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Alteration of Memory in the Reduction of Children's Distress During Repeated Aversive Medical Procedures

Edith Chen, Lonnie K. Zeltzer, and Michelle G. Craske
University of California, Los Angeles

Ernest R. Katz
Childrens Hospital Los Angeles and
University of Southern California School of Medicine

The present study sought to reduce children's distress during aversive medical procedures using a brief, cost-effective intervention aimed at reframing memory. Fifty children diagnosed with leukemia (25 treatment, 25 attention control, aged 3–18) were observed as they underwent 3 consecutive lumbar punctures (LPs; baseline, postintervention, and follow-up). Self-report, physiological, and observable distress measures were collected before and after each LP. At posttreatment, children in the intervention group showed reductions in anticipatory physiological and self-report ratings relative to the control group. At follow-up, these effects generalized to reductions in procedural distress. These results suggest that (a) a simple memory-based intervention is efficacious at reducing children's distress and (b) benefits from this intervention are maintained over 1 week even without continued intervention.

Children undergoing treatment for acute lymphoblastic leukemia (ALL; the most common form of cancer in childhood) must endure a series of lumbar punctures (LPs), which involves inserting a needle into the child's spinal column to withdraw spinal fluid and administer chemotherapy. LPs are associated with intense pain and anxiety (Jay, Elliott, Ozolins, Olson, & Pruitt, 1985; Katz, Kellerman, & Siegel, 1980). Although numerous previous studies have documented efficacious methods of intervening to reduce distress in this population (French, Painter, & Coury, 1994; Jay, Elliott, Fitzgibbons, Woody, & Siegel, 1995; Jay, Elliott, Katz, & Siegel, 1987; Jay et al., 1985; Jay, Elliott, Woody, & Siegel, 1991; Katz, Kellerman, & Ellenberg, 1987; Manne, Bakeman, Jacobsen, Gorfinkle, & Redd, 1994; Manne et al., 1990; McGrath & de Veber, 1986; Melamed & Ridley-Johnson, 1988; Sallie, Burgmeier, & Schmidt, 1988; Zeltzer & LeBaron, 1982), these interventions have typically focused on teaching children strategies to cope with an upcoming procedure. Given the repeated nature of LPs as part of cancer treatment protocols, the present study tested an intervention that focused on children's memories of previous LPs as a means of reducing anticipatory and procedural distress during subsequent LPs.

Conditioning paradigms have been applied to aversive medical procedures (e.g., Jacobsen, Bovbjerg, & Redd, 1993). In the case of LPs, the needle insertion may serve as an unconditional stimulus (UCS), eliciting the unconditional response (UCR) of procedural distress (e.g., crying or screaming). Over time (repeated procedures), other cues present at the time of the procedure (e.g., procedure room or nurses) serve as conditional stimuli (CSs) that become associated with the UCS and elicit the conditional response (CR) of anticipatory distress.

Cognitive factors have been posited to moderate conditional associations in humans. Specifically, CRs alter when the meaning of the UCS changes, a process known as *UCS revaluation* (Davey, 1989, 1992). UCS revaluation occurs with additional contact with the UCS (in the absence of the CS) at a different intensity through socially or verbally transmitted information (e.g., being told that a UCS will be less likely to occur in the future) or through the reevaluation of one's reaction to the UCS or CS (e.g., believing that pain was endured well during a prior exposure to a UCS results in less pain at future UCS presentations). For example, individuals who are deceived to believe that they emitted strong UCRs or CRs show stronger CRs that are more resilient to extinction on later CS presentations (Cracknell & Davey, 1988). According to these principles, individuals who reduce their evaluation of the negativity or painfulness of previous LPs should show less anxiety on subsequent exposures to the LP.

UCS revaluation can occur by altering individuals' memories about previous conditioning experiences. Research on the relationship between anxiety and memory has demonstrated that during a

Edith Chen and Michelle G. Craske, Department of Psychology, University of California, Los Angeles (UCLA); Lonnie K. Zeltzer, Department of Pediatrics, UCLA; Ernest R. Katz, Childrens Center for Cancer and Blood Diseases, Childrens Hospital Los Angeles, Los Angeles, California, and University of Southern California School of Medicine.

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Correspondence concerning this article should be addressed to Edith Chen, who is now at the Department of Psychiatry, University of Pittsburgh School of Medicine, 3811 O'Hara Street, Pittsburgh, Pennsylvania 15213.

state of heightened anxiety, individuals focus on threatening information. Clinically anxious adults and children display an attentional bias toward threatening information relative to neutral information (MacLeod, Mathews, & Tata, 1986; Vasey, Daleiden, Williams, & Brown, 1995). Clinically anxious children also are more likely to interpret ambiguous situations as threatening (Barrett, Rapee, Dadds, & Ryan, 1996). A similar phenomenon appears to occur for pain perception. For example, individuals who are experiencing pain endorse more threatening, pain-related interpretations of ambiguous homophones compared with patients who are not experiencing pain (Pincus, Pearce, & Perrott, 1996).

Anxiety also may affect subjective memories. Highly anxious dental patients recall more pain than actually was experienced, whereas less anxious patients recall their pain quite accurately (Arntz, van Eck, & Heijmans, 1990). Among children undergoing venipuncture, a significant positive correlation was found between anxiety and recalled pain (Lander, Hodgins, & Fowler-Kerry, 1992). Finally, pain also affects recall. Patients suffering from recurrent or present pain have been found to recall prior pain episodes as more intense than the pain they reported at the time of the episodes (Eich, Reeves, Jaeger, & Graff-Radford, 1985).

The above evidence suggests that negative UCS revaluation may influence children's anxiety and pain during repeated medical procedures. Children who are highly anxious about medical procedures may remember or exaggerate the threatening details and the negativity of their previous medical procedures, which may then inflate the aversiveness of the CS or UCS, resulting in increases in anxiety and pain during future procedures. Evidence for this phenomenon has been found in pediatric cancer populations. Children who showed greater distress during an LP were more likely to remember (1 week later) the LP as more negative (e.g., estimating that the LP took longer than it actually did). Additionally, children whose pain and anxiety memories 1 week after the LP were more negative than their self-report the day of the LP were more likely to be distressed during a subsequent LP (Chen, Zeltzer, Craske, & Katz, in press).

In young children, memories of past experiences may be formed through adult-guided conversations about these experiences. Empirical studies of recall in young children (aged 3 to 4) of an event discussed with their mother revealed that children display good recognition and recall for the details discussed with their mother but do not report recall for any aspects of the event that were observed but not discussed with their mother (Tessler & Nelson, 1994). Parent–child discussions about past events may serve as a form of instruction to the child about how to remember and what to notice.

In addition, memories of an event can be modified by postevent information (Loftus, 1991). Young children (3- to 6-year-olds in one study, preschoolers in another study) given postevent misleading information by an adult experimenter about an event they observed were found to display an increased number of false reports (Leichtman & Ceci, 1995; Marche & Howe, 1995). Additionally, younger children were more likely to endorse these false events than were older children. These results indicate that children's memories may be modified by suggestive postevent interviews conducted by adult experimenters. Thus, for children undergoing aversive medical procedures, such as LPs, an intervention in the form of a guided discussion with an adult about their previous LP experiences could shape the way in which the child determines which details of the LP to remember, as well as how to gauge their reactions to the LP.

The present study examined whether such a memory-based intervention can influence children's distress during painful LPs. Distress can be measured in multiple domains; to attempt to capture this construct more fully, we collected self-report, physiological, and observable measures of distress before and after each LP. We hypothesized that children receiving the intervention would show a greater reduction in all of these distress domains over time compared with children in the attention control group. We hypothesized that these reductions would be evident immediately after the intervention had been administered as well as at a follow-up assessment. To test the range of utility of this intervention within the population of children diagnosed with cancer, we included children ranging in age from 3 to 18 years and tested the moderating effects of age on the intervention.

We also hypothesized that children in the intervention group would show more accurate (less exaggerated) memories after the intervention compared with children in the attention control group but that these groups would not differ at baseline. We also reasoned that if memory is the mechanism through which this intervention works, then among children in the intervention group, there would be a positive association between changes in memory (i.e., decreases in negative exaggerations) over time and decreases in distress (self-report, physiological, and observed).

Method

Participants

This study was conducted at the outpatient Childrens Center for Cancer and Blood Diseases at Childrens Hospital Los Angeles (CHLA). Eligibility criteria included diagnosis of ALL, age between 3 and 18 years, and being English or Spanish speaking. One family declined participation, one family moved before completing any study measures, and 1 patient died before completing any study measures; thus, 55 participants were included in all analyses involving baseline measures. Two families chose to continue treatment at a different hospital (DH), 2 patients completed treatment (CT) before completing participation in the study, 1 patient was changed to a different treatment protocol (DTP) after one LP; thus, a total of 50 participants were included in the posttreatment analyses described below. Seven additional patients did not participate in a follow-up LP (2 DH, 2 DTP, 1 CT, and 2 did not have three LPs during the course of the study period).

Sixty-seven percent of participants were male. Gender proportions were comparable with national statistics (Margolin & Poplack, 1997). In addition, the study sample was 25% Caucasian, 61% Hispanic, 11% Asian, and 4% African American. Twenty-nine percent of the children spoke Spanish only, and 33% of the parents spoke Spanish only. Children in the study averaged 7.3 (SD = 3.7) years of age and ranged from 3 to 18 years of age (see Table 1).

Percentages of missing data (MD) across all three LPs were calculated. Data were missing for the following reasons: child unable to understand self-report questions (27%), physiological equipment malfunction (9%), cortisol levels not within analyzable range (9%), parent not present on LP day (3%), time constraints due to other procedures in the hospital setting (child self-report, 7%; parent self-report, 4%; physiological measures, 2%), and participant refusal (child self-report, 4%; parent self-report, 2%; physiological measures, 2%). The majority of MD lay in the child self-report domain; however, other distress measures (e.g., physiological) were available for these children. Thus, children who were missing any self-report data were compared with children missing no self-report data on demo-

Table 1
Demographic and Medical Variables for the Treatment and Control Groups

Variable	Treatment group				Control group			
	n	%	*M*	*SD*	*n*	%	*M*	*SD*
Gender								
Male	16				17			
Female	9				8			
Ethnicity								
Caucasian		35				16		
Hispanic		50				76		
Age (3–18 years)			7.5	3.5			6.6	3.6
Annual parental income ($)			28,000	16,000			23,000	13,000
No. of previous LPs (0–20)			5.5	4.9			5.4	4.2
LP duration (5–60 min)			13.8	5.5			12.2	3.9
Treatment risk (% high risk)		39				40		
Treatment stage at study entry (% induction stage)		58				52		

Note. None of the differences between the treatment group and the control group on any of these variables were significant. Induction stage refers to the initial period of treatment following diagnosis of acute lymphoblastic leukemia. LP = lumbar puncture.

graphics, baseline distress measures (observed, physiological, and parent- and physician assistant-rated distress), and changes in distress measures over time. Children who had some MD were younger than children with no MD (NMD), $t(53) = 4.65$, $p < .001$. MD children did not differ from NMD children on any baseline distress measures except observational distress. MD children were observed to be more distressed than NMD children: for preparation phase, $t(52) = 2.78$, $p < .01$; for needle-insertion phase $t(53) = 4.65$, $p < .001$. MD children did not differ from NMD children in changes in distress over time. Among children in the intervention group, MD children did not differ from NMD children in changes in distress.

Experimental Conditions

Treatment group. Treatment was conducted at two time points: immediately following the first observed LP and before the second observed LP, given that repeated suggestions about previous events are more likely to change memories than single suggestions (Zaragoza & Mitchell, 1996). Intervention took place in one of the waiting rooms and was conducted individually with each child. Parents were allowed to be present but did not actively participate. Therapists included a clinical psychology graduate student and trained research assistants. Bilingual research assistants helped to translate the intervention for Spanish-speaking families.

Children's memories of the most recent LP were elicited through a memory interview that tested for biases in recall of threatening details, anxiety, and pain. The therapist was present for observational purposes during the LP for all participants. In conducting the intervention, the therapist encouraged children to (a) reevaluate their reactions to the last LP through enhancing their beliefs about the efficacy of their own coping strategies (e.g., reminding them how asking the physician assistant questions helped them), (b) realistically appraise their responses to the LP (e.g., assessing the extent to which they cried, screamed, or protested), and (c) increase the accuracy of their subjective memory. For example, some children were unable to remember any coping strategies when in fact they made observable attempts to cope, others remembered crying during the entire LP when in fact they may have cried 50% of the time, and others remembered (1 week later) the LP as being more painful or anxiety provoking than they themselves reported the day of the LP. In all cases, the therapist and child discussed specific differences between the child's memories and observed behaviors or the child's previous self-report. Children were not taught coping skills but were encouraged to remember successful coping attempts that they naturally had made.

Additionally, to remind them about the intervention techniques during subsequent procedures, we offered children a fluorescent card that contained a cartoon drawing of a child thinking about his or her LP experience. Children wrote down memories discussed during the intervention on the card and then took the card into the procedure room. This card was intended to trigger thinking about the intervention in the absence of the therapist (during future LPs).

Attention control group. Children spent the same amount of time with the therapist as did the treatment group, both after the first observed LP and before the second observed LP, but were engaged in non–procedure-related activities (e.g., drawing). Children in both groups were offered support and encouragement by the nurse and physician assistant during LPs and received preparation from the child life staff, including information and demonstrations with dolls. However, children in the attention control group did not have a card to take with them during their LPs.

Measures

All measures were translated into Spanish, and children and parents completed the measures in their preferred language.

Self-report questions. Children rated their anxiety and pain on a 10-cm vertical visual analogue scale (VAS) ranging from 0 (*not anxious/painful at all*) to 10 (*extremely anxious/painful*). Parents rated their child's anxiety and pain on the same VAS. The physician assistant who performed the LP rated the child's procedural distress on the VAS. Physician assistants were not blind to treatment condition because they observed children with the intervention card. Pain and anxiety questions were administered to all children; however, if a child was too young to understand the question, the data were not analyzed.

Memory interview. The 35-item measure probed details of the child's last LP. This interview format is similar to one developed by Merritt, Ornstein, and Spicker (1994), which has high interrater reliability (.94) and includes both open-ended and yes–no questions. Questions included details present and absent (e.g., "Did the nurse take your temperature during the procedure?"). Also, questions probed memories of intensity of pain and anxiety during the last LP. Interviews were conducted by a graduate student or trained research assistant, and responses were coded as either correct or incorrect. The memory interview was scored by calculating the

percentage of LP administration details correctly endorsed (total memory score) and the percentage of misleading questions (administration details that were not part of the LP) endorsed.

Additionally, items were categorized as negative or positive/neutral in valence by six raters. There was 81% agreement across all questions, with a kappa of .61. Kappas greater than .60 are considered acceptable agreement (Landis & Koch, 1977). Negative questions included "How large do you think the needle was?" whereas positive questions included "Did your mom hold your hand during the LP?" Percentages of negatively and positively valenced items remembered were calculated.

Observational measure. Using the Procedure Behavior Check List, trained observers rated children's distress during the LP along 10 operationally defined behaviors that indicate anxiety and/or pain (e.g., screaming or crying). Each behavior is rated on a scale ranging from 1 (*very mild*) to 5 (*extremely intense*) during three time periods: preparation, needle insertion, and postprocedure. Observational distress scores are calculated by summing the ratings for the 10 behaviors for each phase. This measure correlates significantly (.26 to .53) with patient ratings of anxiety and pain before and during cancer procedures (LeBaron & Zeltzer, 1984).

On completion of their training, all research assistants rated five videotaped LPs. Reliability correlations (the correlation in distress rating between every pair of trained observers across the five videotapes) ranged from .82 to .90 for each phase. In addition, 25% of all LPs at CHLA were observed by two raters, and reliability correlations for each phase of the LP ranged from .90 to .95. Observers were not blind to treatment condition because they saw children with the intervention cards.

Physiological measures. Blood pressure was recorded from a Dinemap automatic system, which consists of a blood pressure cuff attached to a monitor. The cuff was placed around the child's arm over the brachial artery. Three blood pressure readings taken 1 min apart were obtained at each time point described in the *Procedures* section, and an average blood pressure reading was calculated. Heart rate also was recorded from the Dinemap automatic system. Three heart rate readings were taken 1 min apart, and an average heart rate was calculated. To examine salivary cortisol, we obtained a 1- to 2-ml saliva sample from each child at each time point described in the *Procedures* section. Saliva was obtained by having each child place a small cotton roll in his or her mouth for 1 to 2 min. Saliva was extracted using a 10-cc syringe and frozen at −70 °C until shipped overnight to the Pennsylvania State University Behavioral Endocrinology Laboratory. Samples were pH corrected by dilution using 20× phosphate buffered saline. The assay used a commercially available serum cortisol radioimmunoassay (Pantex, Santa Monica, CA) modified for use with saliva by the University of Minnesota Endocrine Hospital. The average interassay coefficient of variation was 8.81%. All samples were tested in duplicate, and values were averaged. Samples were reassayed if the values returned from duplicate tests had greater than 5% error.

Medical records. We obtained information about age at diagnosis, number of previous LPs, treatment protocol, stage of treatment, and treatment risk from patients' medical records.

Procedures

Once written informed consent had been obtained, children were randomized into the intervention or attention control condition. During their next scheduled LP (baseline LP), an assessment was conducted prior to the LP, which included parent and child anticipatory anxiety and pain ratings as well as physiological measurements. During each LP, an observer rated behavioral displays of anxiety and pain and the physician assistant rated each child's distress. Post-LP assessment included parent and child anxiety and pain ratings of the LP as well as physiological measures. Intervention was conducted immediately following the first observed LP and immediately preceding the second LP for 15 min each time.

On the day of the second LP (typically 1 week later), the memory interview was conducted followed by the intervention. Then the same pre-LP and post-LP assessment described above was conducted. This LP was considered the postintervention LP. A third LP (the child's next scheduled procedure, typically 1 week after the second LP) was observed to assess longer term effects of the intervention. The same measurements were taken as with the second LP, but no intervention was conducted. This LP was considered the follow-up LP. Children in the attention control group were offered the intervention following their third study LP, thus allowing all the children in the study to receive the intervention. During the clinic visit following the third LP, a second memory interview was conducted for all children.

Data Analysis Strategy

To determine the efficacy of the intervention, we conducted one-way analyses of variance (ANOVAs) that examined differences between the treatment and control groups on distress change scores (postintervention minus baseline, follow-up minus baseline) covarying baseline scores. Because of the a priori directional predictions, one-tailed significance tests were used. Additionally, to evaluate the magnitude of treatment effects, we calculated effect sizes (ESs). Cohen (1988) labeled ESs of 0.20 as small, 0.50 as moderate, and 0.80 as large. To examine the moderating effects of age on the intervention, we conducted regression analyses in which change in distress was regressed on age, treatment condition, and the interaction between age and treatment condition.

To examine the effects of the intervention on children's memory scores, we conducted *t* tests in which children's memory scores in the intervention and attention control groups were compared at baseline and after intervention. We conducted correlations only for the intervention group to examine the association between changes in memory and changes in distress. Because of the a priori directional predictions, one-tailed significance tests were used.

Results

Baseline Characteristics of the Treatment and Control Groups

The intervention and attention control groups did not differ on any of the following demographic variables: age at time of study entry, gender, ethnicity, or parental income (all $ps > .05$). Nor did they differ on any of the following medical variables: age at diagnosis, number of previous LPs before study entry, average duration in minutes of an LP, treatment risk (good vs. poor prognosis), treatment protocol (typically assigned on the basis of treatment risk), or stage of treatment at time of study entry (all $ps > .10$). Finally, they did not differ on any baseline-dependent measures, such as self-report, parent report, and physician assistant report of pain and anxiety, physiologic measures, or observations of distress (all $ps > .10$). See Table 1 for a comparison of demographic and medical characteristics of the treatment and attention control groups.

Efficacy of Intervention

Posttreatment effects. Average distress change scores and standard deviations for self-report, physiological, and observed distress measures are provided in Table 2. We conducted a series of one-way ANOVAs to test for treatment condition differences in distress change scores (posttreatment minus baseline), covarying baseline scores for all self-report, physiologic, and observational-dependent measures. In the self-report domain, parents of children in the intervention group thought their child expected less LP pain

Table 2
Self-Report and Physiological Distress Change Scores (Posttreatment Minus Baseline)

Variable and group	Anticipatory change scores			During LP change scores		
	n	*M*	*SD*	*n*	*M*	*SD*
Child self-report of pain						
Treatment group	17	−2.4	4.7	15	−0.6	3.9
Control group	14	0.9	3.4	9	−0.2	3.2
Parent rating of child pain						
Treatment group	22	−1.0	2.5	20	0.4	3.1
Control group	25	−0.2	2.7	22	−0.1	1.8
Physician rating of child distress						
Treatment group				25	−0.2	2.6
Control group				25	−0.5	1.9
Heart rate						
Treatment group	22	−13.1	16.2	24	0.1	26.9
Control group	23	0.3	15.8	20	−4.9	21.8
Blood pressure (SBP/DBP changes)						
Treatment group	22	−3.2/−1.3	10.5/9.5	23	−0.5/−4.1	11.8/10.9
Control group	22	−3.6/0.7	9.7/8.0	19	−5.4/2.9	7.9/10.2
Cortisol						
Treatment group	18	−0.02	0.27	22	0.01	0.18
Control group	21	−0.02	0.19	22	0.01	0.20
Observed distress						
Treatment group				25	−0.62	3.7
Control group				25	−0.48	2.0

Note. Greater negative change scores indicate greater decreases in distress over time. LP = lumbar puncture; SBP = systolic blood pressure; DBP = diastolic blood pressure.

over time than did parents of children in the attention control group, $F(1, 44) = 3.01$, $p < .05$, ES = 0.44. No other self-report measures showed significant differences.

For physiological measures, children in the intervention group showed greater decreases in anticipatory heart rate over time than did children in the attention control group, $F(1, 42) = 8.09$, $p < .01$, ES = 0.84. In contrast, children in the attention control group showed greater decreases in post-LP systolic blood pressure over time than did children in the intervention group, $F(1, 39) = 3.02$, $p < .05$, ES = −0.50. No differences in diastolic blood pressure or cortisol emerged.

In behavioral observations, no significant effects emerged.

Follow-up effects. Average distress change scores and standard deviations for self-report, physiological, and observed distress measures are provided in Table 3. We conducted a series of one-way ANOVAs to test for treatment condition differences in distress change scores (follow-up minus baseline), covarying baseline scores for all self-report, physiologic, and observational-dependent measures. Children in the intervention group reported greater decreases in pain during the LP over time than did children in the attention control group, $F(1, 21) = 11.36$, $p < .01$, ES = 1.20 (see Figure 1). Physician assistants also rated children in the intervention group as showing greater decreases in distress over time than children in the attention control group, $F(1, 40) = 2.78$, $p = .05$, ES = 0.48.

In the physiological realm, children in the intervention groups showed greater decreases in pre-LP cortisol levels than did children in the attention control group, $F(1, 33) = 5.03$, $p < .025$, ES = 0.73 (see Figure 1). No differences in heart rate or blood pressure emerged.

In the behavioral observation realm, children in the intervention group showed greater decreases in observable distress over time than did children in the attention control group: for postprocedure phase, $F(1, 40) = 3.75$, $p < .05$, ES = 0.30 (see Figure 1).[1]

Impact of age on efficiency of intervention. One question that arises is how applicable the intervention is for ALL patients of different ages. To assess whether age moderated the effects of treatment on distress, we computed a series of regression equations in which distress change scores were regressed on age, treatment condition, and the interaction of age and treatment condition. Although there were no statistically significant results, some trends did emerge. Because of the large number of patients required to detect significant interactions in multiple regression equations (Aiken & West, 1991), these trends are explored in more detail below.

The interaction between age and treatment group approached significance for children's anticipatory heart rate ($\beta = -0.34$, $p = .09$). Among children in the treatment group, there was a trend toward a positive association between age and distress change scores ($\beta = 0.11$), indicating that younger children tended to show greater decreases in heart rate from baseline to postintervention. Among children in the attention control group, there was a trend toward a negative association between age and distress change

[1] Age and number of previous LPs correlated with baseline distress scores, whereas duration of LP did not. Thus, we repeated all postintervention and follow-up analyses of treatment efficacy using children's age and number of previous LPs as a covariate. The pattern of significant and nonsignificant findings was the same as reported above.

Table 3
Self-Report and Physiological Distress Change Scores (Follow-Up Minus Baseline)

Variable and group	Anticipatory change scores			During LP change scores		
	n	*M*	*SD*	*n*	*M*	*SD*
Child self-report of pain						
Treatment group	18	−1.2	4.4	16	−2.1	3.2
Control group	12	−0.2	3.8	8	1.6	3.1
Parent rating of child pain						
Treatment group	19	−1.1	2.8	16	0.3	3.3
Control group	22	−0.7	3.2	20	0.4	2.7
Physician rating of child distress						
Treatment group				21	−0.7	2.1
Control group				22	0.2	2.0
Heart rate						
Treatment group	19	−11.8	16.3	21	−7.5	21.6
Control group	20	−6.8	21.7	17	−12.3	22.2
Blood pressure (SBP/DBP changes)						
Treatment group	20	−4.7/−6.0	10.1/10.4	20	−3.6/−5.4	15.4/9.9
Control group	18	−6.9/−7.0	13.0/10.9	17	−4.3/−4.4	11.6/9.8
Cortisol						
Treatment group	18	−0.10	0.18	18	−0.01	0.26
Control group	18	0.14	0.48	17	−0.01	0.13
Observed distress						
Treatment group				21	−0.81	3.1
Control group				22	0.00	2.3

Note. Greater negative change scores indicate greater decreases in distress over time. LP = lumbar puncture; SBP = systolic blood pressure; DBP = diastolic blood pressure.

scores ($\beta = -0.37$), indicating that younger children tended to show greater increases in distress over time. In other words, the intervention appeared to be more efficacious for young children when heart rate is considered. This may be due in part to younger children naturally exhibiting more distress over time, as evidenced by the control group findings (see Figure 2).

A similar trend occurred at postintervention for physician assistant ratings of child's distress during the LP (interaction $\beta = -0.33$, $p = .10$). Younger children who received treatment tended to show greater decreases in distress from baseline to postintervention ($\beta = 0.31$). In contrast, younger children who did not receive treatment tended to show greater increases in distress over time ($\beta = -0.16$).

At follow-up, a similar trend occurred for the interaction between age and treatment group for physician assistant ratings of child's distress during the LP ($\beta = -0.36$, $p = .11$). Younger children who received treatment tended to show greater decreases

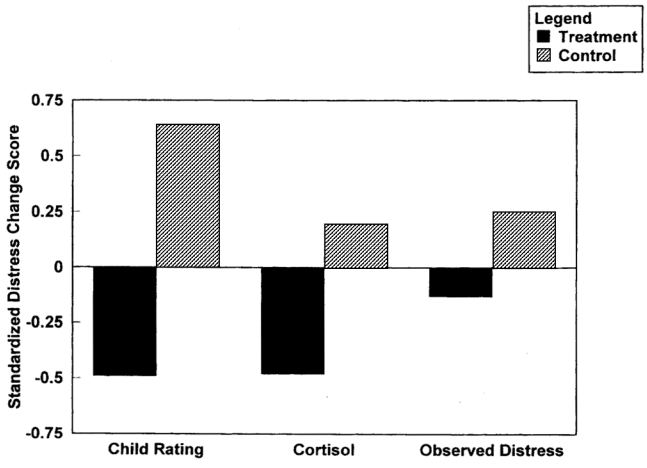

Figure 1. Standardized distress change scores (follow-up minus baseline) for the treatment and control groups in self-report, physiological, and observed distress domains. Greater negative distress change scores indicate greater decreases in distress over time.

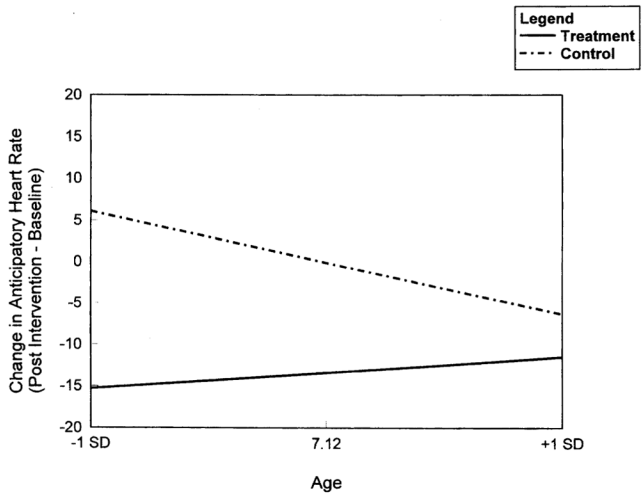

Figure 2. Correlation between age and anticipatory heart rate change score (postintervention minus baseline) for treatment and control groups. Greater negative changes scores indicate greater decreases in heart rate over time.

Table 4
Treatment-Related Memory Interview Data

Time and variable	Treatment group			Control group		
	n	*M*	*SD*	*n*	*M*	*SD*
Baseline						
% total memory	25	67.6	27.5	21	62.7	18.5
% negative memory	25	64.0	30.9	21	53.6	25.1
% positive memory	25	69.9	23.8	21	71.4	13.8
% misleading questions endorsed	25	31.2	37.9	21	24.8	34.6
Postintervention						
% total memory	18	79.7	15.7	16	71.3	22.0
% negative memory	18	78.1	20.6	16	63.0	26.4
% positive memory	18	74.3	10.1	16	67.5	22.9
% misleading questions endorsed	18	8.9	15.7	16	31.2	40.0

in distress from baseline to follow-up ($\beta = 0.24$). In contrast, younger children who did not receive treatment tended to show greater increases in distress over time ($\beta = -0.25$).

Effect of Intervention on Memory Scores and Distress

The intervention and attention control groups did not differ on any memory scores (total score, percentage of positive or negative questions answered correctly, and number of misleading questions endorsed) at the first memory interview (all $ts < 1.3$, $ps > .20$). The second memory interview, conducted after the intervention group had received treatment, revealed that children in the treatment group endorsed significantly fewer misleading questions as true, $t(30) = 2.2$, $p < .025$, and more accurately remembered negative questions, $t(30) = 1.8$, $p < .05$, compared with children in the attention control group. In contrast, children in the two groups did not differ in terms of their memory for positive questions. Qualitative questions in the memory interview (e.g., "How big was the needle?") were coded in such a way that a correct score was given if the child responded with the correct or a less negative response (e.g., smaller needle length). Thus, a less accurate memory score indicates a more exaggerated negative memory. These results demonstrate that the intervention increased the accuracy of, and decreased the exaggeration in, children's memories for negative aspects of the LP (see Table 4).[2]

To examine more directly whether memory was responsible for changes in distress among children in the intervention group, we calculated "negative memory change scores" that reflected the difference between amount of pain or anxiety recalled from the previous LP and self-report of pain or anxiety the day of the LP. Exaggeration was indicated by greater pain or anxiety recalled 1 week later than reported the day of the LP. Among children who received the intervention, those who displayed less exaggeration in negative memory of anxiety over time reported greater decreases in anticipatory anxiety at posttreatment and follow-up, $t(11) = 2.19$, $p < .05$, and $t(10) = 4.77$, $p < .01$, respectively; procedural anxiety at posttreatment and follow-up, $t(10) = 3.37$, $p < .01$, and $t(10) = 3.90$, $p < .01$, respectively; parental rating of child anxiety at follow-up, $t(8) = 3.88$, $p < .01$; parental rating of child pain at posttreatment, $t(7) = 2.31$, $p < .05$; physician assistant rating of child distress at follow-up, $t(10) = 2.15$, $p < .05$; post-LP heart rate at follow-up, $t(10) = 2.94$, $p < .025$; and post-LP systolic blood pressure at posttreatment, $t(10) = 2.71$, $p < .025$. In terms of pain ratings, children who showed less exaggerations in pain negative memory displayed greater decreases in heart rate at posttreatment and follow-up, $t(10) = 2.70$, $p < .025$, and $t(9) = 2.72$, $p < .025$, respectively, and had parents who rated their child's pain as decreasing at posttreatment, $t(9) = 1.94$, $p < .05$. However, children with less exaggeration in pain negative memories also showed greater increases in pre-LP cortisol levels posttreatment, $t(8) = -2.47$, $p < .025$. In general, the findings demonstrate that among children in the intervention group, less negative exaggeration in recall of pain and anxiety is associated with greater reductions in distress by postintervention and follow-up.

Discussion

Efficacy of Intervention

The findings from this study indicate that a psychological intervention that aims to reframe children's memories of their previous experiences with LPs has an immediate effect of reducing some measures of children's anticipatory distress. Children in the intervention group showed reductions in parent ratings of the child's anticipatory pain and anticipatory heart rate by postintervention, whereas children in the attention control group did not. The more potent effects of this intervention emerged at the follow-up LP, where reductions in various measures of anticipatory and procedural distress were greater in the intervention group, including reductions in child report, physician assistant report, physiological, and observational measures of distress. The magnitude of these effects was large in comparison with behavioral interventions among cancer patients (Meyer & Mark, 1995). In addition, ESs at both postintervention and follow-up were within the moderate to large range by Cohen's (1988) standards, with the exception of changes in observed distress at follow-up (ES = 0.30). Unfor-

[2] After controlling for initial accuracy in memory, we found that children in the intervention group still endorsed fewer false questions as true compared with children in the attention control group, $F(1, 31) = 5.39$, $p < .025$; however, the finding that children in the intervention group had greater negative memory accuracy than children in the attention control group was no longer significant, $F(1, 31) = 1.22$, $p = .14$.

tunately, comparisons of the present study's ESs with cognitive–behavioral packages for LPs (Jay et al., 1987, 1991) were not feasible because of the completely within-subject design of those studies. One caveat to consider in interpreting these results, however, is that the sample size of ALL patients in the study was small.

The pattern of results from the present study is interesting in that most of the reductions in distress *during* the LP did not emerge until the follow-up assessment. It is possible that immediately after the intervention, children remember more vividly coping attempts they had made in the past, resulting in reduced self-report and physiological anticipatory measures of distress. However, because of the brief duration of the intervention, learning may have been insufficient, resulting in typical distress behaviors on entering the procedure room. Over the ensuing week, children in the intervention group may have rehearsed their memories about coping strategies and their effectiveness, leading to a stronger reevaluation of the LP as less aversive and a more generalized reduction in both anticipatory and procedural distress at the follow-up LP. Additionally, cues such as the intervention card may have reinforced such learning. This pattern fits with data showing that emotional suggestions regarding a vaccination (being told the shot did not hurt) for 5-year-old children resulted in remembering less crying 1 year, but not 1 week, after the suggestion (Bruck, Ceci, Francoeur, & Barr, 1995). Additionally, Christenfeld (1997) found that distracting instructions lowered pain ratings 10 min after an experimental pain task but not immediately posttask, possibly because the delay gave the participants time to reconstruct their memories of the pain experience.

Additionally, the analyses of the intervention effects by age suggest target groups for this intervention. Regression analyses revealed trends indicating that the benefit of intervention (in terms of decreases in distress) increases for younger age groups. This may be because younger children's memories are more malleable or because younger children often display greater distress to begin with. This finding is promising in light of the fact that the peak age of incidence of ALL is 4 years (Robison, 1997); thus, this type of memory-based intervention would probably be appropriate for a majority of pediatric patients with ALL.

Effectiveness of Intervention

Currently, 22% of surveyed hospitals offer no preparation for pediatric oncology procedures. Empirically validated interventions, such as educational videos, are used by fewer than 10% of oncology settings (O'Byrne, Peterson, & Saldana, 1997). These data indicate that although various treatments have been found to be efficacious in controlled trials, there exist barriers to implementing them in oncology settings, which reduce the effectiveness of the treatment. Any new approach to treatment should be designed with consideration for its feasibility, given the time and resource constraints of many hospitals. We hope that two characteristics of the memory intervention in the present study will make it appealing to pediatric oncology staff. First, the amount of time required is relatively brief. Some cognitive–behavioral treatment packages require approximately 1 hr of intervention the day of the LP (Jay et al., 1987; Jay, Ozolins, Elliott, & Caldwell, 1983); in contrast, our treatment required 30 min across two treatment sessions (15 min each). However, it should be noted that the memory intervention is more time intensive than some distracting techniques (e.g., use of a party blower; Manne et al., 1994). Second, the memory intervention is designed so that the therapist does not need to be present during each LP. Some treatment approaches, although quite efficacious, necessitate a therapist present during each LP to coach the child through techniques such as hypnosis (Katz et al., 1987). Future studies need to formally compare cost-effectiveness among the various existing treatments for procedure-related distress to determine which interventions provide the greatest reductions in distress for the lowest cost in terms of staff time.

Memory as a Mechanism for Change

UCS revaluation theory (Davey, 1992) as well as theories of trauma treatment (Foa, Molnar, & Cashman, 1995) posit that changes in memory as a result of reevaluating the aversive event should be associated with decreases in anxiety. Data comparing the treatment and control groups revealed that, following intervention, the treatment group showed more accurate memory for negative aspects of the LP (but not neutral aspects) compared with the control group. In addition, those in the treatment group who displayed the smallest exaggerations in negative memory showed the greatest decreases in distress at postintervention and follow-up. The finding that those children in the treatment group with smaller exaggerations in negative memory showed greater increases in pre-LP cortisol may reflect an adaptive anticipatory response to support coping with an upcoming stressor, similar to neuroendocrine responses found for other stressful situations (Baum & Grumberg, 1995). Overall, these data provide evidence that the intervention affected children's distress through reducing children's exaggerated negative memories about their previous LPs.

It is possible, however, that other mechanisms of change operated during the intervention and that the changes in memory reflected these mechanisms. For example, the intervention may have produced changes in coping behaviors during the LP, which may also be associated with less exaggerated negative memories of the LP. Alternatively, it is possible that the intervention cue card by itself had a beneficial effect on perceptions of children's distress. Future studies testing this type of intervention would need to include measures of alternative mechanisms to determine whether memory changes truly drive this intervention.

Limitations and Future Directions

The primary limitation of this study was the relatively small sample size, which limited our statistical power. This problem was exacerbated by the fact that some children in the study were too young to complete the self-report measures. Additionally, the wide age range included in this study makes it difficult to determine treatment efficacy for specific age groups. Future larger scale studies would enable tests of the magnitude of the intervention effects within specific age groups, as well as more complex analyses regarding the process of treatment change. Finally, an important goal of future studies should be to examine long-term treatment effects. The present study provided evidence that over the

course of 1 week, the effects of the intervention generalized from anticipatory to procedural distress, but the issue of whether the memory changes and reductions in distress can be maintained long term remains unclear.

References

Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testing and interpreting interactions.* London: Sage.

Arntz, A., van Eck, M., & Heijmans, M. (1990). Predictions of dental pain: The fear of expected evil is worse than the evil itself. *Behaviour Research and Therapy, 28,* 29–41.

Barrett, P. M., Rapee, R. M., Dadds, M. M., & Ryan, S. M. (1996). Family enhancement of cognitive style in anxious and aggressive children. *Journal of Abnormal Child Psychology, 24,* 187–203.

Baum, A., & Grumberg, N. (1995). Measurement of stress hormones. In S. Cohen, R. Kessler, & L. Gordon (Eds.), *Measuring stress: A guide of health and social scientists* (pp. 175–192). New York: Oxford University Press.

Bruck, M., Ceci, S. J., Francoeur, E., & Barr, R. (1995). "I hardly cried when I got my shot!" Influencing children's reports about a visit to their pediatrician. *Child Development, 66,* 193–208.

Chen, E., Zeltzer, L. K., Craske, M. G., & Katz, E. R. (in press). Children's memories for painful cancer treatment procedures: Implications for distress. *Child Development.*

Christenfeld, N. (1997). Memory for pain and delayed effects of distraction. *Health Psychology, 16,* 327–330.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Erlbaum.

Cracknell, S., & Davey, G. C. L. (1988). The effect of perceived unconditioned response strength on conditioned responding in humans. *Medical Science Research, 16,* 169–170.

Davey, G. C. L. (1989). UCS revaluation and conditioning models of acquired fears. *Behaviour Research and Therapy, 27,* 521–528.

Davey, G. C. L. (1992). Classical conditioning and the acquisition of human fears and phobias: A review and synthesis of the literature. *Advances in Behaviour Research and Therapy, 14,* 29–66.

Eich, E., Reeves, J. L., Jaeger, B., & Graff-Radford, S. (1985). Memory for pain: Relation between past and present pain intensity. *Pain, 25,* 375–379.

Foa, E. B., Molnar, C., & Cashman, L. (1995). Change in rape narratives during exposure therapy for posttraumatic stress disorder. *Journal of Traumatic Stress, 8,* 675–690.

French, G. M., Painter, E. C., & Coury, D. L. (1994). Blowing away shot pain: A technique for pain management during immunization. *Pediatrics, 93,* 384–388.

Jacobsen, P. B., Bovbjerg, D. H., & Redd, W. H. (1993). Anticipatory anxiety in women receiving chemotherapy for breast cancer. *Health Psychology, 12,* 469–475.

Jay, S. M., Elliott, C. H., Fitzgibbons, I., Woody, P., & Siegel, S. (1995). A comparative study of cognitive behavior therapy versus general anesthesia for painful medical procedures in children. *Pain, 62,* 3–9.

Jay, S. M., Elliott, C. H., Katz, E., & Siegel, S. E. (1987). Cognitive–behavioral and pharmacologic interventions for children's distress during painful medical procedures. *Journal of Consulting and Clinical Psychology, 55,* 860–865.

Jay, S. M., Elliott, C. H., Ozolins, M., Olson, R. A., & Pruitt, S. D. (1985). Behavioral management of children's distress during painful medical procedures. *Behaviour Research and Therapy, 23,* 513–520.

Jay, S. M., Elliott, C. H., Woody, P. D., & Siegel, S. (1991). An investigation of cognitive–behavior therapy combined with oral valium for children undergoing painful medical procedures. *Health Psychology, 10,* 317–322.

Jay, S. M., Ozolins, M., Elliott, C. H., & Caldwell, S. (1983). Assessment of children's distress during painful medical procedures. *Health Psychology, 2,* 133–147.

Katz, E. R., Kellerman, J., & Ellenberg, L. (1987). Hypnosis in the reduction of acute pain and distress in children with cancer. *Journal of Pediatric Psychology, 12,* 379–394.

Katz, E. R., Kellerman, J., & Siegel, S. E. (1980). Behavioral distress in children with cancer undergoing medical procedures: Developmental considerations. *Journal of Consulting and Clinical Psychology, 48,* 356–365.

Lander, J., Hodgins, M., & Fowler-Kerry, S. (1992). Children's pain predictions and memories. *Behaviour Research and Therapy, 30,* 117–124.

Landis, J. R., & Koch, G. G. (1977). An application of hierarchical kappa-type statistics in the assessment of majority agreement among multiple observers. *Biometrics, 33,* 363–374.

LeBaron, S., & Zeltzer, L. (1984). Assessment of acute pain and anxiety in children and adolescents by self-reports, observer reports, and a behavior checklist. *Journal of Consulting and Clinical Psychology, 52,* 729–738.

Leichtman, M. D., & Ceci, S. J. (1995). The effects of stereotypes and suggestions on preschoolers' reports. *Developmental Psychology, 31,* 568–578.

Loftus, E. (1991). Made in memory: Distortions in recollection after misleading information. In G. H. Bower (Ed.), *The psychology of learning and motivation* (Vol. 27, pp. 187–215). San Diego, CA: Academic Press.

MacLeod, C., Mathews, A., & Tata, P. (1986). Attentional bias in emotional disorders. *Journal of Abnormal Psychology, 95,* 15–20.

Manne, S. L., Bakeman, R., Jacobsen, P. B., Gorfinkle, K., & Redd, W. H. (1994). An analysis of a behavioral intervention for children undergoing venipuncture. *Health Psychology, 13,* 556–566.

Manne, S. L., Redd, W. H., Jacobsen, P. B., Gorfinkle, K., Schorr, O., & Rapkin, B. (1990). Behavioral intervention to reduce child and parent distress during venipuncture. *Journal of Consulting and Clinical Psychology, 58,* 565–572.

Marche, T. A., & Howe, M. L. (1995). Preschoolers report misinformation despite accurate memory. *Developmental Psychology, 31,* 554–567.

Margolin, J. F., & Poplack, D. G. (1997). Acute lymphoblastic leukemia. In P. A. Pizzo & D. G. Poplack (Eds.), *Principles and practice of pediatric oncology* (3rd ed., pp. 409–462). Philadelphia: Lippincott-Raven.

McGrath, P. A., & de Veber, L. L. (1986). The management of acute pain evoked by medical procedures in children with cancer. *Journal of Pain and Symptom Management, 1,* 145–150.

Melamed, B. G., & Ridley-Johnson, R. (1988). Psychological preparation of families for hospitalization. *Developmental and Behavioral Pediatrics, 9,* 96–102.

Merritt, K. A., Ornstein, P. A., & Spicker, B. (1994). Children's memory for a salient medical procedure: Implications for testimony. *Pediatrics, 94,* 17–23.

Meyer, T. J., & Mark, M. M. (1995). Effects of psychosocial interventions with adult cancer patients: A meta-analysis of randomized experiments. *Health Psychology, 14,* 101–108.

O'Byrne, K. K., Peterson, L., & Saldana, L. (1997). Survey of pediatric hospitals' preparation programs: Evidence of the impact of health psychology research. *Health Psychology, 16,* 147–154.

Pincus, T., Pearce, S., & Perrott, A. (1996). Pain patients' bias in the interpretation of ambiguous homophones. *British Journal of Medical Psychology, 69,* 259–266.

Robison, L. L. (1997). General principles of the epidemiology of childhood cancer. In P. A. Pizzo & D. G. Poplack (Eds.), *Principles and practice of pediatric oncology* (3rd ed., pp. 1–10). Philadelphia: Lippincott-Raven.

Sallie, H., Burgmeier, R., & Schmidt, L. R. (1988). A meta-analysis of

studies on psychological preparation of children facing medical procedures. *Psychology and Health, 2,* 107–132.

Tessler, M., & Nelson, K. (1994). Making memories: The influence of joint encoding on later recall by young children. *Consciousness and Cognition, 3,* 307–326.

Vasey, M. W., Daleiden, E. L., Williams, L. L., & Brown, L. M. (1995). Biased attention in childhood anxiety disorders: A preliminary study. *Journal of Abnormal Child Psychology, 23,* 267–279.

Zaragoza, M. S., & Mitchell, K. J. (1996). Repeated exposure to suggestion and the creation of false memories. *Psychological Science, 7,* 294–300.

Zeltzer, L. K., & LeBaron, S. (1982). Hypnosis and nonhypnotic techniques for reduction of pain and anxiety during painful procedures in children and adolescents with cancer. *Journal of Pediatrics, 101,* 1032–1035.

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