the pediatric dental experience, making it less stressful and more positive for young children.

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