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Clinical Section

BEHAVIORAL TREATMENT FOR CHILD DISTRESS DURING REPEATED NEEDLE STICKS

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Abstract. The objective of this study was to evaluate a multi-component behavioral intervention for child distress during repeated needle sticks. An AB single-subject experimental design with replication of procedures across five subjects was used to assess intervention effects on distress and procedure duration for five children (age 3–7 years). Playing preferred activities, signaled button pressing, and following directions were positively reinforced first during simulated then actual needle procedures. The results indicate that distress decreased substantially for three children, slightly for a fourth and was unchanged for one. Heart rate (HR) data obtained from one child provided preliminary evidence of counterconditioning. For three children with follow-up data, benefits were maintained after intervention transfer to caregivers. In conclusion, distraction and counter-conditioning appear to be compatible conceptualizations for designing interventions to reduce the distress of experienced children who undergo repeated invasive procedures. The independent and synergistic effects of behavioral interventions based on these two theories should be examined in future studies.

Keywords: Invasive procedures, behavior therapy, conditioning, pediatric.

Introduction

Children with chronic conditions consider painful procedures the worst part of their illness, do not become desensitized with repetition (Manne et al., 1990; Weekes & Savedra, 1988), and may require sedation, physical restraint or general anesthesia (Anderson, Zelter, & Fanurik, 1993).

For the *naive* child, provision of ''sensory information'' by pre-exposure to medical stimuli via demonstrations, role-play, or modeling may be helpful (Dahlquist, 1993; Melamed, Robbins, & Graves, 1982). ''Experienced'' children may develop conditioned anxiety and avoidance requiring more intensive intervention such as controlled breathing, progressive muscle relaxation, visual imagery, and distraction to supplement pharmacological management (Dahlquist, 1992; Fowler-Kerry & Lander, 1987; Gonzalez, Routh, & Armstrong, 1993; Jay, 1988; Powers, Blount, Bachanas, Cotter, & Swan, 1993; Stark et al., 1989).

Distraction has been beneficial for some ''experienced'' children (e.g., Blount, Powers, Cotter, Swan, & Free, 1994; Cohen, Blount, Cohen, Schaen, & Zaff, 1999; Dahlquist, 1992; Fanurik, Koh, Schmitz, & Brown, 1997; Gonzalez et al., 1993; Powers et al., 1993; Stark et al., 1989). The mechanism by which distraction can produce pain reduction is not well understood. It has been assumed that pain perception is not a fully automatic process and that some cognitive processing is involved. That is, attention must be directed toward the painful stimulus in order for it to cause distress. If the child's capacity for attending is limited, and another stimulus or task competes enough with the noxious stimulus, theoretically, perception of the noxious stimulus as pain should be altered (McCaul & Malott, 1984; Varni, Blount, Waldron, & Smith, 1995).

Distracting activities also may serve a counterconditioning function. Counterconditioning is a behavior therapy technique based upon principles of conditioning and learning (Rimm & Masters, 1979). In this conceptualization, stimuli that are salient in the environment when an individual experiences a painful event can acquire conditioned aversive qualities. Thus, if a clinic treatment room is associated with a painful procedure, then merely seeing or walking into the treatment room may begin to evoke behavioral distress (e.g. physiological arousal, motivation to avoid or escape the room). Counterconditioning involves attempting to weaken these conditioned associations using planned stimulus pairing. First, the environ-

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ment is arranged to induce relaxation and encourage approach of the conditioned stimulus (e.g. treatment room). Relaxation and approach responses can be induced in young children by providing familiar, preferred activities (similar to those described above for distraction). Using a gradual exposure approach, these activities can be paired with the conditioned stimulus (e.g. placed in the treatment room) and the child can receive praise and tangible rewards for engaging in these activities in the treatment room without trying to leave. If necessary, the exposure to the feared situation can be conducted gradually, with increasing proximity and duration over time. Theoretically, for counterconditioning to occur, it is essential that the child experience exposure to the conditioned stimulus (e.g. treatment room) without experiencing the painful stimulus (e.g. painful needle stick). Thus, such an approach depends on the possibility of exposure without pain using practice sessions when no real medical procedure is performed and using topical anesthetic to make the actual procedure pain-free, if possible.

In Behavior Analysis studies the negative behavioral effects of aversive stimulation have been reduced by: (1) counterconditioning (Morse & Kelleher, 1977); (2) discrimination training (Derrickson, Neef, & Cataldo, 1993); and (3) making some contiguous environmental stimulus controllable by manipulating an apparatus (Holtz, 1968). A distraction and counterconditioning-based intervention recently decreased behavioral distress and increased cooperation in five children undergoing invasive pediatric procedures by pairing preferred activities with medical stimuli during simulations and differentially reinforcing activity engagement and following instructions (Slifer, Babbitt, & Cataldo, 1995).

In the present study the distraction and counterconditioning procedures employed by Slifer et al. (1995) were replicated with five young children (aged 3–7 yrs.) receiving repeated needle sticks. The current study employs a single subject experimental design to evaluate a multi-component intervention for child behavioral distress during repeated needle sticks in experienced children. This study expands on the work of Slifer et al. (1995) by adding: (1) a salient conditional stimulus to signal the needle stick; and (2) teaching the children to use both hands to press buttons on a counter to earn positive reinforcement during needle sticks.

Method

Children and setting

This study was conducted in an outpatient pediatric specialty clinic at a large university affiliated medical institution located in an urban area on the eastern seaboard of the United States of America. The five children who participated are described in detail in Table 1. Each child had been diagnosed with a chronic medical condition. Their diagnoses included: growth hormone deficiency resulting in short stature and treated with growth hormone injections (Child 1); leukemia, a form of childhood cancer, requiring treatment with chemotherapy (Child 2 and Child 5); kidney failure requiring kidney transplantation and frequent follow-up blood tests (Child 3); and testicular cancer, which had required surgical removal of one testis, and a course of chemotherapy (Child 4). All participating children required frequent repetition of a medical procedure involving penetration of the skin with a hypodermic needle. Prior to referral for this intervention study, all five children were identified by medical staff as showing evidence of conditioned anxiety and avoidance in the medical

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Table 1. Characteristics of participating children

Child	Age (years)	Race	Sex	cognitive function	CBCL T-Score INT	CBCL T-Score EXT	CBCL T-Score TOT	Medical diagnosis	Needle procedure	Local anesthesia used
1	4	Caucasian	Male	Above average	59	68	71	Growth hormone deficiency	Injection in leg	yes
2	3	Caucasian	Male	Low average	55	49	52	Cancer (leukemia)	Needle insertion into indwelling tube under skin in chest	yes
3	7	Bi-racial	Female	Below average	59	70	67	Visual impairment, kidney failure/ transplantation	Needle and small tube inserted in vein of arm	yes
4	5	African American	Male	Average	–	–	–	Cancer (testicular tumor)	Needle insertion into indwelling tube under skin in chest	no
5	5	African American	Male	Average	63	71	71	Cancer (leukemia)	Needle insertion into indwelling tube under skin in chest	yes

*Cognitive functioning was screened using a standardized parent interview and questionnaire, The Developmental Profile II (Alpern, Boll, & Shearer, 1986).

CBCL = Child Behavior Checklist, a standardized child behavior problem rating scale completed by the parent (T-score mean = 50, standard deviation = 10) (Achenbach, 1991, 1992). INT = internalizing behavior problem factor T-score; EXT = externalizing behavior problem factor T-score; TOT = total behavior problem scale T-score.

clinic. The children's anticipatory behavioral distress made it difficult and unsafe for the nurses to complete necessary needle sticks.

Before each child and caregiver entered the study, informed consent was obtained in writing from the child's parent or legal guardian. The procedures involved in study participation were also explained to the child using developmentally appropriate language, and the child was asked for his/her assent to participation. These subject recruitment procedures were conducted in accordance with the policies of the institutional review board at the medical center charged with the protection of human subjects. This same board had also reviewed and approved in advance the methods to be employed in this study.

Simulated medical procedures were conducted by a behavior therapist in an outpatient clinic room. Actual medical procedures were conducted by medical staff in a pediatric treatment room (except for Child 1 whose mother gave his injections).

Measures

The Observation Scale of Behavioral Distress (OSBD; Jay, Ozolins, Elliott, & Caldwell, 1983; Jay, Elliott, Ozolins, Olson, & Pruitt, 1985; Jay, Elliott, Katz, & Siegel, 1987) was employed to score verbal, vocal, and motor distress behaviors from video tapes of both actual and simulated needle stick procedures using 15-second continuous intervals. The scored intervals were summed, multiplied by intensity (weighted 1–4), and divided by the number of intervals.

Procedure duration was timed from site preparation to needle removal or taping the needle in place.

Heart rate. Heart rate (HR) for Child 3 was measured using a portable ECG event recorder (Heart Access Plus,™ Paceart Associates, L.P., Edgewater Commons II, 81 Two Bridges Rd., Fairfield, NJ 07004). Ten seconds of data were recorded during the needle stick and again during quiet play for both simulated and actual needle sticks. Resources and logistical considerations precluded measuring heart rate for the other participants. HR was measured only for Child 3.

Experimental design

Results were examined using an AB single subject experimental design with replication of procedures across five subjects.

Interobserver agreement

Eighteen percent of the medical procedures were scored independently by two observers, yielding a mean Kappa coefficient of 0.76 for the OSBD scores.

Procedures

For all children except Child 4, whose guardian declined to use local anesthetic, the skin site where the needle was to be inserted during the medical procedure was prepared with a local anesthetic cream 60 to 90 minutes before each needle stick observed in this study. Specifically, the caregivers of the other four children applied a Eutectic Mixture of Local

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Anesthesia (EMLA® – Astra Pharmaceutical Products, Inc., Westborough, MA) at home prior to coming to the outpatient clinic as prescribed by the child's physician.

EMLA is a topical cream containing the active ingredients lidocaine (2.5%) and prilocaine (2.5%). Both ingredients are amide-type local anesthetics that accumulate around dermal pain receptors and nerve endings. They stabilize the neuronal membranes by inhibiting the ionic fluxes required for the initiation and conduction of nerve impulses. EMLA must be applied to the skin at the site of the needle stick at least one hour in advance to provide local anesthesia of the skin and epidermal tissues penetrated by the needle. The cream is applied by spreading approximately 2.5 grams in a thick layer over a 2-in. square of skin. The cream is not to be rubbed into the skin and must be covered with an occlusive bandage to prevent the child from spreading it to unsafe areas such as eyes, mouth, or open wounds (Physicians' Desk Reference, 1998).

Baseline. Three to four baseline observations per child were obtained under usual care conditions.

Behavioral intervention

Simulation. A behavior therapist conducted training with the child and caregiver during a series of 20-minute simulated needle stick procedures. Typically these simulation treatment sessions were conducted just before an actual needle stick was conducted. However, these sessions sometimes were scheduled during separate days between the medical visits when the actual needle stick procedures were performed. Tangible reinforcers were prominently placed in the treatment room from which the child selected a ''prize'' to be earned during the ''practice'' medical procedure. The prize was given to the parent or placed out of reach until session's end. The child selected stickers to be earned as intermediate reinforcers. Medical materials were initially kept out of sight. The child was provided with a play activity. For Child 1, 2, 4, and 5, this was an interactive toy robot (VTECH Industries, LLC. 101 E. Paletine Road, Wheeling, IL 60090–5822), with two thumb buttons added, which advanced a counter. Child 3's visual impairments made it difficult for her to see the games on the robot. After the first treatment session, she was given movies instead of the robot, and two hand held tally counters.

With the child playing comfortably, the child and care-giver(s) participated in simulation of several routine procedures (e.g. listening with a stethoscope, taking blood pressure, looking in mouth). Child cooperation was reinforced using praise and stickers to establish behavioral momentum (Davis, Brady, & Williams, 1992). Stickers were traded for the selected prize at session's end.

After the child earned reinforcement for cooperation with these non-invasive routines, the needle procedure was stimulated using an empty syringe or a blunt ''needle'' to apply topical pressure. The child was told that a ''touch,'' ''push,'' or ''pressure'' might be felt. During site preparation with alcohol, etc., the child continued to receive praise and stickers for cooperation and continuing to play. If anxious or disruptive behavior occurred, the therapist redirected the child to the play activity.

Discrimination training. To help the child discriminate when in the sequence of real medical events pain might occur, a conditional stimulus was provided 3 seconds before the simulated ''needle stick'' using a portable door chime (Radio Shack, Tandy Corp., Fort

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Worth, TX 76102 – model RSU 11267671). The signal remained on until the simulated stick was completed. The child was prompted to press the buttons on the robot (for Child 3 to press hand-held tally counters) in response to the signal to earn a final sticker and the prize. The child practised doing this in response to the signal during the simulation sessions. There were no consequences for negative vocalizations, which were regarded as normative, justifiable expressions of discomfort. The same activities, prompts and reinforcers were subsequently provided during the real procedure. Initially, the therapist used the door chime to signal the needle stick, but also prompted the person performing the stick to count aloud ''1–2–3'' after the chime began before performing the needle stick. By the end of treatment, the tone was withdrawn, but counting aloud from one to three signaled the stick.

Training and transfer of intervention. Care-givers were trained during the simulations using verbal explanations, modeling, rehearsal and corrective feedback. The therapist gradually taught them to provide verbal prompts and differential reinforcement. By treatment's end, the care-giver and medical staff were implementing treatment.

Results

The individual session data are presented in Figure 1.

Behavior during simulations

The children and their caregivers participated in and were videotaped during four to nine treatment sessions conducted during simulated needle stick procedures. Three of the children (#s 1, 2, & 5) demonstrated low distress during simulated needle sticks (M = .40, .17, .53, respectively). Child 3 exhibited significant distress during the first simulation, but with repetition, distress decreased (M = 1.6). Distress for Child 4 decreased during the first simulation session, but overall did not decrease during simulations (M = 3.26) when compared to real procedures.

Child 1 and his mother received intervention during 9 bi-weekly subcutaneous injections (SQ) over 5-weeks. Follow-up observations were conducted for 16 bi-weekly SQs over 8 weeks. His total OSBD scores initially decreased from baseline (M = 9.03) to treatment (M = .296). Near the end of treatment and the beginning of follow-up, his OSBD scores were higher and more variable (sessions 10–19), but ultimately returned to the initial treatment levels (follow-up M = 4.01). Behavioral intervention also decreased the procedure time (M baseline = 6.33 min, M treatment = 2.67, and M follow-up = 1.31 min).

Child 2 and his mother received intervention during eight Portacetheter access sticks (PC) over 30 weeks. Overall, his total OSBD score decreased slightly from baseline (M = 2.04) to treatment (M = 1.12). Distress scores decreased to a very low level (M = .34) after the third PC with intervention. Child 2 had the lowest level of baseline distress of the five participating children. Thus, there was relatively less room for improvement, potentially resulting in a ''floor effect''. Procedure time decreased from baseline (M = 4.25 min) to treatment (M = 2.56 min). No follow-up data were possible because the parent withdrew from the study after the treatment phase ended.

Child 3 and her grandmother received intervention during four venipunctures (VP) over 24 weeks. Because of her cognitive and visual deficits, massed practice was provided during

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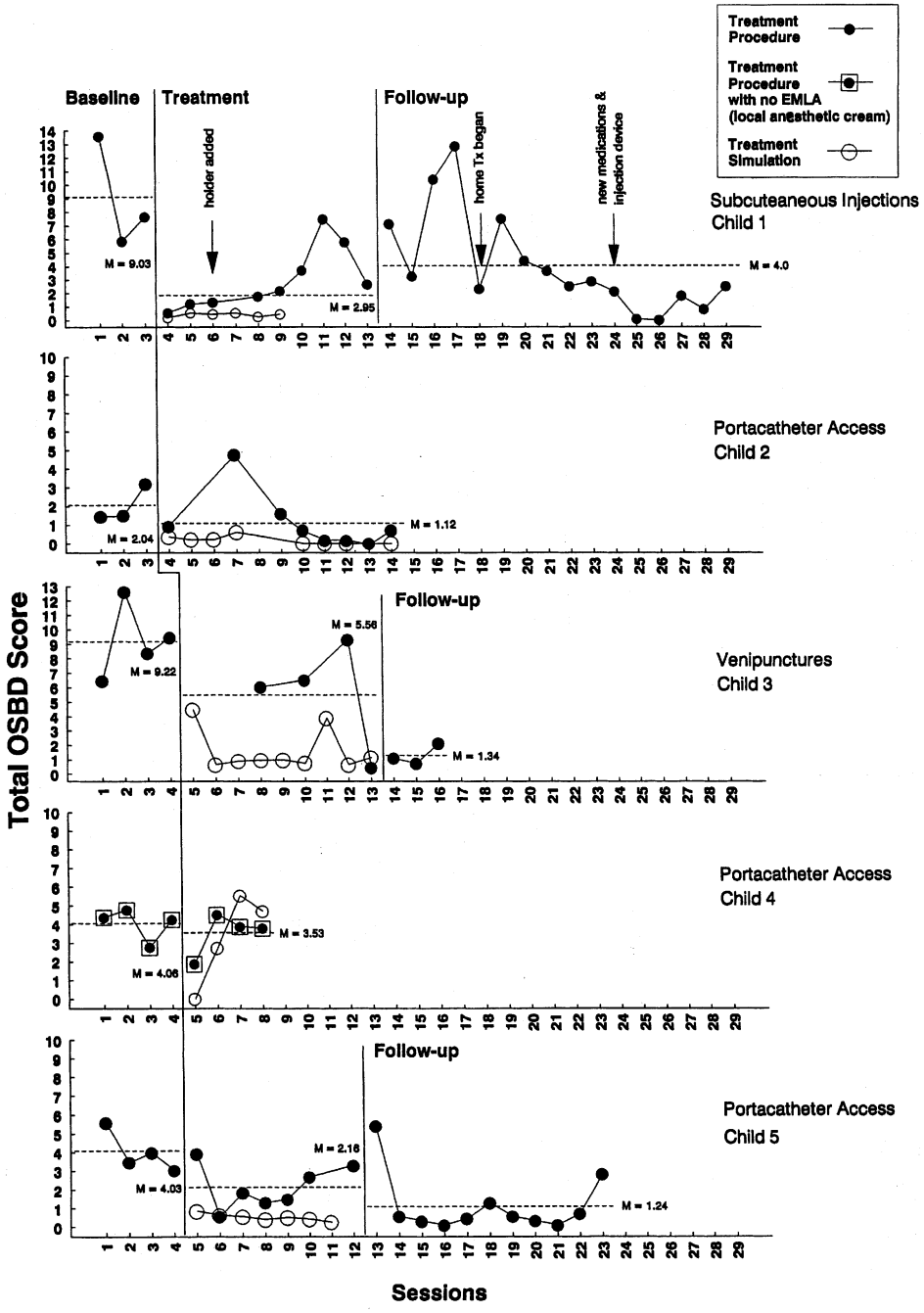


Figure 1. Child distress (OSBD) scores across baseline and treatment sessions during simulated and actual medical procedures

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four simulation sessions prior to the first real needle stick in the treatment phase. Total OSBD scores declined from baseline (M = 9.23) to treatment (M = 5.57) to follow-up (M = 1.34). Length of the procedure increased slightly (baseline M = 2.38 min, treatment M = 2.56 min, follow-up M = 3.08 min), but on average, the increase was less than one minute. Whereas she required physical restraint to complete the procedure during all baseline observations and the first two actual needle sticks with the intervention, thereafter she no longer required physical restraint during treatment or follow-up. The greatest reduction in her behavioral distress occurred during the last VP of the treatment phase. This was the second VP she had undergone without the need for manual restraint, and the first during which she sat independently in the phlebotomist's chair rather than on her grandmother's lap.

Heart rate (HR) data for Child 3 were analyzed in relation to her corresponding resting HR. During baseline, HR was elevated by a mean of 37 beats per minute during needle sticks relative to resting HR. During treatment simulations, HR did not change significantly from resting phase and when actual needle sticks were performed, the mean increase in HR from resting phase was 29 beats per minute. By the end of treatment, HR during needle sticks was approaching resting HR (M difference = +5 beats/minute).

Child 4 and his grandmother received intervention during four PCs over 4 weeks. No follow-up data were obtained because the child completed his chemotherapy and required no more procedures. His OSBD score decreased from a baseline mean of 4.06 to 1.90 during the first procedure after treatment began. However, the overall mean distress score during treatment was 3.53 showing no sustained improvement with treatment. Mean procedure duration changed very little (M = 2.65 minutes during baseline; M = 2.38 during treatment).

Child 5 and his mother received intervention during seven PCs over 8 weeks. Follow-up observations were conducted over 28 weeks. Total OSBD scores decreased from baseline (M = 4.03) to treatment (M = 2.16) to follow-up (M = 1.24). The duration of the procedure decreased slightly from baseline (M = 2.83) to treatment (M = 2.44) but increased during follow-up (M = 5.48), due to a faulty portacatheter.

Discussion

A multi-component behavioral intervention for procedural distress was investigated with five experienced children undergoing repeated needles sticks. The intervention employed behavioral strategies based on both distraction and counterconditioning conceptualizations. Treatment benefits were documented for four of the five children (all except Child 4). Distress scores decreased relative to baseline during simulated needle sticks for all children except Child 4. The other children generally were able to remain calm during these simulations while medical stimuli were systematically paired with preferred activities and differential positive reinforcement.

Distraction effects are based on the theory that a child's capacity for attending is limited, and if another stimulus or task competes with the painful event, the perception of pain is altered (McCaul & Malott, 1984; Varni et al., 1995). Recently, this is the most commonly cited conceptualization of interventions for procedural pain in experienced children. This is one possible explanation for the effects observed in this study.

Another explanation is counterconditioning, which, theoretically, weakens the association between other stimuli in the medical environment and the noxious simulation of the needle. For example, if the procedure room has been paired with painful needle sticks, conditioned

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anxiety may develop so that seeing or entering the room increases anxiety. For counterconditioning to occur, the procedure room must be paired with an activity that is reinforcing and induces relaxation (e.g., playing a familiar, preferred, distracting game) in the absence of pain in order to weaken the conditioned anxiety response. The mostly calm behavior during simulations of the four successfully treated children is consistent with the process of counterconditioning.

Our equipment did not allow for viewing heart rate data during treatment sessions, but retrospective analysis of heart rate for Child 3 provided additional support for counterconditioning. Child 3's heart rate was elevated during baseline sessions relative to resting phase. Her heart rate during simulation was always at or below her resting heart rate, suggesting relaxation was maintained during the *simulated* injections. The fact that heart rate during actual needle sticks gradually decreased to near resting levels provided evidence of a weakening of the distress response.

There was no evidence of counterconditioning for Child 4. This was likely because he was the only one of the five children whose caregiver refused to use EMLA cream. Also, his distress scores during simulations corresponded closely with those for actual needle procedures, suggesting that he did not discriminate simulated from actual needle sticks. The fact that his distress increased during these sessions further supports that he did not learn the difference between simulated and actual needle sticks. He might have benefited from massed practice during several simulations *before* an actual needle procedure was attempted. Child 3, who did receive massed practice, did show differentiation in OSBD scores for simulations versus actual needles. Thus, for some more highly distressed children, massed practice may be crucial to facilitate discrimination and enhance counterconditioning.

Simulations were conducted in order for the children to experience the needle stick routine without anxiety *or* pain and to associate the routine with relaxation and reinforcement. Assuming EMLA cream is both used and effective, the previously painful stimulus (i.e., real needle) also may be associated with relaxation and reinforcement. The fact that intervention was not effective with Child 4, who did not use EMLA, supports the importance of using topical anesthetic during real needle sticks in combination with simulations to accomplish counterconditioning. The intervention used in this study was a multi-component intervention. It was beyond the scope and resources of this clinical study to conduct a component analysis of the intervention. Therefore, concluding that counterconditioning definitely resulted from the intervention would be premature. Distress may have decreased over time simply as a function of repetition of needle sticks. However, such a habituation effect is less likely in light of previous studies, which have not consistently documented child habituation to needle sticks (Manne et al., 1990; Weeks & Savedra, 1988).

The activities provided during simulated and actual needle procedures were distracters, and distraction may have been the mechanism of distress reduction. The reduction also may have been due to differential positive reinforcement of approach and play behavior that was incompatible with distress, avoidance and escape. Finally, all of these components (distraction, habituation, and differential reinforcement), along with carefully planned stimulus pairing, may interact to produce the phenomenon that has been described as counterconditioning. The fact that there are so many possible explanations for the current results serves to highlight how little is really known about how and why behavioral interventions alter acute procedural distress.

In this study, some reduction in procedure-related distress was associated with the inter-

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vention for the four children who used EMLA cream and who also apparently were able to discriminate simulations from actual procedures. Reductions were accomplished despite the fact that many medical events were unpredictable and changing as the children's medical treatment progressed. The portacatheter failed several times for Child 5 (sessions 14, 17, 18 & 20). The caregivers accompanying Child 1 and 4 changed on some occasions, as did the setting for injections and medication for Child 1. Child 4 probably experienced more pain because topical anesthetic was not used. In light of these difficult to control clinical variables, developing a robust intervention for distress in children receiving repeated needle sticks continues to be elusive. Some preliminary support for a counterconditioning conceptualization is presented here, but this approach requires more research to demonstrate the variables that moderate the magnitude, durability, and generality of treatment effects. More research is needed in which behavioral and physiological data are immediately available to document conditioning and counterconditioning of distress, and to guide within session therapy decisions.

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