The role of attachment and cognitive inhibition in children's memory and suggestibility for a stressful event

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Abstract

There has been increasing interest in children's abilities to report memories of and resist misleading suggestions about distressing events. Individual differences among children and their parents may provide important insight into principles that govern children's eyewitness memory and suggestibility for such experiences. In the present study, 51 children between the ages of 3 and 7 years were interviewed about an inoculation after a delay of approximately 2 weeks. Results indicated that parents' attachment Avoidance was associated with children's distress during the inoculation. Parental attachment Anxiety and the interaction between parental Avoidance and children's stress predicted children's memory for the inoculation. Cognitive inhibition was also a significant predictor of children's memory errors and suggestibility.

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Theoretical implications concerning effects of stress and individual differences on children's eyewitness memory and suggestibility are discussed.

Increasing numbers of studies have focused on children's ability to report memories and resist misleading suggestions about stressful events (Howe, Courage, & Peterson, 1995; Peterson, 1999; Quas et al., 1999; see Pezdek & Taylor, 2002, for a review). Much of this research has investigated children's eyewitness memory for naturally occurring incidents, such as hurricanes (Bahrick, Parker, Fivush, & Levitt, 1998), sniper attacks (Pynoos & Nader, 1989), and medical experiences (e.g., catheterization procedures, Goodman, Quas, Batterman-Faunce, Riddlesberger, & Kuhn, 1994, 1997; Merritt, Ornstein, & Spicker, 1994; emergency room visits, Peterson & Bell, 1996; inoculations, Goodman, Hirschman, Hepps, & Rudy, 1991). Such research has shown that many of the principles governing memory for nonstressful events (e.g., that memory fades over time) also apply to memory for stressful experiences. More elusive has been the discovery of principles that apply uniquely to distressing incidents. Because of their particular relevance to children's reactions, individual differences among children and their parents may provide important insights into principles that govern children's memory for stressful events (Pipe & Salmon, 2002; Quas, Qin, Schaaf, & Goodman, 1997).

The present study was designed to test 3- to 7-year-olds' memory and suggestibility about a naturally occurring stressful event (an inoculation). The inclusion of individual-difference measures permitted investigation of a socio-emotional predictor (parental attachment) and a cognitive predictor (inhibition) of children's memory and resistance to suggestion. Parental attachment is related to parenting attitudes and behaviors (George & Solomon, 1999; Rholes, Simpson, & Blakely, 1995) and to the style and frequency of parents' discourse with their children about emotions (Goodman et al., 1997). By influencing the way children experience (Edelstein et al., 2002), think about, and talk about stressful events, individual differences in parental attachment may be related to children's memory about attachment-related stressful events. In contrast, cognitive inhibition, or the ability to deliberately prevent a probable response, may be more generally related to memory for a variety of events. Specifically, cognitive inhibition involves the ability to process information while inhibiting the influence of irrelevant or distracting information (Harnishfeger & Bjorklund, 1994; Lorsbach & Reimer, 1997), an ability that is important for encoding, storing, and retrieving information from long-term memory. Next,

we briefly review current research on stress and memory, attachment and memory, and inhibition and memory to provide the background and rationale for selecting these individual-difference variables as predictors of children's eyewitness memory.

Stress and memory

Few would disagree that cognitive processes such as memory are linked to emotion (Fischer & Bidell, 1998) and in turn to children's reactions to stressful events. However, there is considerable debate concerning the underlying mechanisms for and the direction of the relation between stress during an event and children's subsequent memory. For instance, some research suggests that distress is associated with memory in a curvilinear fashion, so that moderate stress leads to particularly accurate memory reports (Bahrick et al., 1998), whereas other research indicates that stress during an event may not be positively or negatively associated with later memory for the event in a consistent manner (Quas et al., 1999).

It is also possible that, because of the emotional content of stressful experiences, they are encoded, stored, and retrieved differently than other types of events, leading to extremes of retention or forgetting (e.g., Pezdek & Taylor, 2002). Distress may be associated with decrements in memory performance (Vandermaas, Hess, & Baker-Ward, 1993) because cognitive resources are focused on coping or self-regulation at the expense of attentional focus on details of the event. More specifically, inescapable stress may overwhelm children's coping mechanisms or lead to a greater likelihood of memory distortion concerning negative events, resulting in less accurate memory reports (Johnson & Howell, 1993).

Another possibility is that stress leads to stronger eyewitness memory for at least some details of a target event (Goodman et al., 1991; Pezdek & Taylor, 2002; Shrimpton, Oates, & Hayes, 1998). Stress may render events more personally meaningful and distinctive, thus enhancing memory (Howe, 1997). Furthermore, higher levels of cognitive activation may be maintained and attention may be directed toward significant features of events because of their emotional quality (e.g., Hamann, 2001). If stress causes attention to be focused on central details of an experience, it may lead to better memory for primary features of the event (Christianson, 1992).

Attachment and memory

One explanation for the inconsistent findings concerning the relations between stress and memory in children may be individual differences. It is possible that individual-difference variables, such as parental attachment style,

moderate the relation between children's stress and their memory for an experience. Having a parent with a relational style that facilitates effective coping in the face of distress may enhance children's coping abilities and, thus, children's memory for stressful experiences. Furthermore, having a parent with an attachment style that is related to less optimal coping responses may leave children with a lack of effective means of coping, and thus may cause stress to have a null or negative relation with children's memory. Because attachment-system activation is especially likely in stressful or threatening situations (e.g., Bowlby, 1969), the effects of parental attachment on children's stress and memory may be particularly relevant for experiences that involve threats.

Attachment theory was originally developed to explain how emotional bonds form between infants and their primary caregivers and how the quality of these bonds influences children's developing personality and emotion-regulation capacity (Ainsworth, Blehar, Waters, & Wall, 1978; Bowlby, 1969). Investigators have since expanded the theory to explain adults' relationship styles with parents and romantic partners (Brennan, Clark, & Shaver, 1998; Main, Kaplan, & Cassidy, 1985). Researchers in the fields of personality and social psychology have generally accepted a two-dimensional characterization of individual differences in adult attachment (see Fraley & Shaver, 2000, for review), which is conceptually parallel to the two dimensions underlying Ainsworth's three infant attachment patterns (Ainsworth et al., 1978, Fig. 10, p. 102). These dimensions, called Anxiety and Avoidance, are independent of one another. The attachment Anxiety dimension refers to fear of abandonment and rejection in the context of close relationships. The attachment Avoidance dimension involves discomfort with close relationships. Individuals scoring low on both dimensions are considered secure.

Because parental working models of attachment affect parenting behavior (e.g., George & Solomon, 1999) and because parent–child interaction patterns have implications for children's memory (e.g., Haden, Hayne, & Fivush, 1997), it may prove fruitful to examine associations between children's memory for stressful or threatening events and parental attachment. Insecure parents (those high in Anxiety and/or Avoidance) tend to respond negatively to emotional situations (Zeanah et al., 1993), thus possibly transmitting fear to their children, or dismissing or avoiding discussion of attachment issues with their children (Goldberg et al., 1998, as cited in Hesse, 1999). Such parental attitudes and behaviors may directly or indirectly limit children's encoding of attachment-related events, the opportunities children have to rehearse overtly the events after they have occurred, and the comfort with which children discuss emotional issues with others. In contrast, secure parents (those low in Anxiety and Avoidance) may enhance their children's processing capabilities by providing supportive and responsive caregiving (van IJzendoorn, 1995), thereby creating an environment conducive to

exploration and open discussion of stressful experiences (Bowlby, 1969), which would enhance memory.

Adult attachment style has recently been linked to memory in both adults (e.g., Fraley, Garner, & Shaver, 2000; Miller & Noirot, 1999) and their children (Goodman et al., 1997; Quas et al., 1999). In fact, recent studies indicate that adult attachment measures administered to parents predict children's emotional reactions to and memory for a stressful medical procedure (e.g., Goodman et al., 1997; Quas et al., 1999). For instance, Quas et al. (1999) interviewed 43 children ages 3–13 years old about a previous painful medical experience (i.e., voiding cystourethogram fluoroscopy; VCUG). Parental Fearful attachment (high Anxiety *and* Avoidance) was positively related to children's stress before the VCUG. Furthermore, general parental insecurity (indicated by high scores on Anxiety and/or Avoidance) was associated with increases in children's commission and omission errors regarding the VCUG.

Thus, there is reason to predict a link between parental attachment style and children's memory and suggestibility, yet many questions remain concerning the nature of this association. First, studies examining the relation between parental attachment and children's memory have focused on a highly stressful and embarrassing medical event, VCUG. These findings require replication and extension to other types of events. Second, it is of interest to explore whether children's temperament or parents' personality explains the relation between adult attachment and children's memory.

Researchers have noted the difficulties in separating the effects of attachment style from effects of temperament and personality (e.g., Stevenson-Hinde, 1991); however, there are important differences, and the theoretical implications of the constructs differ considerably. Attachment style is believed to result from relational interactions (Ainsworth et al., 1978; Bowlby, 1969; Fraley & Shaver, 2000), whereas broad personality traits (e.g., introversion) are thought to arise from genetically based temperamental characteristics (e.g., shyness; Caspi, 1998). Because attachment is most relevant in the context of stressful events (Bowlby, 1969), it is likely that parental attachment plays a role in children's memories for threatening or stressful experiences. Adults rely on their attachment system to deal with stressful or threatening information (Fraley & Shaver, 2000), and parental reactions, coping responses, and interaction patterns in and concerning such contexts are relevant to how children learn to react to their experiences (Edelstein et al., 2002). In contrast, adults' broader personality characteristics (i.e., their scores on measures of the ''Big Five'' personality traits; Costa & McCrae, 1992) are generally active across a variety of contexts.

Research demonstrates that adults' attachment style may relate at least slightly to adults' broader personality traits (Shaver & Brennan, 1992), which are thought to be distinct from the effects of attachment history. It

is thus important to explore the separate influences of parental attachment and parental personality on children's memory, yet this kind of exploration has rarely been attempted. Furthermore, because of potential relations between children's temperamental characteristics and their memory for a variety of experiences (Greenhoot, Ornstein, Gordon, & Baker-Ward, 1999; Merritt et al., 1994), it is also important to explore the separate influences of children's temperament and parental variables, namely parental attachment and parental personality, because attachment likely contributes something special to children's memory, at least for stressful, attachment-relevant experiences. Despite their applied and theoretical importance, however, questions regarding the predictive value of parental attachment and personality style on children's memory for stressful events have rarely been examined empirically.

Inhibition and memory

In addition to individual differences related to socio-emotional and parenting factors, individual differences in cognitive capacities may influence children's memory and suggestibility. It is imperative to understand how differences in executive function, which play an important role in information processing, relate to eyewitness memory performance. Executive function is thought to rely on the frontal cortex, which undergoes considerable development during childhood and is known to play an important role in memory (Schacter, Kagan, & Leichtman, 1995). Although few studies have investigated executive function in relation to children's memory or suggestibility, results have linked suggestibility with working memory (Bottoms, Davis, Nysse, Haegerich, & Conway, 2000), inhibition (Ruffman, Rustin, Garnham, & Parkin, 2001; Schaaf, Goodman, & Alexander, 1999), and impulsivity (Quas & Schaaf, in press), all of which are believed to reflect executive function.

Inhibitory abilities help children to ignore irrelevant stimuli. Thus, deficiencies in inhibitory abilities may cause limited encoding of relevant stimuli and consequently weaker overall memory traces for events (Harnishfeger & Bjorklund, 1994). When memory is tested sometime after an event, children with inhibitory deficiencies may be less able to provide complete and accurate reports and may be more suggestible. Additionally, children with low levels of inhibition may be unable to refrain from providing the prepotent response suggested by the interviewer (e.g., in misleading questions). Specifically, because inhibition aids in retrieval through processes such as suppressing irrelevant information (Lorsbach, Katz, & Cupak, 1998) and reducing sensitivity to interference (Dempster, 1992), children may be more resistant to suggestion when inhibition is greater (e.g., Schaaf et al., 1999). Although inhibition has important implications for predicting children's

memory and resistance to suggestion, little research has focused on inhibition and eyewitness memory (but see Ruffman et al., 2001).

The present study

In the present study, children's eyewitness memory and suggestibility were examined in relation to children's stress, parental attachment, and cognitive inhibition. Children ranging in age from 3 to 7 years received an inoculation (as part of their standard medical care) and later answered questions about the event. They also completed a measure of inhibition, and parents completed questionnaires concerning themselves (including attachment and personality measures) and their children.

Based on previous research, several predictions were advanced. First, age differences in memory and suggestibility were expected, as has been commonly reported using a variety of question types and target events (e.g., Goodman & Reed, 1986; Gordon, Baker-Ward, & Ornstein, 2001; Quas et al., 1999). Older children were expected to answer memory questions with greater accuracy and to resist suggestion more effectively.

Second, consistent with former studies of children's memory for inoculations (Goodman et al., 1991; Shrimpton et al., 1998), an overall positive relation was expected between stress and memory for the inoculation event; the stressor was expected to focus attention and cognitive resources on the event, which would enhance memory (Christianson, 1992).

Third, parental attachment style was expected to predict children's memory and suggestibility for the inoculation. Because inoculations cause distress for both parents and children and may thus elicit feelings of fear or threat associated with attachment-system activation (Bowlby, 1969), an inoculation event was deemed appropriate as the attachment-related experience. Parents who rated themselves as more secure (i.e., less anxious and avoidant) were expected to have children with better memory and greater resistance to suggestion than children of parents who rated themselves as insecure (i.e., more anxious and/or avoidant; e.g., Goodman et al., 1997; Quas et al., 1999). The contribution of parental attachment to memory for the inoculation was expected to be independent of the contribution of parental personality traits, indexed by the NEO Five-Factor Inventory, or children's temperamental characteristics, assessed by the Children's Behavior Questionnaire. That is, the addition of parental personality variables or children's temperament measures was not expected to reduce the value of parental attachment in predicting children's memory or suggestibility.

Our fourth hypothesis was that, consistent with theoretical expectations about the relation of cognitive inhibition to memory (Harnishfeger & Bjorklund, 1994), children with higher levels of inhibition would provide

more accurate information and be less suggestible than children with lower levels of inhibition.

Method

Participants

Families were solicited at two county immunization clinics. All children who were 3–7 years old, who spoke English, and whose legal guardians consented to allowing their children to participate in the study were eligible. Fifty-three children initially participated in the study. However, one child was non-responsive and another never talked about the inoculation during the memory interview. The final sample thus consisted of 51 3- to 7-year-old children, $M = 5.30$ years, $SD = 1.07$, including 27 females and 24 males. Socioeconomic status (SES) was derived from parent occupation, which was rated according to a modified version of the Hollingshead index. Participants had ratings ranging from 1 (low) to 7 (high), $M = 3.31$, $SD = 1.94$. Children's ethnicity varied: 59% were European American, 29% were Hispanic American, 10% were African American, and 2% were Native American. Children received small toys upon completion of the memory interview, and families were compensated with $50 at the end of the last session.

Measures

Demographic questionnaire

A standard parent-report demographic questionnaire was used to gather information about the child's and family's background (e.g., child's date of birth, ethnicity, parents' occupations).

Parental relationship questionnaires

Parental attachment was assessed using both the Relationship Questionnaire (Bartholomew & Horowitz, 1991) and an adapted version of the Relationship Scales Questionnaire (Griffin & Bartholomew, 1994). For the Relationship Questionnaire, adults rate the similarity of their current relationship style to each of four attachment styles: Secure, Preoccupied, Dismissing, and Fearful. Ratings are made on 7-point Likert scales (1 = very much like me, 7 = not at all like me). For the Relationship Scales Questionnaire, adults rate their level of agreement (7-point scale; 1 = absolutely disagree, 7 = absolutely agree) with 30 statements concerning close relationship styles. The means for items corresponding to each of the four attachment styles were calculated (Griffin & Bartholomew, 1994). The internal consistency of the subscales ranges from .75 to .79 (Scharfe &

Bartholomew, 1994), and the measure shows moderate stability over an 8-month period (i.e., correlations ranging from .64 to .73, Scharfe & Bartholomew, 1994). Standardized (z) scores for the four categories for the two measures were summed to create a composite measure of attachment (Ognibene & Collins, 1998), and these scores were further combined as per Griffin and Bartholomew's (1994) suggestion, to compute scores for the two dimensions underlying Bartholomew and Horowitz's (1991) four attachment patterns. For the purpose of the present paper, these two scales were considered sufficient to represent individuals' location in the two-dimensional space defined by Anxiety and Avoidance and described by Bartholomew and Horowitz (1991) and Fraley and Shaver (2000). Higher scores indicate higher levels of parental attachment Anxiety and Avoidance.

Day/night task

The Day/Night Task, designed by Gerstadt, Hong, and Diamond (1994) to approximate the Stroop test with 3- to 7-year-olds, was administered to assess children's cognitive inhibition. Children are shown two cards: one white with a yellow sun, the other black with a white moon. They are instructed to say "night" when shown the sun card, and "day" when shown the moon card. Performance on this task is significantly related to other measures of cognitive inhibition (Carlson & Moses, 2001). Once children demonstrate an understanding of the rules, 16 trials are administered, 8 with each card in a mixed order that is the same for each child. For the present study, inhibition scores are reported as proportion of correct responses out of total trials administered, with higher scores indicating greater inhibitory control and more advanced executive functioning.

Children's behavior questionnaire

The Children's Behavior Questionnaire (Rothbart, Ahadi, & Hershey, 1994) was used to assess children's temperament. This measure, designed for use with 3- to 7-year-old children, includes 120 statements that caregivers rate on a 7-point scale according to how true each statement is about their child (1 = extremely untrue, 7 = extremely true). The measure is scored by summing responses to questions representative of one of 12 categories. These 12 categories can be further reduced by creating three temperamental factors: Surgency (High Intensity Pleasure, Activity Level, Approach, and Shyness [reversed]), Negative Affect (Sadness, Fearfulness, Anger, and Soothability [reversed]), and Effortful Control (Low Intensity Pleasure, Inhibitory Control, Attentional Focusing, and Perceptual Sensitivity [reversed]). Internal consistency of the scales ranges from .67 to .94, and the 2-year test-retest reliability ranges from .50 to .79 (Ahadi, Rothbart, & Ye, 1993). Higher scores are indicative of more Surgency, Negative Affect, or Effortful Control.

NEO

The NEO Five-Factor Inventory (Costa & McCrae, 1992) is a self-administered questionnaire used to assess adults' broad personality traits. It is a 60-item version of a widely used, longer personality inventory, the NEO-Personality Inventory (Costa & McCrae, 1988). Adults rate statements according to how much each corresponds to how they feel about themselves on a 5-point scale (1 = strongly disagree, 5 = strongly agree). The measure yields scores for five traits: Neuroticism, Extroversion, Openness, Agreeableness, and Conscientiousness. In a normative sample, 3- to 6-year stability coefficients ranged from .68 to .83, and the internal consistency of the five personality scales ranges from .76 to .93 (Costa & McCrae, 1988). Higher scores indicate higher levels of the corresponding personality trait.

Inoculation memory questionnaire

This questionnaire (see Appendix A) begins with a free-recall section including up to six prompts, then proceeds with a mix of 52 direct and yes/no questions. The latter mix includes 18 direct questions (10 specific and 8 misleading) and equal numbers of specific and misleading yes/no questions (17 each specific and misleading questions). The yes/no questions were designed to yield equal numbers of correct-yes and correct-no answers, whereas direct questions were those directing the child to a particular detail of the event and requiring brief narrative responses. Unlike specific questions, which did not include false presuppositions, misleading questions presupposed incorrect details of the inoculation (e.g., the question "You sat on the nurse's lap while you were getting your shot, didn't you?" presupposes that the child sat on the nurse's lap, when in fact this did not occur).

Procedure

Children were tested individually. Informed consent for each session was obtained from parents.

Session 1

Families were solicited at two county immunization clinics. A female researcher approached parents of children in the appropriate age range and explained the study. To avoid parents coaching children for the memory test, parents were not told at the outset that this was a memory study. Instead, parents were told that we were interested in children's reactions to medical procedures and that we would invite them to return to the laboratory in 2 weeks. If parents wished to participate, they signed a consent form indicating approval of the researchers' videotaping the inoculation(s). When the nurse called children to administer the inoculation(s), a researcher followed the family to the immunization room. At least one parent or guardian was present during each child's inoculation. The inoculations were often

preceded by administration of an oral polio vaccine. Children received between 1 and 5 inoculations ($M = 1.88$) administered by a female nurse employed by the clinic. Children were generally seated on the parent's lap and, if necessary, the parent and/or clinic personnel restrained the child. Once the inoculation(s) were complete, the nurse gave each child a prize, after which families left the clinic. The entire inoculation event typically lasted for 5 minutes, $M = 4.67$ minutes, $SD = 6.92$. In addition to videotaping the event, a researcher filled out a detailed checklist indicating the precise procedures and reactions of children. These objective records were later used for scoring children's memory accuracy.

Session 2

Session 2 took place at a university child development research laboratory. The delay between Sessions 1 and 2 was approximately 2 weeks ($M = 12.21$ days; range $= 3$–33 days). Once informed consent was obtained from parents, children were led into a separate room where a female research assistant (RA) who was not present during the inoculation administered the inoculation memory interview. Children were informed that they could say "I don't know" to questions they could not answer and that they could tell the interviewer if she made a mistake. At the end of the interview, the RA administered the day/night inhibition measure. While children were being interviewed, parents completed the battery of questionnaires about themselves and their child.

Coding

Stress

Children's stress level was rated from the videotapes. A global measure of distress was used, such that a score of 1 indicated that the child was very happy whereas a score of 7 indicated that the child was hysterically upset. Independent coders scored 26% of the videotapes. Inter-rater reliability was .75 for this subsample. Discrepancies were discussed and resolved, and both researchers scored the remaining data. The mean rating was used for analyses. Proportion of agreement across the entire sample, within one scale point, was .98. Although researchers documented in detail the events taking place during each child's inoculation, lack of video recording for some participants reduced the number of participants to 43 for analyses including the stress rating.

Memory

All narrative information provided by children in response to free-recall and direct questions was scored for units using a system similar to those employed in previous studies of children's memory (e.g., Poole & Lindsay, 1995; Quas & Schaaf, in press). For responses to free-recall prompts and

direct questions, a statement about any agent, object, action, recipient, or descriptor that included information about the event in question was considered a unit of information and was scored as correct or incorrect. For example, the statement, "I saw a nurse...she tickled my foot," was scored by crediting the child with having provided 6 units of information: three correct for "I," "saw," and "nurse," and three incorrect for "She," "tickled," and "foot." Units were collapsed across all free-recall prompts. Irrelevant and unverifiable information, such as a child's digression about what her dog did that day, was not included in the scoring.

Children's responses to specific and misleading yes/no questions were scored as proportions for correct responses, omission errors, commission errors, do-not-know replies, or unscoreable content. Commission errors were responses indicating that something happened or was present when in fact it did/was not. Omission errors were responses that failed to indicate that something happened or was present when in fact it did/was. Do-not-know and unscoreable responses constituted only 4% and 2% of children's responses, respectively, and are not considered further.

Two independent coders scored 19% of the memory interviews. Proportion agreement for dependent measures ranged from .82 to .95. Discrepancies were resolved, and each researcher coded half of the remaining interviews.

Results

The present study was designed to address questions concerning inconsistencies in the stress and memory literature, which may be due, in part, to individual differences in children and their parents. Means and standard deviations for memory variables are presented in Table 1. Correlations among individual difference and memory measures are displayed in Table 2. As rel-

Table 1
Means and standard deviations for memory and suggestibility measures

	M	SD
Toal units free recall		
Correct	9.39	6.69
Incorrect	1.90	3.34
Proportion correct	.85	.25
Mean units to direct questions		
Correct	1.02	.38
Incorrect	.33	.43
Proportion correct	.78	.22
Proportion correct to yes/no questions		
Specific	.71	.14
Misleading	.76	.20

Table 2
Correlations among individual difference, memory, and suggestibility variables

Variable	Age	SES	Stress	Avoidance	Anxiety	Inhibition
Individual differences						
Age		.24 (51)	−.29 (43)	−.26 (47)	−.02 (47)	.21 (44)
SES			−.26 (43)	−.33* (47)	−.16 (47)	.26 (44)
Stress				.34* (39)	.05 (39)	−.28 (38)
Parental avoidance					.16 (47)	.08 (41)
Parental anxiety						.03 (41)
Inhibition						
Memory for inoculation						
Total free recall correct	.26 (51)	−.03 (51)	.02 (43)	.07 (47)	.37** (47)	−.11 (44)
Total free recall incorrect	−.12 (51)	−.07 (51)	.11 (43)	−.07 (47)	.06 (47)	−.34* (44)
Mean direct correct	.51*** (51)	.03 (51)	.13 (43)	−.06 (47)	−.09 (47)	−.02 (44)
Mean direct incorrect	−.27 (51)	−.34* (51)	.02 (43)	.21 (47)	.34* (47)	−.27 (44)
Proportion specific yes/no correct	.56*** (51)	.26 (51)	−.10 (43)	−.14 (47)	−.02 (47)	.17 (44)
Proportion misleading yes/no correct	.44** (51)	.33* (51)	−.21 (43)	−.28 (47)	−.28 (47)	.30* (44)

Note. Ns are indicated in parentheses next to each correlation.
* $p \leq .05$.
** $p \leq .01$.
*** $p \leq .001$ (two-tailed tests).

evant, we examined partial correlations (controlling for age) between memory variables and key individual differences. Next, to identify the relative contributions of stress and attachment on children's memory, we conducted regression analyses. Finally, we examined the relation between inhibition and memory. Because there are missing data for some variables, we report the number of participants included in each analysis. Dependent measures consisted of: total correct and incorrect units of free recall, mean correct and incorrect units to direct questions, and proportion correct to specific and misleading yes/no questions. Proportion incorrect responses to specific and misleading yes/no questions were generally the inverse of correct responses. However, in certain cases, analyses of commission or omission errors were informative and are reported.

Correlations were conducted to investigate whether time delay played a role in memory or suggestibility. A significant correlation emerged only between delay and number of incorrect units to direct questions, $r = .33$, $n = 51$, $p < .05$. Delay was thus considered in analyses involving this dependent measure.[1]

Although SES has rarely been studied in relation to eyewitness memory, extant studies have revealed relations between SES and children's memory and suggestibility (Poole & Lindsay, 2001; Shyamalan, Lamb, & Sheldrick, 1995). As Table 2 shows, higher SES was significantly associated with fewer errors in response to direct questions, and greater accuracy to misleading yes/no questions. Thus, SES was considered in further analyses. Gender was not significantly related to any memory or suggestibility measures; thus, gender is not considered further.

Age and memory

As can be seen in Table 2, typical age-related changes in memory performance were uncovered for correct units to direct questions, proportion correct to specific yes/no questions, and proportion correct to misleading yes/no questions. As children's age increased, so did memory accuracy and resistance to suggestion.

Stress, attachment, and memory

Stress ratings ranged from 2 (happy) to 7 (hysterical), $M = 4.44$, $SD = .98$. Stress was not significantly correlated with age, SES, or gender, but was positively related to the number of shots children received, $r = .33$, $n = 43$, $p < .05$. Moreover, as in previous studies examining associations between parental attachment and children's distress (e.g., Goodman

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[1] We also conducted correlational analyses including delay and other independent variables (i.e., age, SES, parental attachment, inhibition). None of the correlations were significant.

et al., 1997; Quas et al., 1999), stress was significantly related to parental attachment (see Table 2). That is, parents scoring higher on Avoidance had children who exhibited more stress during the inoculation. This correlation remained sizable when number of shots was controlled, $r = .31$, $n = 39$, $p = .06$. The relation between parental Anxiety and children's stress was not significant. Thus, parental Avoidance but not Anxiety was associated with greater stress in children. Furthermore, as expected, with age partialled, greater stress was associated with providing fewer incorrect units in response to direct questions, $r = -.34$, $n = 51$, $p < .05$.[2]

Previous studies of memory for stressful events, specifically for VCUG, have indicated significant positive relations between children's memory and resistance to suggestion, on the one hand, and parents' attachment security, on the other hand. Similar associations were uncovered for parental attachment Anxiety (see Table 2), and even with age partialled, significant relations remained, $rs \geq | .30 |$, $ps < .05$. First, Anxiety was significantly positively related to correct units of free recall, such that increased Anxiety was associated with better memory performance. Second, Anxiety was positively related to incorrect units provided in response to direct questions. That is, more parental Anxiety was associated with increases in incorrect information provided. This relation remained significant even with delay statistically controlled, $r = .35$, $n = 47$, $p < .05$. This pattern may imply that the children of anxious parents provided more units of information overall for free recall and direct questions. Thus proportional measures were created (correct units divided by correct plus incorrect units) separately for responses to free recall and direct questions. With *proportional* measures, the relation between Anxiety and free recall units correct became negative and non-significant, $r = -.08$, whereas the association between Anxiety and incorrect units to direct questions was significant, $r = .34$, $n = 47$, $p < .05$. Thus, Anxiety was associated with less accuracy, at least when the amount of information children produced was considered.

Third, with age partialled, proportion correct to misleading questions was inversely related to Anxiety, $r = -.30$, $n = 47$, $p < .05$, such that children provided more correct responses to misleading yes/no questions if parental Anxiety was lower. Thus, as expected and has been found previously (Goodman et al., 1997), parental attachment Anxiety was consistently associated with increased errors in children's memory reports concerning a stressful event when the total amount of information children provided was considered. Unexpectedly, however, Avoidance was not related to memory or suggestibility in this series of correlations. Because the primary goal of the present study was to identify the relative contributions of multiple

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[2] Examination of the data using a series of quadratic regressions with stress as the independent variable and each memory variable as the dependent measure did not indicate any curvilinear relations between stress and memory.

Table 3
Regression analyses predicting memory and suggestibility variables ($N = 39$)

	Total free recall				Mean direct				Proportion specific yes/no		Proportion misleading yes/no	
	Correct		Incorrect		Correct		Incorrect		Correct		Correct	
	β	t	β	t	β	t	β	t	β	t	β	t
Children's age	.32	2.08*	−.10	−.54	.63	4.04**	−.25	−1.52	.57	4.17**	.33	2.13*
Family SES	−.06	−.41	−.06	−.30	−.07	−.47	−.24	−1.41	.10	.75	.17	1.09
Parent's avoidance	−.02	−.15	−.15	−.76	−.02	−.13	.09	.50	−.06	−.41	−.15	−.87
Parent's anxiety	.32	2.18*	.06	.34	−.12	−.80	.32	2.04*	−.04	−.34	−.22	−1.47
Child's stress	.21	1.29	.11	.54	.34	2.05*	−.19	−1.11	.23	1.58	.05	.29
Avoidance × stress	−.45	−3.02**	−.02	−.10	−.11	−.76	.14	.85	−.43	−3.19**	−.14	−.93
Anxiety × stress	.03	.17	.08	.41	.06	.42	−.10	−.66	.05	.38	−.17	−1.19

Note. For total free recall correct, $R^2 = .40^*$; total free recall incorrect, $R^2 = .05$; mean direct correct, $R^2 = .38^*$; mean direct incorrect, $R^2 = .29$; proportion specific yes/no correct, $R^2 = .51^{**}$; and proportion misleading yes/no correct, $R^2 = .36^*$. The addition of the interaction terms led to significant R^2 changes for total free recall correct and proportion specific yes/no correct, R^2 *changes* $\geq .16^*$.

* $p < .05$.
** $p < .01$.

predictors of children's memory, we used a series of regressions to analyze the data further.

In addition to age, SES, stress, and the two parental attachment dimensions, we entered terms representing the interactions between children's stress and parental attachment Anxiety and children's stress and parental attachment Avoidance. Interaction terms were created based on standardized (z) scores for parental attachment and children's stress. We included these variables because the predicted positive link between stress and memory may exist primarily for children of parents who are high or low on the dimensions of attachment Anxiety or Avoidance. Moreover, it may be only when high levels of children's distress are reached that parental attachment orientation becomes relevant to children's memory.

Table 3 displays the results from the regression analyses. Significant results emerged for total correct units of free recall, mean direct units correct, specific yes/no proportion correct, and misleading yes/no proportion correct. In addition to relations previously uncovered, the interaction between Avoidance and children's stress emerged as a significant predictor of total free recall correct and proportion correct to yes/no questions. Interestingly, no significant change was observed in any of these regressions with the addition of the five parent personality variables in one step, R^2 *changes* $\leq .13$, ps $\geq .38$, followed by the three child temperament variables in a subsequent step, R^2 *changes* $\leq .11$, ps $\geq .24$. These results suggest that parental attachment was related to children's memory and suggestibility beyond the contributions of parents' or children's personality.

To interpret the significant interactions between children's stress and parent's attachment Avoidance, regression lines were plotted according to the intercepts and slopes provided in each equation. The interaction for total
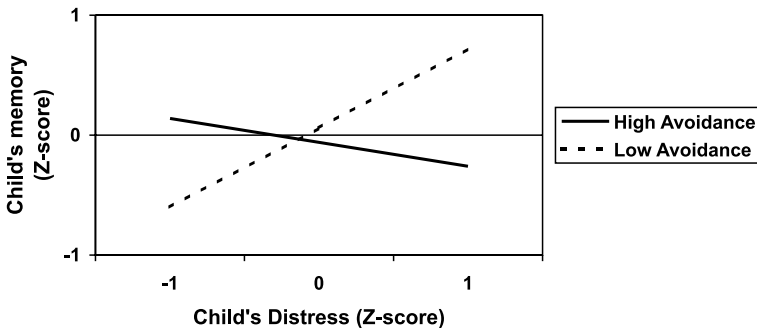

Fig. 1. The relation between children's distress and children's total correct units of free recall for parents high and low on Avoidance. For children's distress, higher numbers indicate greater distress. Lines are plotted for individuals one standard deviation above and below the mean of Avoidance.

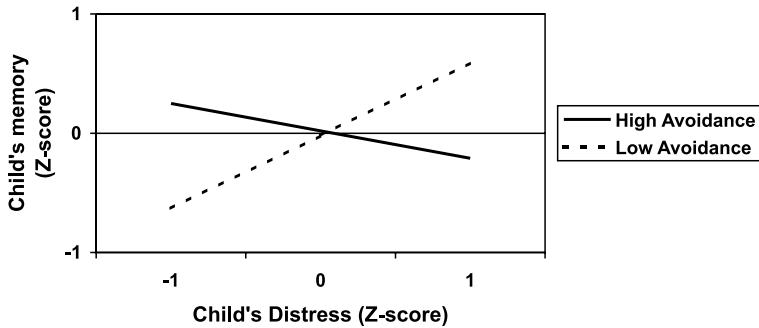Interaction between Stress and Avoidance for Proportion Correct to Specific Yes-No Questions

Fig. 2. The relation between children's distress and children's proportion correct to yes/no questions for parents high and low on Avoidance. For children's distress, higher numbers indicate greater distress. Lines are plotted for individuals one standard deviation above and below the mean of Avoidance.

free recall correct is plotted in Fig. 1. As can be seen, the positive relation between children's stress and memory existed only for children of parents who were low in Avoidance. A trend in the opposite direction existed for children of parents high in Avoidance. Fig. 2 illustrates the similar pattern that resulted for proportion correct to specific yes/no questions. [3,4]

Inhibition and memory

Age was not significantly related to inhibition as measured by the Day/Night Task proportion correct score (see Table 2), although the correlation was in the expected direction. However, examination of the data revealed an outlier (greater than 2 *SD*s below the mean), and when this outlier was excluded, the correlation became significant with a one-tailed test, justified by the prediction, $r = .26$, $n = 43$, $p < .05$. Older children evinced greater inhi-

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[3] Measures of free recall (and direct) proportion correct were also created by dividing the sum (or mean) of correct and incorrect units by the total (or mean) of correct units. Including these variables as dependent measures in the regression equations led to somewhat different results. For proportion free recall correct, the equation and all predictors became non-significant, $R^2 = .11$. For proportion correct to direct questions, the equation was close to significance, $R^2 = .31$, $p = .08$, and only age, $\beta = .31$, $p = .06$, and parental attachment Anxiety, $\beta = -.28$, $p = .08$, approached significance.

[4] Because parental presence may play a role in the relation between parental attachment and children's memory, additional analyses were conducted for all memory and suggestibility measures excluding 4 children because their caregiver was not present at both the inoculation and Session 2 (to complete the attachment measures). Results were virtually identical to those reported for the entire sample.

bition. Thus, remaining correlations between children's inhibition, memory, and suggestibility were computed with age partialled.

We expected that, even with age statistically controlled, cognitive inhibition would positively predict children's memory accuracy and negatively predict their memory errors. Cognitive inhibition was significantly inversely related to total incorrect units provided in response to free-recall prompts, $r = -.34$, $n = 44$, $p < .05$, and to omission errors made to misleading yes/no questions, $r = -.29$, $n = 44$, $p = .05$. Children were less likely to answer a question such as, "The nurse didn't give you a shot, did she?" by saying, "No, she didn't" as inhibitory ability increased. (Note that all children received inoculations.) Children with poorer inhibition skills exhibited increased inaccuracies to free-recall and misleading yes/no questions, even with age controlled.

Because of interrelations among variables in the present study, we conducted regression analyses including cognitive inhibition as well as children's age, SES, children's stress, parental attachment Anxiety and Avoidance, and the interactions between stress and Anxiety and Avoidance. Although the inclusion of these variables resulted in nonsignificant overall regression equations because of the relatively low degrees of freedom (listwise $N = 34$), the predictive value of inhibition decreased only slightly or not at all as compared to the partial correlations: Total free recall incorrect, $\beta = -.28$, and proportion omission errors to misleading questions, $\beta = -.30$. The fact that the betas for inhibition remained large despite the addition of other important predictors of children's memory supports the conclusion that children's general ability to inhibit prepotent responses independently predicts (at least in part) children's inaccurate responses to memory questions.

Discussion

The primary objective of this study was to investigate individual differences in relation to children's memory and suggestibility. These findings provide insight into the controversy concerning stress and memory in children.

Age and memory

It was expected that there would be age differences in children's memory and resistance to suggestion (e.g., Gordon et al., 2001; Roberts & Blades, 1999). This prediction was supported in that age was related to children's provision of a greater amount of accurate information to direct questions and to accuracy and resistance to suggestion to yes/no questions. With age, children's information-processing abilities improve, thus aiding memory during encoding, storage, and retrieval (Brainerd & Ornstein, 1991;

Case, 1998). Additionally, older children are better at resisting suggestion because of improved cognitive, linguistic, and social skills (e.g., Carter, Bottoms, & Levine, 1996; Goodman & Reed, 1986). However, as in other studies, age was not a significant predictor for all memory variables (e.g., Poole & Lindsay, 2001). These results underscore the importance of noting that age alone does not account for all of the variance in children's memory; there are multiple potential influences, such as attachment and inhibition.

Stress, attachment, and memory

Based on previous research concerning children's memory for inoculations (e.g., Goodman et al., 1991; Shrimpton et al., 1998), stress during the inoculation was expected to be associated with better memory and resistance to suggestion. In line with our expectations, children's correct units to direct questions were positively related to higher stress levels. Otherwise, however, memory and suggestibility measures were largely unrelated to children's distress, at least until parental attachment was considered.

As discussed earlier, findings from studies using a variety of stressors are inconsistent concerning relations between stress and children's memory and suggestibility. One possible reason concerns the nature of the stressors involved. For instance, in studies of children's memory for VCUG, researchers have found a negative relation between stress and units of correct information in free recall (Goodman et al., 1997; Merritt et al., 1994). It is possible that VCUG is a more difficult topic for children to discuss than is an inoculation, especially if children found the VCUG highly stressful and embarrassing, and that the emotion involved at time of interview inhibits narratives even when memory is quite complete. A second possible reason for inconsistencies concerns measurement of children's stress. Few researchers in this area have examined effects of different methods used to measure stress (e.g., behavioral scales vs. physiological indices; but see Quas, Hong, Alkon, & Boyce, 2000), which may have important implications for memory (Bugental, Blue, Cortez, Fleck, & Rodriguez, 1992). Third, investigation of individual differences may aid in explaining inconsistencies in stress and memory research.

Parental attachment was examined as one potential source of individual differences in the relation between children's stress and memory. Parental attachment has been shown to predict parental behaviors and parent–child interactions (e.g., Edelstein et al., 2002; Rholes et al., 1995). In the present study, attachment Avoidance was significantly associated with children's stress during the inoculation, such that greater parental Avoidance was associated with more stress in children. These findings are consistent with theoretical expectations (Alexander, Quas, & Goodman, 2002; Bowlby, 1969; Fraley & Shaver, 2000) and previous research on children's reactions to stressful medical procedures (Goodman et al., 1997). It is possible that

children of less avoidant parents were better prepared for the event by discussions about what was going to happen. By knowing what to expect, these children may have been more able to regulate their emotions during the event. More avoidant parents may have been less supportive during the event. It is also possible that children of more avoidant parents are less trusting of others, and thus experience more arousal in stressful situations involving adults.

Parental attachment Anxiety was positively related to children's provision of correct units of information in response to free recall prompts and inaccurate information to direct questions, and negatively related to proportion correct to misleading yes/no questions. Of importance, when proportional measures were analyzed, the relation between Anxiety and correct units became nonsignificant for free recall. This suggests that children of anxious parents simply talk more, providing an increased number of both correct and incorrect units. For direct question proportions and proportion correct to misleading yes/no questions, however, Anxiety remained significantly associated with children's provision of less accurate and more inaccurate information, even with the amount of information controlled.

Avoidance was largely unrelated to children's memory reports until stress was also considered. Specifically, the interaction between parental attachment Avoidance and children's stress emerged as a predictor of children's memory for the inoculation. Among children of parents low in Avoidance, a positive association between stress and memory was evident, whereas children of parents high in Avoidance demonstrated, if anything, a negative association between stress and memory. One explanation for these results is that parents low in Avoidance are more attentive to their child's stress level and are more likely to talk about the event to prepare their child, and to comfort their child before, during, and after the event than are parents high in Avoidance (e.g., Goodman et al., 1997). Attentiveness may then facilitate memory by allowing for more cognitive resources focused on the event rather than on self-regulation or parental reactions. Another explanation concerns rehearsal rather than encoding. Highly avoidant parents may be more likely to dismiss the event and less likely to talk about it afterward as children's stress increases (Goodman et al., 1997), whereas parents low in Avoidance may be more likely to talk to children about the experience when children were more distressed. Discussing the event with a parent provides a narrative structure for children's memories (Fivush, 1993), as well as opportunities for rehearsal, which are known to enhance memory.

Parental presence and reaction during stressful experiences may have affected children's stress and memory. Parental attachment may influence how parents react during a stressful event, thus influencing how their children interpret the event and also what the children focus on during the event. For instance, secure as compared with insecure parents rate themselves as having more time to attend to their children's reactions to a stressful event, and

parental inattention to children's reactions is associated with children's greater inaccuracies in remembering such an event (Goodman et al., 1997). The relations between parental attachment and children's memory may also be the result of the history of interactions between parents and children rather than parental presence during the event. Such a history may be played out in parenting behaviors that, in turn, influence children's memory (Fivush, 1993; Goodman et al., 1997).

Furthermore, children's attachment may mediate the relation between parental attachment and children's memory for stressful experiences. Insofar as parental attachment insecurity (i.e., Anxiety or Avoidance) is related to children's attachment (Benoit & Parker, 1994), children of more insecure parents may fear rejection or experience discomfort in the context of the interview and thus feel compelled to provide answers to interviewers' questions regardless of their memory for that detail.

An additional explanation is that children of more secure parents have greater general cognitive abilities. Accordingly, children of secure parents may have performed better during memory interviews because of enhanced intelligence. Although plausible, such an explanation is unlikely because parental attachment was not related to cognitive inhibition. Insofar as cognitive inhibition is representative of at least one important feature of general cognitive ability, intelligence does not explain the attachment relations found in the present study.

Because of the consistent and replicated results concerning parental attachment as an important predictor of children's memory for distressing situations, mediators of this relation need to be explored. Also, although it would be difficult to design such a study, it would be ideal to investigate relations between attachment and memory for two events that differed only in attachment-relatedness. Nonetheless, the current findings contribute to previous results regarding the relation between parental attachment and children's memory for stressful events (Goodman et al., 1997; Quas et al., 1999). In addition, the present findings suggest that the relation between children's stress and memory for attachment-related events may be moderated by parental Avoidance.

Inhibition and memory

Does children's level of cognitive inhibition predict memory and suggestibility about an experienced event? In the present study, cognitive inhibition was associated with decreased errors, even with age statistically controlled. Specifically, as inhibitory ability increased, children made fewer errors in response to free recall questions and fewer omission errors in response to misleading yes/no questions. The magnitude of these associations remained when other important memory predictors were considered simultaneously. This indicates that inhibition is a unique predictor of children's memory errors.

It is possible that children with greater inhibitory skill are better able to inhibit distractions during encoding, which then leads to the development of a more accurate representation. Both greater attention and deeper processing during encoding are associated with enhanced recall (e.g., Craik & Lockhart, 1972). It is also possible that, during retrieval, children with better inhibitory skills are more able to suppress unrelated or suggested thoughts.

Because this is one of the first studies in which inhibition was examined in relation to children's memory and suggestibility, and because the direction of the finding was consistent with theoretical expectations, further research is warranted. In fact, a recent study revealed that inhibition and working memory were related to children's false alarms to questions about a videotaped event (Ruffman et al., 2001). However, the results of that study demonstrated that inhibition was specifically related to the ability to avoid false alarms, but not to the provision of accurate information. Rather, working memory was a stronger predictor of overall memory performance. Along with the results of the current study, these findings demonstrate that inhibition plays a role in some forms of memory, but that other executive functions are equally or more important predictors for other forms of memory. These issues warrant further exploration.

First, it would be of interest to examine the relation between cognitive inhibition and memory or suggestibility for a variety of experiences, and to determine whether inhibition is related to false memory formation for similar types of experiences. Second, it is important to investigate in greater detail the precise memory process (i.e., encoding, storage, or retrieval) that may be influenced by cognitive inhibition. Third, it would be useful to understand more precisely the role of multiple features of executive processes, including not only inhibition, but also working memory and impulsivity, in predicting memory and suggestibility across development. It is only with thorough investigation of multiple social, emotional, and cognitive factors that we will gain a complete understanding of how children remember and report stressful personal experiences.

Acknowledgments

Appendix A. Inoculation memory questionnaire

Free recall
 1. Remember last time you went to see the nurse. Did she look at your arm or did she do something that hurt your arm? I wasn't there so I don't know what happened. What happened that time?
 2. What happened first in the room with the nurse?
 3. What happened next?
 4. What happened after that?
 5. What happened last with the nurse?
 6. Even if it isn't important, please tell me everything you remember about what happened with the nurse.

Direct questions
 7. Which arm did you get a shot in?
 8. How many shots did you get?
 9. What were you sitting on when you got poked?
10. What was in the room when you got your shot?
11. Who else was there in the room with the nurse?
12. What did the nurse look like?
13. What did the nurse do to your feet?
14. Why did the nurse yell and scream when you were there?
15. What special treat did the nurse give you when she was done?
16. Why did you bite the nurse?
17. What broke when you were with the nurse?
18. Who was wearing the clown costume in the room when you got your shot?
19. What were you wearing when you got your shot?
20. What kind of animal walked into the room when you were getting your shot?
21. What was the nurse wearing when she gave you a shot?
22. What did the machine that you had to blow into while you got your shot look like?
23. What kind of ice cream did the nurse give you when you were done?
24. What color were the walls in the room where you got your shot?

Yes/no questions
25. Did you get poked with anything?
26. That room you got your shot in didn't really have any chairs in it, did it?
27. Did the nurse take off your pants to give you the shot?
28. You went to get your shot all by yourself, didn't you?
29. Your (family member) wasn't there when you were with the nurse, was s/he?

30. Didn't the nurse who gave you the shot have on a funny hat?
31. Did the nurse make you swallow something?
32. Did you play a game with the nurse?
33. Was there a broom in that room where you got your shot?
34. You watched TV while you were getting your shot, didn't you?
35. Did someone hold your arms while you were getting a shot?
36. You were sitting on the nurse's lap, weren't you?
37. Was there a table/desk in the room with the nurse?
38. Was there a radio on when you were with the nurse?
39. Did your (family member) sign papers while you waited to see the nurse?
40. Did the nurse give you a stuffed animal when you were done?
41. The room you got the shot in didn't have a door, did it?
42. Was there a camera, like a big video camera, in the room with the nurse?
43. There was a rug on the floor where you got the shot, wasn't there?
44. Were there posters on the wall in the room where you got the shot?
45. Was the person who gave you a shot a woman?
46. Did the nurse wear gloves when she gave you a shot?
47. Did the nurse clean your arm before she gave you a shot?
48. Did you cry when you got your shot?
49. Did the nurse who gave you the shot have a mask on?
50. That nurse who gave you the shot didn't ever stand up did she?
51. That nurse who gave you the shot wasn't wearing any clothes was she?
52. You had to walk down some stairs to get to the room to have your shot didn't you?
53. That nurse shook your hand after you were done, didn't she?
54. You had to be all by yourself when you got your shot, didn't you?
55. The nurse sang a song to you before you got a shot, didn't she?
56. There weren't any shots or needles in that room with you, were there?
57. You didn't really get a shot, did you?
58. You never really went into a room to see the nurse did you?

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