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EFFECTIVENESS OF USING NONCONTINGENT ESCAPE FOR GENERAL BEHAVIOR MANAGEMENT IN A PEDIATRIC DENTAL CLINIC

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In a randomized controlled trial, 151 children 2 to 9 years old were exposed to either usual behavior management or to a fixed-time schedule of brief breaks (noncontingent escape) from ongoing dental treatment. Results demonstrated that the routine delivery of scheduled breaks from treatment significantly reduced the vocal and physical disruptive behavior and the need for restraint in a nonclinical sample of children undergoing restorative dental treatment. In addition, the treatment did not add significantly to the typical time spent on behavior management by dentists. Together with findings from previous studies, these results suggest that using brief breaks from ongoing dental treatment has good efficacy, acceptability, and generality and may be a useful management tool, both in everyday dental practice and in more demanding instances of specialized need.

Key words: noncontingent escape, behavioral medicine, dentistry, children, randomized controlled trial

Going to the dentist can be a pain, so it should not be surprising that children often seek to escape or avoid it (Do, 2004). Nearly 20% of all children exhibit marked distress and disruptiveness at the dentist (Brill, 2000; Klingberg & Broberg, 2007; Raadal, Milgrom, & Weinstein, 1995). These problems are even more pronounced in preschool-aged children (Allen, Hutfles, & Larzalere, 2003) and are compounded by the threatening or invasive procedures typically used during tooth restoration, such as oral injections, drilling to remove cavities, and filling or crowning teeth. Indeed, the more discomfort that is associated with a procedure, the more likely that intense disruptive behavior will be observed (Brill, 2000). Moreover, because young children can be difficult to manage, many dentists are not willing to treat them when anything more than a simple cleaning is required (Casamassimo, Seale, & Ruchs, 2004; Cotton et al., 2001). This is unfortunate given the recent interest in increasing preschool children's access to quality oral health care (Edelstein, 2000; Grembowski & Milgrom, 2000; Waldman & Perlman, 1999).

As a result of their encounters with children who are disruptive during tooth restoration, dentists have considerable interest in behavior management, and it is part of a national call to promote oral health (U.S. Department of Health and Human Services, 2003). In fact, national guidelines on behavior management by the American Academy of Pediatric Dentistry (AAPD) advise that safe and effective treatment and health promotion with children often require

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modifying the child's behavior (AAPD, 2011). Typical AAPD behavior management guidelines include the use of sensory and procedural information, effective command giving, positive reinforcement (e.g., praise, small toys), and distraction. The guidelines also advise that good behavior management skills can reduce the amount of time required to deliver oral health care, can reduce the risk of injury during treatment, and ultimately can improve the quality of oral health care (AAPD, 2011).

To improve behavior management of children during dental treatment, dental professionals have sought to understand why children are distressed and disruptive. Many variables have been considered. Previous investigations have explored the extent to which maternal anxiety, child anxiety, parenting style, or child temperament contributes to disruptive behavior during treatment (e.g., Casamassimo, Wilson, & Gross, 2002; Johnson & Baldwin, 1969; Quinonez, Santos, Boyar, & Cross, 1997; Radis, Wilson, Griffen, & Coury, 1994). However, none of these variables have proven to be reliable predictors of disruptive behavior.

More recently, dentists have been encouraged to consider patient–environment interactions to understand the variables most responsible for child distress and disruptive behavior during dental treatment (Allen & Wallace, in press). From the outset, the dental operatory is an environment of unusual noises and unfamiliar sensations. Furthermore, young children who undergo restorative dental work must lie on their backs, open their mouths, and have someone wearing a mask and gloves insert sometimes multiple instruments, some of which inflict pain or discomfort. Avoidance behavior would be an expected reaction, especially in preschool-aged children for whom noises, masks, strangers and strange situations, and separation from a caregiver often elicit fear responses (Barrios & O'Dell, 1998). Even older children have been found to overpredict the discomfort they will experience during dental treatment and seek to avoid it (Carlsen, Humphries, Lee, & Birch, 1993). As a result, the fact that some children might be highly motivated to escape dental treatment should not be surprising. Indeed, assessments in the dental clinic have suggested that the function of much of the disruptive behavior that is observed is escape from the dental procedures, even if that escape is only briefly available (Allen & Stokes, 1989).

Over the past 20 years, we have worked to develop a treatment that takes advantage of a child's motivation to escape dental treatment (Allen & Wallace, in press). In the original procedure, the dentist provided brief (10 to 15 s) periods of escape from ongoing dental treatment contingent on the child lying still and being quiet. Conversely, contingent on disruptive behavior, the dentist postponed escape until cooperation was regained (i.e., escape extinction). In the original studies, researchers delivered the intervention outside the typical visit with the dentist, although the effects were evaluated in situ. In two separate studies, this use of differential negative reinforcement combined with escape extinction produced marked reductions in highly disruptive behavior exhibited by young children (Allen, Stark, Rigney, Nash, & Stokes, 1988; Allen & Stokes, 1987).

In a subsequent study, dentists delivered the intervention in situ. In addition, the escape extinction component was removed because it proved to be particularly difficult for a dentist to implement, both for safety reasons and for expediency. Nevertheless, the use of contingent escape alone was effective in markedly reducing disruptive behavior in a relatively short amount of time. Children as young as 3 years old, considered by many dentists to be "precooperative" (e.g., Nathan, 1995), were able to learn cooperative behaviors and appeared to be less distressed (Allen, Loiben, Allen, & Stanley, 1992).

Although the contingent escape procedure was demonstrated to be effective, the dentists who participated in the research expressed concerns about the effort associated with implementation of the procedure. On the positive side, the procedure had been found to require no more time away from restorative dental work than did traditional behavioral management. However, the expectation that the dentist deliver escape contingent on cooperative behavior required a level of vigilance that the dentists found to be difficult. That is, they were required to notice cooperative behavior and provide brief access to escape while also attending to ongoing treatment procedures. The dentists reported that the requirement for vigilance distracted them from the delivery of quality dental treatment.

To reduce the demand on the dentist and improve ease of use, we modified the procedure to eliminate the contingency. Instead, the dentists were asked to deliver brief access to escape on a time-based schedule. This type of fixed-time (FT) schedule of reinforcement delivery, or noncontingent negative reinforcement (e.g., Vollmer, Marcus, & Ringdahl, 1995; Waller & Higbee, 2010), is thought to reduce problem behavior because the freely available reinforcer reduces the individual's motivation to engage in the behavior (e.g., Lalli, Casey, & Kates, 1997). Further, because the procedure is based on time rather than performance, it can eliminate the vigilance required for implementation of a contingency (O'Callaghan, Allen, Powell, & Salama, 2006).

Using the noncontingent escape approach, a dentist wore an electronic prompter that signaled when access to 10 s of escape from treatment was due. The dentist initially implemented an FT 15-s schedule and then thinned the schedule in 10-s to 20-s increments over the course of the dental procedure until reaching FT 1 min. Decisions about when to thin were based on low occurrences of observed disruptive behavior. This approach was effective in reducing high levels of disruptive behavior in five young children while nearly eliminating the need for physical restraint (O'Callaghan et al., 2006).

These studies represent one of the few systematic and programmatic efforts to evaluate an innovative child behavior management technique in the dental clinic. To date, these studies have focused on single-case experimental designs, which have been important in their emphasis on the demonstration of a functional relation between the availability of escape and the observed changes in behavior during dental treatment. In addition, these single-case studies have demonstrated some generality of the intervention. However, randomized controlled trials (RCTs) can provide additional demonstrations of both the generality and the transportability of the procedure and can be important to the ultimate development and dissemination of an intervention (Barlow, Nock, & Hersen, 2009). In addition, the eventual progression of a program of research to an RCT fits with expectations that behavior analysts might, like those in public health, use group comparisons to evaluate different therapies (Skinner, 1968). Finally, recent commentaries have reaffirmed that RCTs are increasingly pertinent for applied behavior analysts who are interested in the process of developing and validating interventions (Smith, 2012).

The purpose of this investigation was to conduct an RCT of the noncontingent escape procedure with a sample of children typically seen in a general pediatric dental clinic.

METHOD

Participants and Settings

Participants were a convenience sample of 151 children, 2 to 9 years of age, recruited from a continuous sample of patients who presented at two different large, urban, pediatric dental clinics. One clinic was located at a public university medical center and the other was in the outpatient wing of a private children's hospital. Participants were limited to those who required injection of local anesthesia for routine restorative procedures such as fillings, stainless crowns, or tooth extractions. The Developmental Profile-3 (DP-3; Alpern, 2007) cognitive scale was used as a quick screener to estimate developmental level for each participant. The DP-3 provides norm-based standard scores ($M = 100$, $SD = 15$) for infants and children ages 0 to 13 years based on caregiver report. Fifteen of the 151 participants had borderline or lower scores on the DP-3, ranging from 53 to 75, and the remaining 136 children had average to above average scores between 85 and 128. The children with lower scores on the DP-3 had an age and gender distribution that was similar to the remainder of the sample. Children who required passive restraints that continuously restricted movement (e.g., papoose board) or required sedation (e.g., nitrous oxide) to complete treatment were excluded. Children who required temporary manual restraint (e.g., arms or legs held or blocked by a dental assistant or dentist) were included.

The dentists who conducted the restorative dental procedures were enrolled in a 2-year pediatric dentistry residency training program. One was a 33-year-old woman who already had an established dental practice for 5 years and had returned for additional training to pursue board certification in pediatric dentistry. The second was a 27-year-old man in his first year of residency training. Both dentists volunteered to participate in an ongoing program of research investigating various approaches to help dentists effectively manage child behavior during restorative dental treatment.

Measures

Child pain behavior. Measuring pain and distress by observation is a standard practice in the pediatric literature. Pain-related disruptive behaviors were recorded using a 15-s partial-interval recording system (Allen et al., 1992). Disruptive behaviors included physical movements, vocal complaints, moaning, and crying. Physical disruptions were coded if either smaller repetitive motions (without interruption of 1 s or more) or one continuous motion were observed by any part of the body totaling movement of 15 cm or more. Vocal disruptions were coded for any complaining about dental procedures or pain and for gagging, crying, or moaning. Vocal responses to questions by the dentist (including complaints) were not scored. Scoring began when either the dentist or dental assistant were both touching and looking at the child's mouth. Scoring was discontinued when the dentist or assistant stopped looking at and touching the child's mouth for 5 s or more. The primary dependent measure was total disruptive behavior, calculated by summing all of the intervals in which a physical or vocal disruption occurred, and dividing that total by the total number of intervals coded in that visit. Restraint was coded when the dentist or assistant physically restricted movement by holding or blocking the child's body. Although this is technically a measure of the behavior of the dental professionals rather than the behavior of the child, the presence of restraint was considered to be an indirect measure of the intensity of the child's disruptive behavior.

Interobserver agreement. Three different observers were trained to 90% agreement on a video criterion test of observer skills. Observers included a graduate student in school psychology, a college graduate research assistant in genetics, and a postgraduate research assistant in psychology. When the primary and secondary observers were coding sessions, they were both positioned near the foot end of the exam chair but in different corners of the dental operatory. Interobserver agreement was assessed on 26% of the observations. Total agreement was calculated by dividing intervals in which both observers agreed a response did or did not occur by the total number of intervals and converting the result to a percentage. Average reliability was 95% (range, 81% to 100%).

Fidelity of implementation. The observers recorded the occurrence and timing of the dentists' delivery of scheduled breaks in three different ways. First, the observers recorded whether the dentists provided a pretreatment practice with the noncontingent breaks, including four breaks at FT 10 s and four breaks at FT 15 s. Integrity was calculated by dividing the actual number of breaks provided by the planned number of breaks. Second, the observers, who could see when the dentist reached down to adjust the timing on the MotivAider prompting device, also recorded when the dentist thinned the schedule. Integrity was calculated by summing the number of times the dentists thinned the schedule as prescribed, divided by the number of planned thinnings. Finally, the observers recorded the frequency of the occurrence of each break in both experimental and control conditions to evaluate whether the rate of breaks was significantly different between conditions. In addition, in the experimental condition, the total number of breaks was compared to the total number of breaks predicted by the schedule.

Analyses of the three integrity measures demonstrated that the treatment was delivered as described. First, the dentists provided exposure to the breaks during the pretreatment practice as prescribed with 98% integrity. Second, they thinned the schedule as prescribed with 91% integrity. Finally, breaks per minute were at the predicted level for the experimental condition and significantly greater than the control condition (experimental group $M = 1.47$ breaks per minute, control group $M = 0.49$ breaks per minute). Thus, breaks were delivered consistently by the dentists and as dictated by the procedure.

Treatment acceptability. The dentists were asked to complete a modified version of the Treatment Evaluation Inventory (TEI-SF, Kelley, Heffer, Gresham, & Elliot, 1989). The TEI-SF is a nine-item measure that evaluates the acceptability of treatments designed for children. Each statement is rated on a 5-point Likert-type scale (1 = *strongly disagree*; 5 = *strongly agree*). The the dentists were asked to rate, for example, how acceptable the treatment was, how willing they would be to use the procedure, and how much they liked the procedure. The scores for each item are summed (Item 6 is reverse scored) for a maximum possible score of 45. A total TEI-SF score of 27 reflects moderate acceptability for the nine items. The TEI-SF has been found to have good discriminative validity (Kelly et al., 1989).

Apparatus

During the experimental condition, the dentists used a MotivAider to prompt them when to deliver escape (i.e., breaks) from treatment. The MotivAider is an electronic device that sends a pulsing vibration on either fixed- or variable-time schedules that can range from once every second to once every 24 hr. The dentists wore the pager-sized device on their waistbands. They wore the device in both conditions but described its function and turned it on only in the experimental condition. A digital hard drive video camera recorded all baseline and treatment sessions for all subjects in both conditions. The camera was placed on a tripod in one corner of the examination room.

Design

A randomized, controlled, between-subjects design was used in which participants were randomly assigned to either a control (treatment as usual) or experimental (noncontingent escape) condition. Random assignment was determined by random number generator and stratified for age and developmental level. For the randomization process, two age groups (2 to 5 years, and 6 years and older) and two developmental groups (DP-3 score 75 or less, or greater than 75) were created, leading to four separate randomization tables.

Procedure

The project coordinator or research representative approached potential participants and their parents or guardians in the dental office waiting room and invited them to participate in the study. Informed consent was obtained from all parents or legal guardians of the participants. After consent was obtained, the developmental screening measure was completed and participants were randomly assigned to either the control condition or the experimental condition based on the appropriate randomization table. The participants were then escorted to the dental operatory in the usual fashion and assisted into the operatory chair. As a matter of clinic policy, parents were typically asked to remain in the waiting room. Parents were permitted to enter the treatment room only when special circumstances required it (e.g., very young child, language barriers).

Control condition. Participants received treatment as usual. The dentists were instructed to follow all procedures typically implemented at the dental clinic. Typical procedures included an examination of the teeth, the application of a topical anesthetic to reduce discomfort from the injection (Benzocaine), and the injection of local anesthetic (Lidocaine). Mouth props were used between the lower and upper teeth to prevent children from closing their mouths while the dentist was working. A handheld dental drill was used for removal of the tooth decay. The last component of a typical appointment involved the restoration of the tooth (e.g., filling, crown). Throughout all of the procedures, the dentists used a "tell-show-do" behavior management procedure in which they explained what was to be done and described the sensations that a child could possibly experience. Dentists stopped treatment if necessary for safety reasons or to redirect or reprimand the child. Every participant was praised for being cooperative, and participants received a prize (e.g., toothbrush, small ring, sticker, rubber ball) at the end of the treatment regardless of their behavior.

Experimental condition. Participants received dental treatment (i.e., anesthesia, drilling, and restoration) and behavior management (i.e., tell-show-do, praise, redirection or reprimands, and prizes) exactly as described in the control condition. However, these participants also received regularly scheduled breaks from treatment (noncontingent escape) independent of their reaction to treatment. Dentists were instructed to provide a brief (i.e., 8 s to 10 s) break from treatment when prompted by the MotivAider.

Practice. Before the start of treatment, the dentist showed each participant the device and said, "Look at this little box I am wearing. It tells me when we can take a break or a rest. Whenever it buzzes, we will stop and take a break." The dentist then conducted a brief practice, exposing each participant to eight practice breaks. During practice, the child sat in the chair in which the actual work would be performed and the dentist said, "Let's practice our breaks." The dentist then placed common noninvasive instruments such as a mirror or explorer inside the child's mouth until the MotivAider signaled a break. When the dentist felt a vibration from the device, he or she said, "It's break time," and stopped "treatment" for about 10 s. The dentist used an FT 10-s schedule for the first four practice breaks and an FT 15-s schedule during the second four practice breaks.

Treatment. After treatment actually started, breaks initially occurred relatively often (FT 15 s). The length of the intervals was based on previous observations and research suggesting that FT 15 s would be a comparably rich schedule. Then, throughout the visit, the dentist adjusted the schedule so increasingly longer periods of time passed between breaks. The schedule was thinned in 15-s increments as treatment progressed. The dentist was asked to thin the schedule about every 3 min to 5 min but were not prompted by the researchers or observers to do so, nor was feedback given about the fidelity of implementation; this allowed the dentist to independently decide whether to respond to the MotivAider prompts and when to thin the schedule. During a break, the dentist removed the instruments from the child's mouth. However, the dentist was also permitted to manage disruptive behavior as he or she typically would, which could involve the removal of instruments at other times, such as when severe disruptive behavior might increase the risk of injury if instruments were left in the mouth.

Statistical Analyses

Power analysis. Previous data published using noncontingent escape in the dental clinic (O'Callaghan et al., 2006) suggested a large effect size for outcomes that targeted disruptive behavior in general as well as vocal and physical disruptive behavior separately. However, given that previous research was conducted with small samples and within-subject designs, a medium effect size (Cohen's d equivalent of .5) was assumed for the present power analysis. Power analysis (G*Power 3.0.5) indicated that 128 participants would be required to maintain adequate power (0.8) and alpha level (two-tailed less than 0.05) in a one-way between-subjects ANCOVA design (allowing potential need to account for effects of age on behavior).

Statistical analysis plan. Initial analyses were conducted to insure that the number of breaks per minute was at the level required and consistent across the two dentists. In addition, analyses were performed to determine if use of the scheduled breaks resulted in longer dental appointments. Also, analyses were conducted to determine whether nonrandomized variables (i. e., gender, ethnicity, and the specific restorative procedure required) were equally distributed across experimental conditions. The next set of analyses determined if demographic and procedure-related variables affected level of disruptive behavior. After these preliminary analyses, the primary analyses evaluated whether participants in each condition displayed differing amounts of total disruptive behavior, with follow-up analyses planned to assess whether this effect was observed for both physical and vocal disruptive behaviors. Analyses also assessed whether the use of restraint differed in the two experimental conditions and compared a subgroup of participants with identified developmental delays to the larger sample of children with typical development. All analyses were conducted with SPSS Version 18.0.

RESULTS

Equivalence of Conditions

Demographic and treatment characteristics are presented in Table 1, and were statistically compared between control and experimental conditions. Boys and girls were equally balanced across the conditions, and the race or ethnicity of participants assigned to either condition did not differ (t-test and χ^2 analyses were nonsignificant). Also, dental procedures were equally divided across experimental conditions (χ^2 analyses were nonsignificant). Although participants in the experimental condition had slightly longer appointments, this difference was not statistically significant, $t(149) = 1.23$, $p = .22$.

Analysis of Potential Confounding Variables

Based on prior literature, age and developmental level were considered likely contributors to disruptive behavior. However, neither age ($r = -.06$, $p = .48$) nor developmental profile score ($r = -.09$, $p = .26$) correlated with disruptive behavior. No significant differences remained

Table 1
Demographic and Treatment Characteristics

	Control ($n = 77$)	Experimental ($n = 74$)
	M (*SD*) or percentage	
Age	7.18 (1.48)	7.05 (1.34)
Gender	57% female	51% female
Ethnicity: Hispanic	62%	58%
African American	27%	32%
Caucasian	10%	7%
Developmental delay	10%	9%
Prior dental work	71%	74%
Number of prior visits	1.88 (1.67)	1.78 (1.50)
Procedure: Extraction	40%	32%
Filling	45%	54%
Crown	35%	42%
Breaks per minute	0.49 (0.19)	1.47 (0.18)*
Appointment length	18.7 (7.67)	20.2 (7.38)

*$p < .001$.

when these two variables were dichotomized to compare preschool- to school-aged children and developmentally normal to developmentally delayed children. Disruptive behavior was similar for boys and girls, $t(149) = -.66$, $p = .51$, and across race and ethnicity, $F(2) = 1.33$, $p = .27$.

Additional analyses found that the amount of prior dental experience did not correlate with total disruptive behavior ($r = .12$, $p = .14$) or physical disruptions ($r = .01$, $p = .91$), although children with a greater dental history did make more vocalizations during the procedure ($r = .18$, $p = .03$). When dichotomized, children with no dental history did not differ from children with dental history on any of the measures of disruptive behavior. In addition, there were no significant differences in disruptive behavior by dental provider, location of clinic, or whether the chair was in an enclosed room or in an open bay (all $t < 0.52$, all $p > .60$).

Finally, 10 children had a parent present during treatment, but parental presence was balanced across the two conditions (five parents present in control condition and five in experimental condition). Parental presence was associated with child age, $t(149) = 4.21$, $p < .001$, and need for an interpreter, $\chi^2(1) = 4.17$, $p = .05$, but was not associated with gender ($p = .75$).

Effects of Noncontingent Escape

Figure 1 depicts a box-plot analysis combined with a presentation of individual disruptive behavior scores for both the control and the experimental groups. The two boxes (left and right sides) show the range of disruptive behavior within which 50% of the group fell, and the solid line inside the box is the median split for each group. The horizontal bars (center) show the number of participants with individual disruptive behavior scores, which are grouped in 4% ranges (i.e., 0% to 4% intervals with disruptive behavior, 5% to 8% intervals with disruptive behavior, etc.). For example, five participants in the control condition and 10 in the experimental condition emitted problem behavior during 5% to 8% of intervals. The box plot shows that more than half the participants in the experimental group exhibited disruptive behavior in fewer than 30% of intervals, with few participants in the upper disruptive behavior ranges relative to the control group. This reflects a clinically significant outcome, in that previous research has suggested that children who are disruptive more than 30% of the time are considered by dentists to be "uncooperative" or "disruptive," whereas children who are disruptive less than 30% of the time are considered to be "cooperative" or "very cooperative" (Ingersoll, Nash, Blount, & Gamber, 1984). When individual cases were examined based on this 30% criterion, significantly more participants in the experimental condition met the clinical criterion for "cooperative," $\chi^2(1) = 4.93$, $p = .04$.

Because preliminary analyses had identified no potential confounding variables, statistical analyses were conducted to compare the experimental and control groups using independent samples *t* tests. Degrees of freedom for these analyses vary due to the use of *t* tests that do not assume equal variances between conditions, but all analyses include the full sample of 151. Follow-up analyses were conducted with ANOVA to determine if there was any interaction between experimental condition and gender or age group.

As can be seen in Figure 2, participants in the experimental condition were disruptive significantly less often than participants in the control condition, $t(133) = 3.19$, $p = .002$. Participants in the control condition were disruptive, on average, about 31% of the time, and participants in the experimental condition were disruptive, on average, about 20% of the time, which is associated with a medium effect size (Cohen's $d = .52$). The differences between the two groups also were evident when physical disruptions were considered separate from vocal disruptions. Under those conditions, participants in the experimental condition displayed significantly

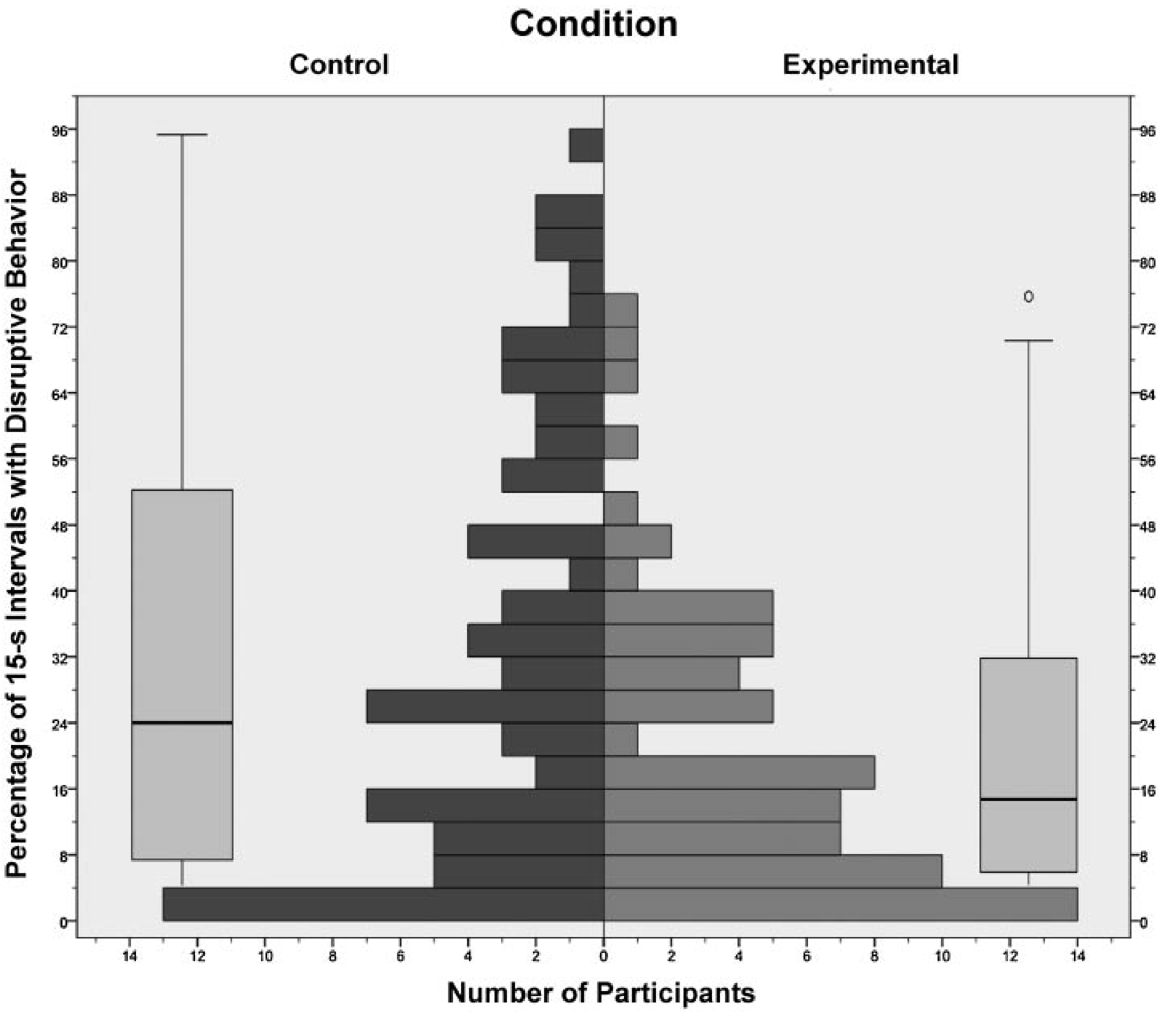

Figure 1. In this box-and-whisker plot, the solid line in the middle of each box (left and right) shows the median (50th percentile), and the bottom and top of the box show the lower (25th percentile) and upper (75th percentile) quartiles for each group. Thus, each box represents the disruptive behavior scores for 50% of each group. The whiskers (the thin lines extending beyond the boxes) show the highest and lowest score observed within 1.5 times the interquartile range (IQR), or the distance from the 25th to 75th percentile. The single observation outside 1.5 IQR is represented with a small circle. The centered horizontal bars show the number of participants that had individual disruptive behavior scores in each of the depicted 4% ranges (i.e., 0% to 4% disruptive, 5% to 8% disruptive, etc.).

less physically disruptive behavior, $t(148) = 1.94$, $p = .05$, $d = .31$, and also significantly fewer vocal disruptions, $t(124) = 3.15$, $p = .002$, $d = .51$, which are associated with small and medium effect sizes, respectively. Participants in the experimental condition required significantly less restraint than participants in the control condition, $t(107) = 2.60$, $p = .01$, $d = .42$, which is associated with a small to medium effect size. Analyzing use of restraint in dichotomous fashion, fewer participants in the experimental condition (27%) required any

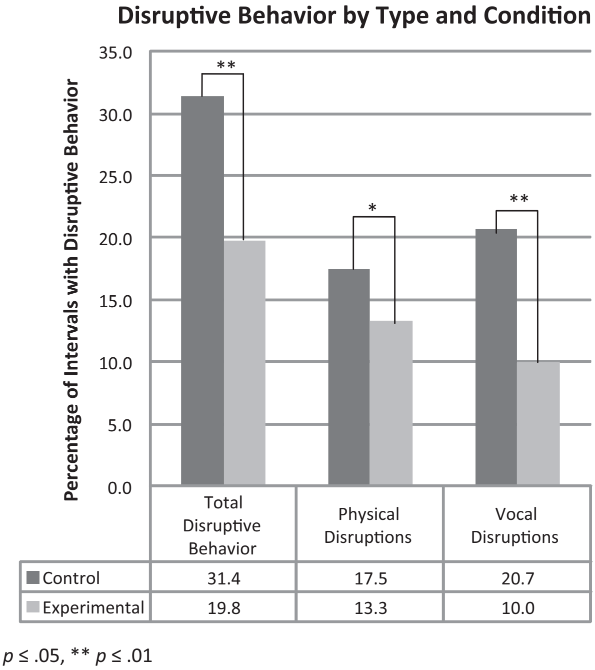

Figure 2. Mean differences in disruptive behavior during restorative dental treatment by treatment condition and by type of disruptive behavior.

restraint than in the control condition (45%), $\chi^2(1) = 5.53$, $p < .05$. This is of particular clinical relevance given that use of restraint was associated with an increased length of treatment (Spearman's rho = .16, $p < .05$).

Figure 3 shows a cumulative record of the rate of disruptive behavior in each of the two groups. The rate was calculated by taking the average number of intervals with disruptive behavior per minute for each group during dental treatment. Rates of disruptive behavior for the control group were stable throughout dental treatment. However, rates of disruptive behavior for the experimental group began to decrease relative to the control group after about 5 min. Subsequently, the rate of disruptive behavior in the experimental group continued to decrease, gradually showing more separation from the control group throughout the treatment visit.

Follow-up analyses were conducted with ANOVA, which allowed investigation of interaction effects between condition and age group and between condition and gender. The ANOVA that included condition and age group did not indicate a significant effect for age group, $F(1) = .34$, $p = .56$, nor for the interaction between age group and condition, $F(1) = 16$, $p = .69$. The ANOVA that included condition and gender also did not indicate a significant effect for gender alone, $F(1) = 0.73$, $p = .39$, nor for the interaction between gender and condition, $F(1) = 3.60$, $p = .06$.

Finally, we assessed whether the small subset of children with developmental delay showed similar responses to treatment as developmentally typical children. Due to the small number (15) of these participants, statistical comparisons are underpowered and not meaningful. However, the data suggest a similar pattern for

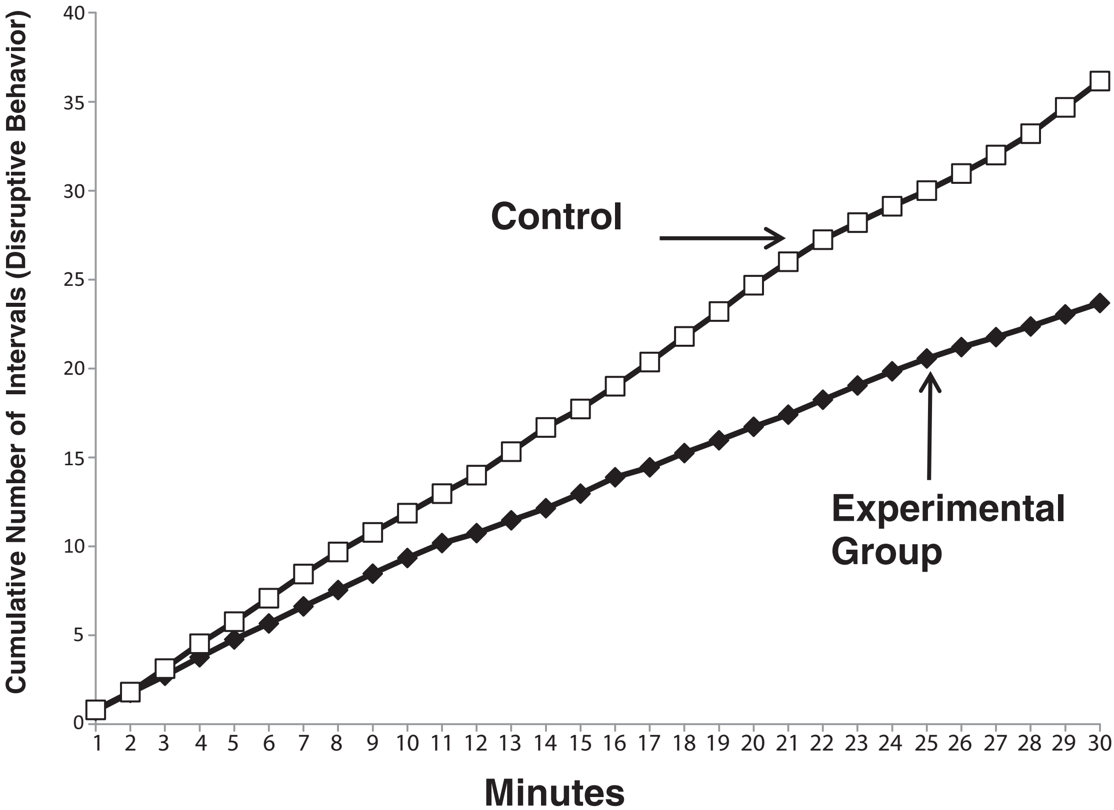

Figure 3. Cumulative intervals of disruptive behavior across minutes of the dental visits for control and experimental conditions.

children with developmental delay; children in the experimental group showed less disruptive behavior (28%) than those in the control group (35%).

Treatment Acceptability

The dentists rated the procedure as a highly acceptable approach for managing children who undergo restorative dental treatment. The two dentists rated the approach with scores of 38 and 39 (of a possible 45), endorsing items suggesting that they found it to be acceptable and indicating that they would be willing to use it. In addition, they provided their highest ratings for the items indicating that they felt positive about the procedure, that it would produce little discomfort, and that they were comfortable using it without consent from the participants.

DISCUSSION

Results of this investigation extend the literature on managing distress of children who undergo restorative dental treatment by demonstrating that the routine delivery of scheduled breaks from treatment can significantly reduce the vocal and physical disruptive behavior of a nonclinical sample of children. In addition, the treatment group required significantly less behavior management by physical restraint. Finally, the results were both clinically and statistically significant, and the dentists reported the use of noncontingent escape to be an acceptable and positive approach that they would consider using in everyday practice. Thus, these results, in combination with previous studies, suggest that the procedure has good efficacy, acceptability, and generality and may be a useful management tool, both in everyday practice and in more demanding instances of specialized need.

The results further extend the literature in this area by demonstrating the effectiveness of noncontingent escape with a large continuous sample of typical children seen in large, urban dental clinics. Previous research investigating the clinical use of contingent escape (e.g., Allen et al., 1992) and noncontingent escape (e.g., O'Callaghan et al., 2006) in the dental setting had targeted children referred for specialized intervention because of severe disruptive behavior. Yet, in the current study, noncontingent escape still produced significant reductions in disruptive behavior and in the frequency of restraint required to manage it. Ultimately, the adoption of any procedure in practice may depend on demonstrations with more typical populations like the one used in this investigation. Increasingly, evidence suggests that dissemination of effective treatments depends as much on demonstrations of effectiveness with the majority of consumers as it does on demonstrations with the most demanding consumers (Rotheram-Borus, Swendeman, & Chorpita, 2012).

Perhaps equally important for dissemination is the fact that the children exposed to the noncontingent escape procedure spent no more time at the dentist than those in the control condition. Thus, the dentists were not required to commit more time to behavior management than that required to typically manage children. In addition, the dentists were not highly trained in behavior management and received no specialized training for this procedure other than simple verbal instruction about how and when to change the timing of the device that prompted the scheduled breaks. These two facts, the ease of learning and ease of implementation, are both important because dentists are reimbursed for neither (Sheller, 2004).

This investigation also continues to extend the literature in applied behavior analysis with respect to the clinical application of noncontingent escape. In recent years, applied behavior analysts have focused almost exclusively on the use of noncontingent positive reinforcement (cf. Waller & Higbee, 2010), particularly in an effort to understand its advantages or deficiencies in relation to other response-dependent schedules of reinforcement (e.g., Allison et al., 2012; Luczynski & Hanley, 2009). However, this study provides evidence that noncontingent escape can be used effectively and acceptably in a primary health care setting. In addition, because this has the potential to improve children's access to important preventive and restorative oral health care, it addresses a socially significant problem.

It should not be surprising that the effectiveness of noncontingent escape seemed to increase across the duration of the dental treatment. Regardless of whether one views noncontingent escape as a process that disrupts the response–reinforcer contingency or abolishes the effectiveness of escape as a reinforcer (e.g., Ecott & Critchfield, 2004), it seems likely that children would need repeated exposure to the breaks for either process to occur. If so, more exposure might produce more learning and subsequently greater change in behavior. This gradual response might be considered a limitation for practitioners who are looking for an intervention with both potency and immediacy. Of course, short of chemical sedation or passive restraints, few behavioral interventions can promise that type of return, given a treatment environment with inherently uncomfortable elements (Allen & Wallace, in press). Nevertheless, the current approach does expand the armamentarium of practitioners who wish to reduce their reliance on invasive and restrictive procedures. Furthermore, intervention effects were evident within just a few minutes.

It is interesting to speculate about the possible role of the pretreatment practice in producing the observed differences between groups. It seems unlikely that the practice alone desensitized the participants to the dentist's hands and tools in their mouths. Decades of research in the dental clinic have suggested that repeated exposure to treatment is not an effective behavior management approach (e.g., Allen & Stokes, 1987; Venham, Bengston. & Cipes, 1977). It also seems improbable that eight exposures to dentist-implemented breaks could disrupt the response–reinforcer contingency or abolish escape as a reinforcer. On the other hand, it seems equally unlikely that those eight practice exposures were irrelevant. The practices alone may not have been sufficient to produce the observed differences in behavior, but they may have been necessary and may have resulted in quicker demonstration of treatment effect. A determination of the relative contribution of the practice component awaits empirical investigation.

Although the sample was large, the generality of the conclusions are somewhat limited by a number of factors. The sample of children with development delays was limited. Although they responded similarly well to the intervention, a replication of the results with a more representative sample of children with developmental disabilities would be valuable to determine whether this intervention would be as effective with that population. In addition, the sample of participating dentists was quite small, although both achieved comparable outcomes in spite of their differences in years of experience. We were pleased that the dentists were able to implement the treatment with good integrity given almost no training, but questions remain about whether and how well other practitioners in private practice would implement this sort of intervention. In addition, the dentists were not blind to treatment condition (and could not have been), posing a potential bias in treatment delivery. Finally, it would have strengthened the study to ask the children about their perception of the acceptability of the intervention. Previous research has found that some interventions, such as passive distractions (e.g., television or videos playing during treatment) are perceived positively by children and are widely used by dentists, even though distraction has not been found to be particularly effective in reducing management problems (Allen & Wallace, in press). Thus, assessment of patient perceptions may be important for eventual dissemination.

Overall, the noncontingent escape procedure might be seen as having the potential to make an important contribution to public health. Part of the ambitious Healthy People 2020 agenda is to prevent and control oral diseases by reducing the distress associated with oral health care and by improving access to those services (U.S. Department of Health and Human Services, 2012). Thus, to the extent that dentists are helped to feel more comfortable providing care to children, then the noncontingent delivery of breaks offers one potential means of addressing important Healthy People 2020 goals. Getting dentists to use new approaches, however, may require targeting dentists while they are in training, are first developing their behavior management repertoires, and are formulating opinions about who they feel competent to treat. This would also likely promote wider, mainstream dissemination of an effective behavioral intervention, an outcome consistent with the goals of applied behavior analysis.

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