Case Study: Videogame Distraction Reduces Behavioral Distress in a Preschool-Aged Child Undergoing Repeated Burn Dressing Changes: A Single-Subject Design

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Objective This single-subject design study evaluated the feasibility and efficacy of passive and interactive videogame distraction on behavioral distress for a preschool-aged child receiving repeated burn dressing changes. **Method** A 4-year-old girl underwent 3 baseline and 10 videogame distraction sessions (5 passive and 5 interactive) using a restricted alternating treatments design. Observed behavioral distress was coded, and parents and nurses rated the child's distress and cooperative behavior. **Results** Relative to baseline, behavioral distress decreased and cooperative behavior increased immediately after the onset of videogame distraction. Single Case Randomization Tests revealed significantly lower behavioral distress and greater cooperation during interactive videogame distraction relative to passive videogame distraction. **Conclusions** Interactive videogame distraction appears to be a feasible and effective pain management strategy for a preschool-aged child undergoing repeated painful medical procedures.

Key words acute pain; burn treatment; distraction; single-subject design study; young children.

Children aged <5 years have the greatest risk of sustaining burn injuries and are twice as likely to die from their injuries as are older children (American Burn Association, 2011). Younger patients with burn injuries often require extensive hospitalization (average length of stay up to 67 days) (American Burn Association, 2011), and are at increased risk of developing post-traumatic stress symptoms and psychosocial difficulties (Tarnowski & Brown, 2010). Although younger children are at increased risk for burn injuries, effective pain management treatments for this age group have not been extensively studied. This case report illustrates the feasibility and efficacy of an empirically supported intervention specifically tailored to address the challenges of behavioral distress that younger children often exhibit during burn treatment.

Children with burn injuries are considered one of the most difficult medical populations to treat owing to the extreme pain and behavioral distress they experience during burn treatment (Foertsch, O'Hara, Stoddard, & Kealey, 1998). The intensity of pain and distress experienced during treatment is closely tied to the severity of the injury, including the total body surface area (TBSA) affected and burn type (degree/depth). Moreover, burn injuries can result in changes in children's anatomy, neurophysiology, and pharmacokinetics that may make standard analgesic treatment less effective than usual (Sharar et al., 2008). Children describe dressing changes and debridement as the most painful components of treatment and typically display the greatest behavioral distress during debridement (Landolt, Marti, Widmer, & Meuli, 2002).

Children aged <5 years typically exhibit more procedural pain and distress than older children (Carlson, Broome, & Vessey, 2000), which may be linked to their level of cognitive development. Younger children often have difficulty verbally expressing their thoughts and feelings and instead exhibit greater anticipatory anxiety

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and pain (Lander & Fowler-Kerry, 1991). Additionally, they have fewer cognitive coping strategies and often do not fully develop adaptive pain coping strategies until later childhood (Brown, O'Keeffe, Sanders, & Baker, 1986). As such, younger children may be more likely to experience distress during painful procedures and to engage in uncooperative, non-compliant behaviors (e.g., verbal refusal, flailing), which can result in disruption in medical care, and consequently, prolonged healing, extended hospitalization, and increased risk of infection and post-traumatic stress symptoms. Adequate pain control has been identified as an integral factor in improving long-term burn outcomes, but remains difficult to achieve, especially with younger children.

Distraction has been shown to effectively reduce procedural pain and distress in children, and it is also particularly well suited to the cognitive abilities of younger children (Uman, Chambers, McGrath, & Kisely, 2008). According to the cognitive-affective model of pain (Eccleston & Crombez, 1999), attention directed toward pain may be disrupted by distraction tasks that place additional demands on the central attentional system, which involves a voluntary redirection of attention to primary goals rather than pain (Legrain et al., 2009). It has been argued that interactive distraction tasks that require an effortful direction of attention should be more effective in competing with pain than passive tasks (e.g., repetitive, routine tasks) that demand less cognitive resources (Law et al., 2011).

Studies specifically examining interventions for preschool-aged children undergoing burn treatment are limited; the few available studies present mixed findings and provide little to no guidance regarding specific treatment components (e.g., distraction, relaxing breathing, imagery, reward) that may result in optimal pain management (e.g., Landolt et al., 2002; Elliott & Olson, 1983). Interactive technology-based distraction, such as virtual reality-enhanced videogame play, has been examined during burn treatment with notable positive benefits, but its use primarily has been evaluated with adolescents (e.g., Hoffman, Doctor, Patterson, Carrougher, & Furness III, 2000), and the few studies on school-aged children rarely include children younger than 5 or 6 years (Das, Grimmer, Sparnon, McRae, & Thomas, 2005; Chan, Chung, Wong, Lien, & Yang, 2007).

However, a recently developed multi-modal distraction device (i.e., customized handheld interactive device that provides games and stories) has demonstrated significant reductions in self-reported pain, behavioral distress, and length of dressing changes in 80 children who are 3–10 years old (Miller, Rodger, Kipping, & Kimble, 2011). Despite the promising findings, the average age of the sample was ~6 years, and it is unclear how many of these children were preschool aged (3–5 years). Additionally, the average TBSA was small (~3%), and distraction only was administered during one to three dressing changes in an outpatient setting. Children who sustain burn injuries affecting a larger TBSA often undergo one or two dressing changes daily for up to several weeks. Therefore, the sustainability of distraction across repeated burn dressing changes in younger children has yet to be adequately addressed.

Laboratory studies of elementary school children experiencing cold pressor pain have consistently demonstrated greater improvements in pain tolerance when children interact with a videogame (i.e., manually or verbally) compared with merely watching the videogame output (Dahlquist et al., 2007; Law et al., 2011). To our knowledge, there have been only two studies of videogame distraction for preschoolers (Weiss, Dahlquist, & Wohlheiter, 2011; Wohlheiter & Dahlquist, 2012). Both studies demonstrated improvements in cold pressor pain tolerance during videogame distraction, but only Wohlheiter & Dahlquist demonstrated a superior effect for interactive videogame distraction in children as young as 3 years old. It is not known whether similar findings would be obtained in a clinical setting.

Although younger children are at increased risk of sustaining burn injuries and managing their procedural pain is challenging, the type of distraction that is most beneficial for them and the sustainability of treatment effects over repeated procedures remains unclear. A single-subject design study was determined to be appropriate to help fill this gap, as it allows researchers to highlight novel approaches for clinical populations in medical settings and allows opportunities to tailor interventions to match the child's developmental needs. The aims of this case report were twofold: (1) to evaluate the feasibility and efficacy of videogame distraction for a preschool-aged child undergoing repeated burn dressing changes, and (2) to examine the differential effects of passive and interactive videogame distraction on the child's behavioral distress and cooperation during dressing changes. By using an alternating treatments single-subject design and Single Case Randomization Tests (SCRT) (Onghena & Edgington, 2005) to evaluate the differential effects of each treatment, this study has promise to identify the type of videogame distraction that may best meet the needs of younger children with burn injury while also fulfilling a need for more effective pain management in a challenging population.

We predicted that the child would exhibit less behavioral distress and better cooperation during both passive

and interactive videogame distraction in comparison with standard care, with even greater improvements in distress and cooperation during interactive distraction relative to passive distraction. We further expected that the child would remain engaged with the distractor for a greater proportion of the painful procedure during interactive distraction compared to passive distraction. Lastly, we expected that the time required to conduct the dressing change would decrease during both passive and interactive videogame distraction relative to standard care, with the greatest reductions expected during interactive videogame distraction.

Methods

Participant

A 4-year-old biracial girl sustained second- and third-degree burns to her shoulders, neck, chest, bilateral forearms, and left thigh (TBSA 20%) from an accidental scald injury. She received inpatient burn treatment in a 102-bed pediatric and rehabilitation hospital and was scheduled to receive at least 13 dressing changes. She had no injuries to the face or any motor, vision, or hearing problems that would interfere with her ability to use the videogame.

Design

A restricted alternating treatments design was implemented to compare interactive versus passive videogame distraction. This design sets an upper limit on the number of times a treatment is administered consecutively to minimize potential order effects (Barlow & Herson, 1984). The two treatments were alternated semi-randomly, with an upper limit of two consecutive administrations of the same distraction treatment (Onghena & Edgington, 2005). In this procedure, the number of treatment conditions equivalent to the number of measurement times for each condition (i.e., five passive distractions and five interactive distractions) were randomly sampled without replacement. If the upper limit of two consecutive treatment conditions was obtained, that treatment condition was provisionally withdrawn, and the alternative treatment condition was assigned.

The participant received standard medical care (i.e., care that is typically provided at the medical facility to manage distress during burn dressing changes) during three baseline observations followed by five administrations of each distraction treatment. Although a stable baseline is not required in an alternating treatments design, at least three baseline observations were included to establish a trend in behavior (Barlow & Herson, 1973). The two distraction treatments used the same videogame segment and audio-visual display. During interactive distraction, she played a 40-min videogame with a wireless handheld controller. During passive distraction, she watched pre-recorded audio-video videogame footage that had been previously generated by someone else playing the same videogame segment used in the interactive distraction condition. For both treatments, the videogame began at the same starting point to ensure visual and auditory stimuli were nearly identical. Aside from subtle differences that may have occurred while playing the game, only the child's level of interaction with the game varied between treatments.

Equipments

The Nintendo Wii (Redmond, WA) and a wireless handheld controller were used to present the *Go Diego Go! Safari Rescue* videogame. This was the first Nintendo Wii videogame designed for 3- to 6-year-old children, requiring use of only one button on the controller. A Panasonic PV-GS31 digital camcorder videotaped the child during dressing changes to facilitate the coding of behavioral distress and engagement with the videogame.

Measures

Observation Scale of Behavioral Distress

The Observation Scale of Behavioral Distress (OSBD) (Jay, Ozolins, Elliott, & Caldwell, 1983) is a well-established behavioral observation scale for assessing distress in children. It consists of verbal, vocal, and motor behaviors indicative of distress in children coded in 15-s continuous intervals and yields weighted means per interval, which controls for differences in procedure duration. The OSBD distress score represented behavioral distress during the entire procedure (i.e., from the nurse's first touch to the nurse's last touch).

Parent and Nurse Report of Child Distress and Cooperation

A 100-mm visual analog scale assessed parent (mother) and nurse's ratings of the child's procedural distress and cooperation. Procedural distress was anchored by ''Not at all anxious or upset'' (0) and ''Extremely anxious or upset'' (100). Cooperation was anchored by ''Not cooperative at all'' (0) and ''Most cooperative possible'' (100).

Procedure Duration and Engagement With the Distractor

The duration of the dressing change was recorded in seconds. Videotapes were coded to quantify how long the child attended to the distractor, using methods adapted

from Dahlquist and colleagues (2002). Engagement with the distractor was defined as the child manipulating the controller and/or looking at the television for at least 5 consecutive seconds. The entire dressing change was continuously coded to compute the total proportion of time the child engaged with the distractor.

Qualitative Post-Intervention Interview
The child, parents, and nurses were asked to rate the helpfulness of the videogame distraction, how much the child enjoyed playing the videogame, and whether they would recommend the intervention to other children to evaluate the social validity of the intervention (Rapoff, 2010). Additionally, nurses were asked whether the distraction tasks interfered with nurse–child communication or completing the procedure.

Procedure

This study was approved by the University Institutional Review Board. Within 24 hr after hospital admission, the family was introduced to the study, and informed consent from parents and verbal child assent were obtained. All dressing change procedures (i.e., dressing removal and application) were performed in the same treatment room. Distraction began 2 min before the onset of dressing removal and continued through dressing removal. Standard care was provided during hydrotherapy owing to the risk of using electrical equipment near water. After hydrotherapy, distraction resumed 2 min before the onset of dressing application and continued until 2 min after dressing change completion.

Parents and nurses who were present during the dressing change completed ratings of the child's distress and cooperation after each procedure. The nurse also indicated whether any medication was provided before and during the procedure. After each baseline and intervention session, the child received a sticker and specific verbal praise for a desired behavior exhibited during the procedure and a handheld distraction toy and movie valued at ~$25 at the end of the study.

Baseline
Filming began when the child entered the treatment room and ended 2 min after the dressing change was complete. Standard medical care at this facility typically included non-procedural talk and access to toys (e.g., bubbles, stuffed animals, etc.) provided by a psychologist or child life specialist. The child primarily engaged in non-procedural talk with the therapist (i.e., pediatric psychologist or graduate-level research assistant in pediatric psychology), and although toys were available, she did not engage with them.

Interactive Distraction Intervention
Before the first interactive session, the child was instructed in how to play the videogame for ~5 min until she could reliably manipulate the videogame. A simple explanation of how playing the videogame will help her hurt less was provided. She started playing the videogame 2 min before the beginning of the dressing change, and the therapist directed and praised her attention to the distractor. If the dressing change exceeded 40 min, the videogame segment was restarted. After the dressing change was complete, the child's attention was directed to the distractor for an additional 2 min.

Passive Distraction Intervention
The passive distraction sessions followed the same procedure as the interactive sessions with a few exceptions. Before the first passive session, the child watched pre-recorded audio-video videogame footage of the same videogame segment presented in the interactive distraction condition for ~5 min. In subsequent sessions, she started watching the videogame footage 2 min before the beginning of the dressing change, with therapist direction and praise for attending to the distractor. All other aspects of the intervention were identical to the interactive sessions.

Post-Intervention
The qualitative interview was completed after the last treatment session. Treatment response was reviewed with medical staff and parents to promote continued use of the most effective intervention during future procedures, if needed.

Videotape Coding
Each dressing change was transcribed and coded for behavioral distress and engagement in distraction. Baseline sessions were coded and evaluated to ensure stability before proceeding with the intervention phase. Raters were graduate and undergraduate research assistants in pediatric psychology trained to a minimum criterion of .90 agreement and Kappa coefficient of .70 on practice videos of children with cancer undergoing invasive medical procedures. They remained naïve to hypotheses and unaware of the child's baseline distress scores to minimize coder bias. About 30% of all videotaped sessions were independently coded by another rater to ensure inter-rater reliability. Raters achieved Kappa coefficients $>.80$ and percent agreement $>90\%$.

Data Analysis Plan

Visual Analysis

Per Cooper and colleagues' (2007) recommendations, behavioral distress (OSBD scores) and parent- and nurse-reported child distress, and child cooperation scores were graphically displayed for visual inspection. The effect of intervention was evaluated by the change in level (i.e., discontinuity of behavior from the end of one phase to the beginning of the next phase) and change in trend (i.e., overall direction or slope) exhibited by the data path from the baseline to intervention phase. It was expected that the level of OSBD scores would shift down following the onset of the intervention, and a change from the baseline trend would occur once the intervention was introduced. Because the severity of the burn injury can influence the rate of natural healing, the child's second- and third-degree burns were expected to increase pain sensations during baseline, as the damaged nerve endings regenerated. Therefore, an increasing baseline trend was expected to change to a decreasing intervention trend.

A decreasing trend for both passive and interactive distraction was expected as the child progressively healed over time (with complete healing spanning the course of at least 3 weeks to several months). However, a clear divergence between the two treatments was expected such that the interactive distraction would exhibit even lower levels of distress relative to passive distraction (e.g., two parallel lines with a negative slope). If lines overlapped, visual inspection was coupled with the following statistical procedures to test the effects of treatments.

SCRTs

The respective mean scores during passive distraction and interactive distraction were calculated for OSBD scores and collateral reports of child distress and cooperation to compute the mean difference scores (M_{diff}) between the passive and interactive conditions. The SCRT computer program was used to determine whether M_{diff} scores were statistically significant. It is designed to conduct randomization tests for alternation designs by computing the probability of the mean difference score based on all possible randomization sequences while also accounting for the restricted randomization (Onghena & Edgington, 2005). The SCRT software has been successfully used to examine treatment effects within an alternating treatments design (e.g., Battles & Wiener, 2002).

Results

The participant received and was observed for a total of 13 dressing changes during admission (one dressing change per day). Consistent with standard care, she routinely received analgesic medication (oxycodone) at least 30 min before the dressing change. She also received an antihistamine for itching 3 hr before the dressing change on observation 11, resulting in increased levels of fatigue and irritability.

Visual Analysis of the Effect of Videogame Distraction Intervention

OSBD distress scores demonstrated the expected change in level and trend from the baseline to the intervention phase. Distress scores immediately decreased from 5.30 during the baseline phase to 2.92 (45% decrease) following the onset of the intervention (Figure 1). The slope of OSBD scores changed from an increasing trend during baseline to a decreasing trend during the intervention phase. The slight increase in her procedural distress score at observation 11 was likely related to side effects of antihistamine use (e.g., fatigue and irritability) (Figure 1).

Parent report of the child's distress did not exhibit the expected change in level from the baseline to the intervention phase (7% increase) following onset of intervention (Figure 2). In contrast, nurse report of the child's distress demonstrated the expected change in level (16.5% decrease) after the first intervention session. For parent- and nurse-report, distress scores changed from an increasing trend during baseline to an overall decreasing trend during the intervention phase. However, an increase in child distress was reported during observation 11.

Lastly, the child's cooperation per parent report did not display the expected change in level from baseline to intervention (12% decrease) following the first intervention. However, nurse report of the child's cooperation exhibited the expected change in level (39% increase) after the first intervention. Parent report of the child's cooperation exhibited the expected change in trend (decreasing baseline trend to increasing intervention trend), with the exception of the considerable drop in her cooperation during observation 11 (Figure 3). Nurse report of the child's cooperation also demonstrated the expected change in trend for the interactive distraction but exhibited a decreasing trend during passive distraction (Figure 3).

Differential Effect of Passive and Interactive Distraction

Randomization tests revealed significantly lower OSBD scores during the interactive distraction ($M = 0.58$) relative to passive distraction ($M = 1.68$) ($M_{diff} = 1.10$, $p < .05$) (Figure 1). Parent and nurse reports of the child's distress during the interactive distraction ($M = 19$ and 22, respectively) were significantly lower than distress ratings

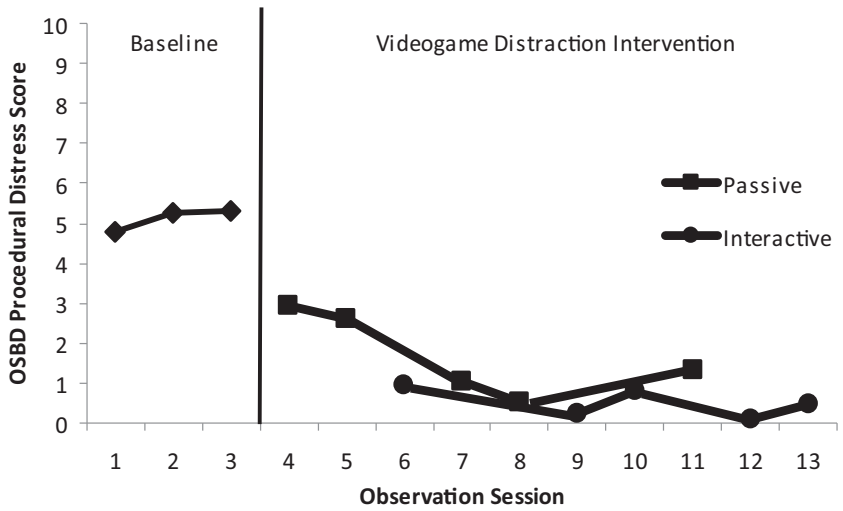

Figure 1. OSBD Procedural Distress Scores during baseline, passive distraction, and interactive distraction across sessions.

during passive distraction ($M = 61.8$ and 67.4; $M_{diff} = 42.8$ and 45.4, $ps < .05$) (Figure 2). Similarly, parents and nurses reported significantly higher levels of cooperation during interactive distraction ($M = 94.6$ and 81.2) relative to passive distraction ($M = 58.6$ and 57.6; $M_{diff} = -36.0$ and -23.6, $ps = .01$) (Figure 3).

The child engaged with the distractor for a significantly greater proportion of time during interactive distraction ($M = .76$) relative to passive distraction ($M = .36$; $M_{diff} = -0.40$, $p = .01$) (Figure 4). Lastly, the average time (in mins) required to complete the procedure was significantly less during interactive distraction ($M = 34.6$) relative to passive distraction ($M = 49.4$; $M_{diff} = 14.8$, $p < .05$); procedure duration during both treatments was shorter compared with baseline ($M = 66.5$).

These analyses maintained statistical significance even with the exclusion of observation 11 as a potential outlier. The one exception involved results for nurse-reported child cooperation, which was no longer statistically significant but trending ($p = .052$).

Qualitative Post-Intervention Interview

The child, parents, and nurses reported that the videogame distraction was very helpful (rated ''7'' on 1–7 scale) during dressing changes. The child reported greater enjoyment in playing the videogame than watching, and parents and nurses reported noticeably greater improvements in her distress and cooperation during interactive sessions. Parents, nurses, and the child strongly recommended the videogame to other children undergoing similar procedures.

During the course of treatment, four nurses were involved in the child's procedures. Per their report, videogame distraction did not interfere with their ability to conduct the dressing changes; two nurses indicated that at times they had to repeat commands related to repositioning (e.g., please lift your arm), but it did not delay the procedure. They appreciated the wireless controller, as it minimized their need to work around wires or bulky handheld equipment.

Discussion

This case report tested the feasibility and effectiveness of videogame distraction as a pain management strategy for a preschool-aged child undergoing repeated burn dressing changes. To our knowledge, this is the first study to attempt to isolate the level of interactivity of videogame distraction in a clinical setting for younger children undergoing repeated medical procedures. As predicted, both passive and interactive videogame distraction were effective in reducing distress compared with standard care. Moreover, interactive videogame distraction resulted in greater reductions in behavioral distress relative to passive videogame distraction, which is consistent with past studies (Dahlquist et al., 2007; Law et al., 2011; Wohlheiter & Dahlquist, 2012). Granted, the difference in behavioral distress between passive and interactive distraction, although statistically significant, was small, and the clinical significance remains unclear. The child's distress reduced from ~5.0 to a score of ~1.0 during passive distraction and at times closely approached 0 during interactive distraction, indicating minimal to no

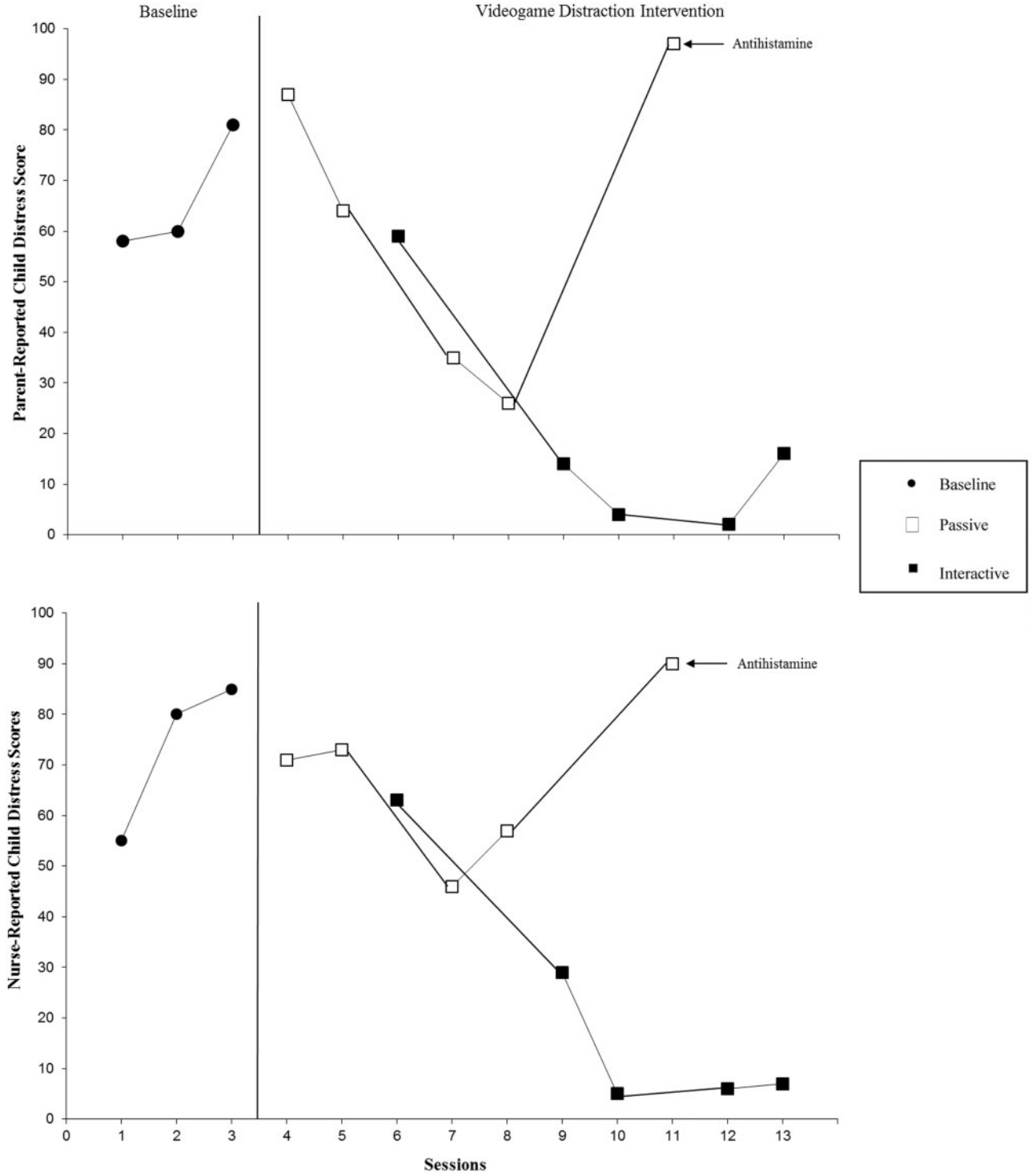

Figure 2. Parent (top) and nurse report (bottom) of child distress during dressing change procedure during baseline, passive distraction, and interactive distraction. An antihistamine was provided for itching 3 hr before the dressing change during observation 11.

behavioral distress and demonstrating the clinical significance of distraction overall.

However, the secondary findings provide further support for the clinically meaningful differences beyond behavioral distress between interactive and passive distraction, as well as the study's internal validity. Specifically, parent- and nurse-report indicated significantly lower levels of procedural distress and sustained improvements in cooperation across repeated procedures during interactive distraction. Behavioral observation also revealed

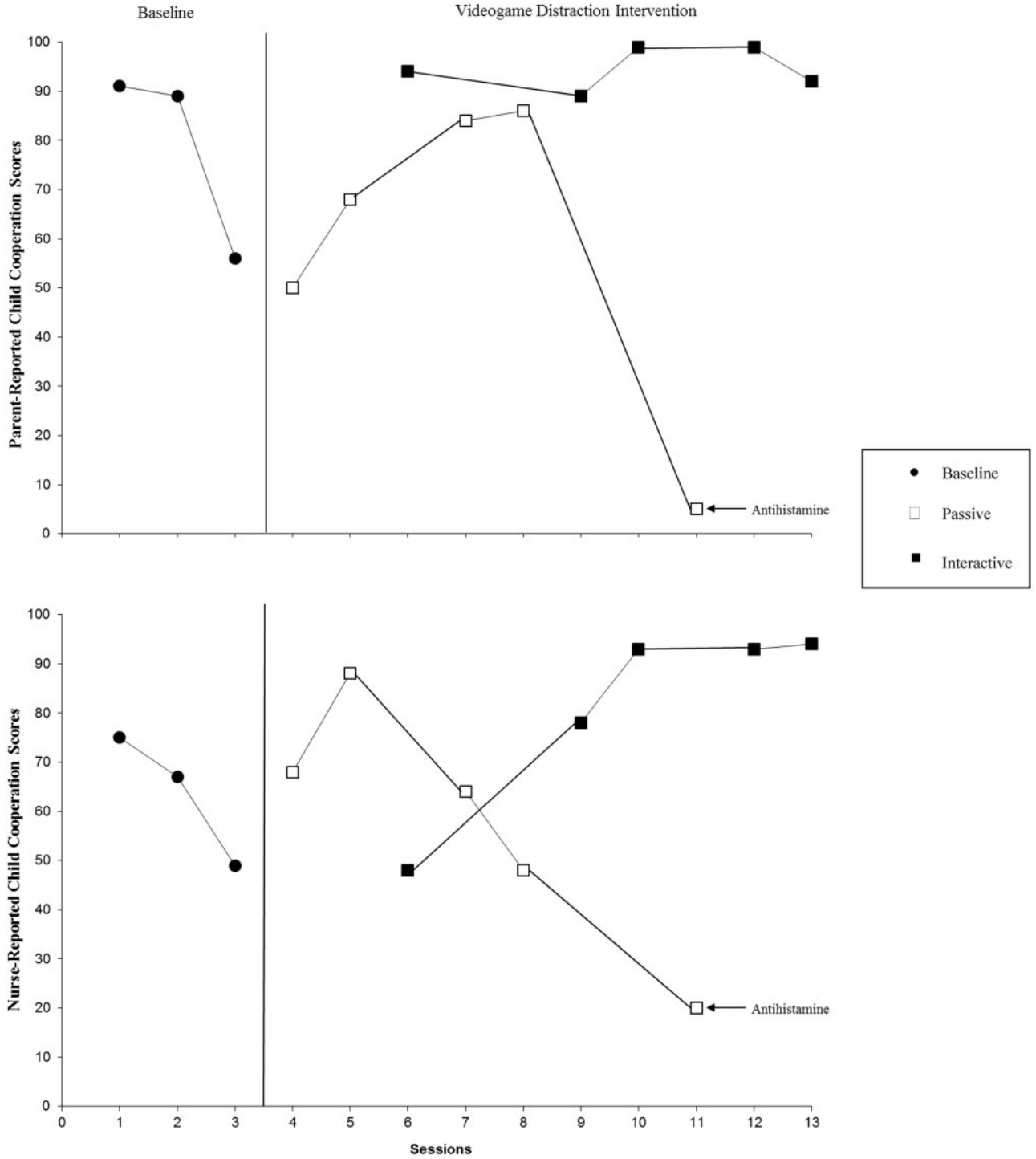

Figure 3. Parent (top) and nurse report (bottom) of child cooperation during dressing change procedure during baseline, passive distraction, and interactive distraction. An antihistamine was provided for itching 3 hr before the dressing change during observation 11.

a greater proportion of time spent engaged with the distractor during interactive distraction. Furthermore, reducing the duration of dressing changes by 26–48% (~20–30 min) relative to standard care also supports the clinical significance of both interventions, with greater reductions in time demonstrated during interactive distraction. This considerable reduction in time spent involved in a medical procedure may help staff work more efficiently, treat more patients, and reduce costs and resources used for medical treatment.

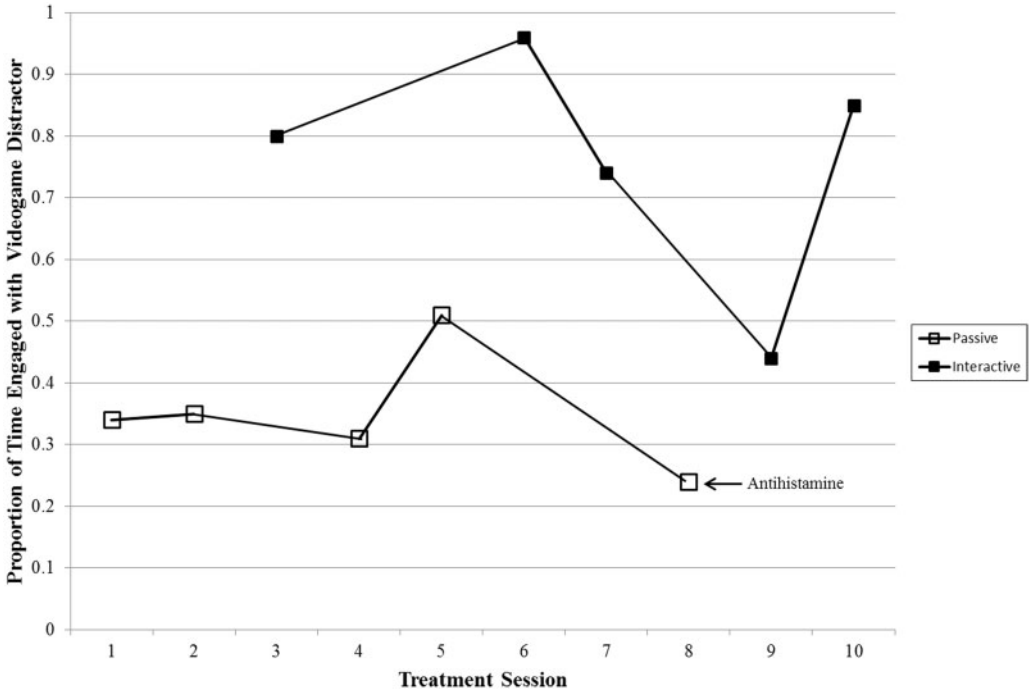

Figure 4. Proportion of time spent watching the distractor during dressing change procedures during passive and interactive videogame distraction. An antihistamine was provided for itching 3 hr before the dressing change during treatment session 8.

A few unexpected findings are worth highlighting. First, the parent reported increased distress and poorer cooperation immediately following the onset of the intervention. This discrepancy from observational data and nurse-report highlights the importance of understanding the influence of parental distress on parent ratings of child behavior. Additionally, nurse-reported child cooperation during passive distraction displayed a decreasing trend as treatment progressed. It is possible that the child's cooperative behaviors varied during the proportion of time she was not engaged with watching the videogame (50–60% of the procedure time), and the familiarity of watching the same videogame affected her cooperation. Although adult studies have tested the sustained efficacy of repeated interactive videogame distraction across multiple treatments (e.g., Rutter, Dahlquist, & Weiss, 2009), additional studies are needed to fully explore young children's response to repeated distraction tasks.

Overall, the results of this single-subject design study provide several significant contributions to the field of pediatric acute pain management. First, the findings provide further evidence for the clinical effectiveness of distraction for younger children with burn injuries, an understudied and challenging population to treat owing to poorly managed procedural pain and distress. Second, it highlights the feasibility of using videogames, an innovative technology-based distraction, with younger children. The accessibility and low cost of the Nintendo Wii is of added benefit over gaming systems that have been specifically designed for research studies and are more expensive and/or not as readily accessible to the general public. Third, it demonstrates that videogame distraction can yield sustained treatment effects across repeated painful dressing changes with younger children, which few studies have previously established. Lastly, the study findings suggest that the child's interaction with the task may be one of the mechanisms through which distraction is most effective, providing further support for conceptual models of attention and pain (Eccleston & Crombez, 1999; Legrain et al., 2009).

Moreover, qualitative data gathered from post-intervention interviews bolster the social validity of the intervention. High ratings of the acceptability of the treatment with minimal procedural care interference, the strong recommendation by the child, parents, and nurses for the use of videogame distraction with other patients, and parents' and nurses' subjective observations of the child's improvement in distress and cooperation following treatment (specifically with interactive videogame distraction) supports the social validity of the treatment procedures.

Lastly, the use of an alternating treatments design offers a major advantage in that it eliminated the need for treatment withdrawal common in reversal designs.

Given that both interventions led to reductions in the child's procedural distress, withdrawing such a beneficial treatment would likely have led to an increase in her distress, thereby inflicting unnecessary harm. Therefore, the ethical concern of withdrawing treatment was avoided.

Limitations

Despite the advantage of an alternating treatments design, it is equally important to consider the primary procedural issue—multiple-treatment interference—that is unique to this design. That is, one treatment condition may interfere in some manner with the other treatment condition. As such, it is difficult to generalize the effect of one treatment because the effect may not be the same if the treatment was implemented alone. Several steps were taken to minimize multiple-treatment interference (Barlow & Herson, 1984), including restricting randomization to an upper limit of consecutive treatment conditions, informing the child of the treatment condition to increase discriminability, and slowing the alternations of treatments (e.g., one treatment presented per day), which likely reduced the risk of this concern but remains difficult to assess.

Another inherent concern in all single-subject design research is the potential for order effects. Unfortunately, order effects cannot be controlled or eliminated from single-subject design studies (Hains & Baer, 1989). Although randomization of treatment sessions helps minimize potential order effects, the improvements in distress and cooperation that coincide with natural healing are difficult to disentangle. Although some healing began during the course of treatment, healing from moderate-severe burn injuries as experienced by this patient typically occurs slowly over the span of several weeks to months (Bessey, 2007), thus healing was not complete by the end of treatment.

Finally, the use of a single participant limits the generalizability of the study results. In the present study, burn treatment was provided in an inpatient setting, which, in itself, may impose additional stressors that may impact a child's ability to cope with medical procedures that might not be present in outpatient burn treatment settings. It also will be important to demonstrate the effectiveness of this intervention with larger samples and broader burn injury characteristics targeting the understudied 3- to 6-year-old population to help strengthen the external validity.

Implications and Future Directions

Despite these limitations, this study adds to the small body of research evaluating effective distraction interventions for young children with burn injuries and points to areas for future research. First, larger studies testing the effectiveness of videogame distraction in young children in clinical settings are warranted. Future studies are needed to identify developmentally appropriate hands-free interactive distraction tasks to extend the benefits of videogame distraction to children with burn injuries to their hands or face or for use during hydrotherapy procedures. Further assessment of child distress using multiple methods and reports in treatment studies as well as an examination of parent's own distress, as it relates to child distress, are needed to help clarify the contribution of parental distress on their ratings of child behavior. Lastly, additional research is needed to evaluate the sustainability of treatment effects for a longer course of hospitalization, as many children with burn injuries require prolonged hospitalization (up to several weeks) and follow-up for medical care.

Overall, this study adds to the limited body of research targeting younger children undergoing burn treatment and begins to identify which distraction tasks are effective for repeated acute pain management. Videogame distraction appears to have the potential to not only ease child distress and improve cooperation during painful procedures but also enhance medical staff's efficiency in providing burn care. Results from this line of research can help guide clinicians in selecting appropriate distraction tasks that may provide the greatest benefit to younger children undergoing repeated painful medical procedures and inform future research goals to evaluate videogame distraction in understudied populations.

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