CHILDREN'S MEMORIES OF A STRESSFUL DENTAL PROCEDURE: EFFECTS OF STRESS AND INDIVIDUAL DIFFERENCES ON REMEMBERING

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ABSTRACT

SEUNGJIN LEE: Children's Memories of a Stressful Dental Procedure: Effects of Stress and Individual Differences on Remembering
(Under the direction of Peter A. Ornstein, PhD)

Two studies were carried out to examine linkages between stress and a range of individual difference factors on children's memory for a potentially stressful event.

For Study 1, 63 children, ranging in age from 4 to 10 years, who had visited a private dental clinic and undergone a minor operative procedure were evaluated. The children's stress levels during the dental procedures were assessed by the dentist and the researchers. The children's memory was assessed immediately after the dental procedure. Overall, higher stress levels were associated with lower levels of memory. However, several individual characteristics specific to each child—previous negative dental experiences, advanced parental preparation, and stress coping strategies— were associated with variations in recall performance.

For Study 2, 85 children, ranging in age from 4 to 9 years, visited the same private dental clinic as in Study 1. Children's biological stress reactivity during the dental procedure was recorded. Their memories of the event were assessed by the same protocol used in study 1, but an additional, one-week-delayed assessment was conducted to examine the memory retention. The findings in Study 2 were consistent with those of Study 1, indicating that overall higher stress levels during an event were associated negatively with children's remembering. In addition, behavioral responses to stress were significantly associated with

other anxiety variables and children's delayed recall whereas stress reactivity as measured physiologically had little relation with children's remembering. As in Study 1, individual difference factors such as previous negative dental experiences, advanced parental preparation, and stress coping strategies were associated with variations in recall performance.

Based on the absence of relation between the biological measures of stress and children's memory and the presence of considerable variation in individual difference variables on remembering of a stressful event, the relation between stress and children's memory of a stressful event might be mediated in part by what children do to manage the stress they experience, rather than the level of stress *per se*.

Finally, the implications of findings for understanding theoretical, clinical, and forensic issues in psychology are discussed.

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ABBREVIATIONS

SPSS	Statistical Package for the Social Sciences
VCUG	Voiding cystourethrogram fluouroscopy
BPRS	Behavior Profile Rating Score
HP	Heart period (ΔHP: Changes in HP)
VT	Vagal tone (ΔVT: Changes in VT)
RSA	Respiratory Sinus Arrhythmia
SBP	Systolic Blood Pressure
DBP	Diastolic Blood Pressure
MAP	Mean Arterial Pressure (ΔMAP: Changes in MAP)
BP	Blood pressure (ΔBP: Changes in BP)
PR	Pulse rate (ΔPR: Changes in PR)
Frankl	Frankl Behavior Rating Scale
CBQ	Child's Behavioral Questionnaire
PPVT- III	Peabody Picture Vocabulary Test, Third edition
WM	Working Memory
STAIC	Spielberger State-Trait Anxiety Inventory for Children
VAS	Visual Analogue Scale
CR	Correct Rejection
FA	False Alarm
IBI	Interbeat interval
ECG	Electrocardiogram
HICUPS	How I Coped Under Pressure Scale

CHAPTER 1

INTRODUCTION

Identification of the Problem

Children's memory researchers have long struggled with the question of why children remember some events better than others and certain features of events better than others. One of the major candidate determinants of whether an event will be remembered accurately or with significant errors is the intensity of stress that the child experiences as the event unfolds.

Despite extensive research having been devoted to the impact of stress level on children's memory, the overall findings remain incomplete and contradictory. In particular, it is unclear whether stress may positively affect memory, as a result of cognitive rehearsal or prolonged rumination (Neisser, Winograd, Bergman, Shreiber, Palmer, & Weldon, 1996), or negatively impact memory, by influencing the deployment of attention and thus affecting encoding in memory (Merritt, Ornstein, & Spicker, 1994). Indeed, it has been proposed that a variation of the narrowing-of-attention hypothesis is at play in stressful situations, in that memory is enhanced as associated stress increases up to a certain threshold point, after which it declines with further increases in stress (Deffenbacher, Borstein, Penrod, & McGorty, 2004). Researchers have considered each of these possibilities in their investigations of children's differential behavioral and biological reactions to stressful events and eventual

memory for the details of those events. Researchers have used to-be-remembered events that range from mildly arousing laboratory incidents (Quas, Bauer, & Boyce, 2004; Quas, Alkon, Goldstein, & Boyce, 2006) to highly distressing personal experiences (Merritt et al., 1994). To some extent, it is reasonable to assume that observed differences in the effects of stress on memory may be a function of the nature of the event itself. Furthermore, a range of individual characteristics exist that have the potential to moderate the ways in which stressful events are encoded and remembered (see Figure 1.1). It seems quite likely that a multifaceted and dynamic mechanism involving all of those factors contributes to memories of stressful experiences.

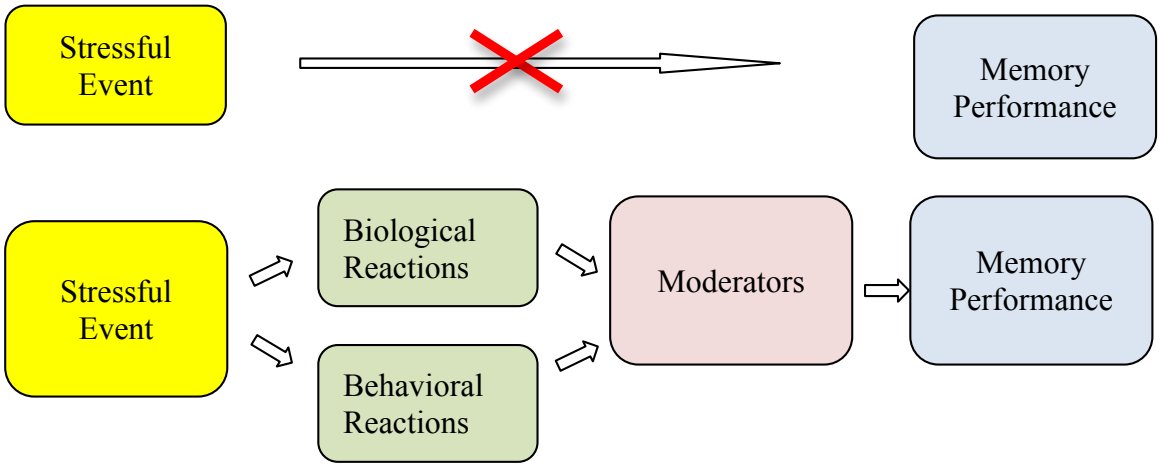

Figure 1.1 Schematic representation adapted from Bauer (2009), Effects of individual reactions and moderators on remembering stressful events.

To unravel such a complex interplay that relies on internal responses to external cues, investigatory efforts should focus on the identification and characterization of potential moderators—that is, individual differences in behavioral and biological stress reactivity, the presence of previous negative experience, the extent of advance parental preparation, stress-

coping strategies, temperament, language ability, and working memory capacity—which influence the impact of stress on remembering. To this end, the studies developed for this research were designed to examine and measure these individual difference variables to determine the impact of stress on memory in the context of a naturally occurring stressful experience, namely, a dental operative procedure.

Significance of Study

Children may undergo a variety of stressful experiences as a result of illness or hospitalization and dental, medical, and surgical procedures. It is also the case, unfortunately, that many children throughout the world are witnesses to social crimes or domestic violence in their homes (Kenning, Merchant, & Tomkins, 1991). Additionally, countless children are victims of physical or sexual maltreatment or both (Volpe, 1996).

In the past two decades, researchers have devoted significant effort to understanding the memory functions involved in children's processing of stressful events. Studies in this field were expected to yield answers about how stress negatively or positively affects individual children's remembering of information gathered under stressful conditions and the reliability of their recall over time. The relation between stress and immediate and long-term recall was also studied in applied areas, with the hope that such knowledge would help tailor treatment regimens for children's individual differences such as temperament or history with event in clinical contexts and to definitively determine the reliability of a child's testimony by which guilt or innocence of a defendant may be based in a legal trial.

When considering eyewitness testimony in particular, it is important to note that children are increasingly asked to testify about cases of physical and sexual abuse that they

may have personally experienced or witnessed. There are many recorded cases in which the courts have admitted children's testimony into evidence (Cunningham & Hurley, 2007). Unfortunately, in events that involve the sexual or physical abuse of a child, the child and alleged perpetrator are often the only witnesses. Thus, it is important to consider how children process and recall memories of stressful events, and to develop concrete strategies to elicit credible and reliable testimony from children at different ages.

Understanding memory for stressful events has additional implications for clinical psychology. Memories of stressful events have been shown influence children's psychological adjustment and their impact on children's ability to function in everyday contexts (Howe, Goodman, & Cichetti, 2008).

Ultimately, research on children's memories of stressful events will contribute to the wider body of information on the reliability of children's eyewitness testimony and provide insight into what details children recall about stressful events and how stress affects that recall. Thus, the relations between stress at memory encoding and the subsequent remembering of a salient, personal experience could have theoretical, clinical, and forensic significances for addressing both basic and applied issues in psychology.

Purpose of the Study

Scientific memory research has focused considerable attention on determining the exact nature of the relation between children's behavioral and biological reactions to stressful events and the accuracy of their subsequent memory of those events. Despite extensive research efforts thus far, much remains to be learned, especially because each new research finding has supported the notion that children's reactions to potential stress-provoking events are affected by a variety of individual difference variables (e.g., Burgwyn-Bailes, Baker-Ward, Gordon, & Ornstein, 2001; Peterson & Bell, 1996).

The principal goals of the current study were to explore the impact of stress on memory by using a naturally occurring stressful event, an operative dental procedure, as a model situation and taking into consideration the ways in which individual characteristics may moderate that impact. Study 1, in particular, was designed to focus on children's behavioral responses to a stressful event and to examine the impact of several social-emotional, individual difference factors on remembering: children's temperament, stress-coping strategies, personal dental histories, and parental preparation of the children for the event. To expand on the findings from Study 1, Study 2 was designed to investigate children's behavioral and biological reactivity to the stressful event and to evaluate the impact of cognitive individual difference factors (i.e., receptive language ability and working memory capacity) on remembering, in addition to those of social-emotional ones.

Research Questions and Hypotheses

The principal objective of this study was to test a conceptual model for predicting children's memory for a stressful event. This model (see Figure 1.2) was established based on several targeted hypotheses.

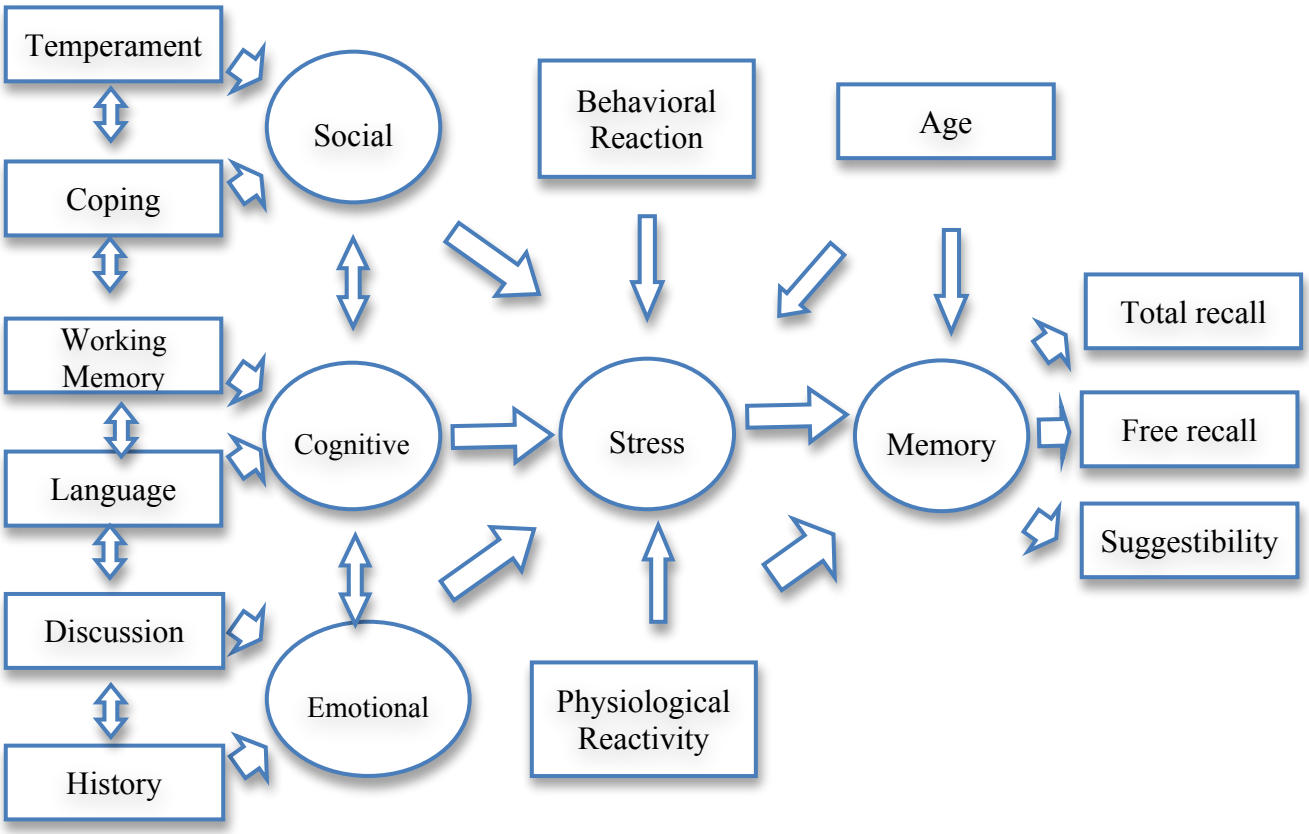

Figure 1.2 Proposed conceptual model indicating hypothesized relation between stress and memory.

First, I hypothesized that children's age would be associated with their overall recall of a stressful event and that their memory would be decreased at delayed assessment periods, whereas errors on suggestible questions would decrease with age and increase over the delay.

Second, higher stress levels would be associated with poorer memory performance and more errors when responding to suggestible questions. Additionally, children who experienced a relatively higher level of stress – as assessed behaviorally and biologically during the event – would be expected to exhibit greater memory decreases than children who experienced lower levels of stress. Third, individual differences among children in terms of a range of factors (e.g., temperament, presence of previous negative experiences, extent of parents' preparation of the child for the event, language ability, working memory capacity, and stress-coping strategies) would be predictive of their memory performance and would impact the relation between stress and memory of the dental procedure under consideration.

The specific research questions and hypotheses follow.

Study Aim 1: Age differences on children's remembering of stressful events.

In general, and consistent with prior reports, older children are more knowledgeable than younger children about what is important to recount, are better able to search memory, can use strategies to help remember information, and are more detailed in their narrations about past events (Bjorklund & Douglas, 1997; Fivush & Hamond, 1990; Ornstein & Haden, 2002), all of which enhance their memory for a range of events. Thus, older children were expected to show superior total recall and provide more information than younger children in response to general probes. For questions suggesting features that did not occur during the event (i.e., absent features), older children would accurately reject them more than younger children, who would provide a blanket "yes" response to the questions more often.

Given the wide age range of the cohort included in the study, variations in performance as a function of age were expected. Research has demonstrated that with

increasing age, children tend to report less pain in response to dental procedures (Jay, Ozolins, Elliot, & Caldwell, 1983), exhibit lower levels of suggestibility (Ceci & Bruck, 1993), report less anxiety (Katz, Kellerman, & Siegel, 1980), have superior receptive language ability (Burgwyn-Bailes et al., 2001), and have increased working memory capacity (Case, 1995). Of particular interest in the current study was also whether, independent of children's ages, the various individual difference factors examined would be related to memory accuracy and suggestibility.

Overall, children's memory was expected to decrease after a week's delay, although it is relatively short duration of the delay. Children were expected to respond "I don't know" more often during the delayed interview, which took place a week after the event. As such, they were expected to lose vivid recollections of specific features of the event.

Study Aim 2: Relation between the level of stress and children's remembering.

There are few studies in which both biological and behavioral stress responses have been measured in the context of a naturally occurring event. However, biological and behavioral stress responses may have different implications for immediate versus delayed remembering. Merritt et al. (1994) reported that children's behavioral stress responses were associated with children's memory but children's biological reactivity (i.e., salivary cortisol levels) was not related to children's memory. The behavioral stress responses were the score from Observational Scale of Behavioral Distress (OSBD; Jay, Ozolins, Elliott, & Caldwell, 1983), used to code behaviors exhibited by the children during an invasive medical procedure involving urethral catheterization, provides operational definitions of behaviors thought to

reflect anxiety and/or pain in children. However, the number of participants was relatively small ($N = 24$), and the age range was restricted (3- to 7-year-olds), and thus without further study, the conclusions must be viewed as tentative.

The current study was designed to examine the effects of the level of stress measured by a range of anxiety indices on children's memory of a potentially traumatic, personally experienced event. Given that a visit to the dentist is an authentic, naturally stressful experience due to its ability to evoke anxiety and fear, stress was expected to be negatively associated with children's memory performance. In other words, children who were biologically and behaviorally more stressed during the dental procedure were expected to exhibit poorer memory of the event. We presumed that stress would cause a narrowing of attention at encoding and consequently lead to lower level of memory. Moreover, specifically in terms of vagal tone reactivity, consistent with the results of Quas et al. (2006), parasympathetic withdrawal may be indicative of general inhibition tendencies or shyness more generally and hence an overall reduced willingness on the part of children to engage in the session, complete the tasks, and/or answer interview questions. This inhibition certainly could lead to lower performance overall on the memory test. In addition, both children's behavioral and physiological responses to stress were expected to decrease with age. The older children would have a better ability to regulate their stress level behaviorally and physiologically and to adapt positive coping strategies to help facilitate stress level reduction.

Age would affect the magnitude of children's stress responses, because of age-related improvements in children's abilities to cope with challenge and stress (Compas, Connor-Smith, Saltzman, Thomsen, & Wadsworth, 2001). Age would also affect the extent to which arousal was related to memory (Bugental, Blue, Cortez, Fleck, & Rodriguez, 1992), with

associations emerging in older age groups but not others (Vandermaas, Hess, & Baker-Ward, 1993). For instance, younger children would lack the ability to engage in sophisticated coping strategies without assistance from someone else. For them, arousal would constitute a normal developmental reaction to even mildly stressful experiences. However, older children would increasingly engage in primary coping strategies to reduce their arousal (Fields & Prinz, 1997). Accordingly, among older children, pronounced stress responses would be indicative of problematic coping (e.g., the use of avoidance-based strategies) or poor emotion regulation capabilities, both of which have implications for their abilities to attend to and remember stressful information.

By including a wide age range of children (preschool to school age; 4- to 9-years-old), it would be possible to determine how associations between children's stress responses and memory change developmentally. Some indicators of anxiety were predicted to be correlated, assuming that the anxiety values reliably are measured children's level of stress during the dental procedure and emotion regulation ability in terms of dealing with a stressful situation. These variables include the child's biological and behavioral stress reactivity, self-reports of pain and anxiety, parents' reports of the child's pain and anxiety, interviewer's ratings, dentist's ratings, and children's responses to the STAIC (State-Trait Anxiety Inventory for children; Spielberger, Edwards, Lushene, Montuori, & Platzek, 1973) anxiety questionnaire as indictors of anxiety variables. Overall, these anxiety variables were hypothesized to positively correlate with each other and negatively correlate with children's memory performance.

Study Aim 3: Individual differences in the relation between the levels of stress and children's remembering.

Various individual difference factors were predicted to affect children's memories of the stressful event. First, considering social-emotional individual differences, children's stress-coping strategies were expected to impact their encoding of information. For instance, children who used a more approach-oriented coping style (e.g., mood elevation, social support, and information seeking), as assessed by the child's self-reports, would likely experience lower levels of stress during the dental procedure, compared to children who used more avoidance-based coping styles (e.g., activated escape, avoidant actions, resignation, emotional expression; Compas, Campbell, Robinson, & Rodriguez, 2009). It is possible that the approach-oriented coping style might lead children to become more aware of their surroundings and, therefore, elicit a superior memory of what happened.

Children's temperament was considered another predictor of children's remembering. Children who have an easy temperament (defined in terms of a combination of regularity, positive approach responses to new stimuli, quick adaptability to change, mildly or moderately intense mood that is preponderantly positive; see, e.g., Chess & Thomas, 1991) would accept a stressful event more easily, which would lead them to more approach-oriented coping styles, thereby enabling them to obtain more information during the event, which ultimately would facilitate accurate remembering (Fivush & Sales, 2006).

Cognitive individual variability might also account for the relation between stress and memory. Working memory (WM) capacity and receptive language ability were expected to be positively related to memory accuracy, as children with superior WM capacity and better

language ability were expected to exhibit better memory during both the immediate and delayed interviews (Diamond, Prevor, Challender, & Druin, 1997; McGuigan & Salmon, 2004). More interestingly, a greater WM capacity might facilitate effective approach-based coping styles so that children would actively minimize the level of stress experienced during the dental procedure, thereby enhancing their memory of the event.

Finally, the presence of children's previous negative dental experiences and the extent of the parents' advance preparation of the children for the event under investigation may affect children's remembering. For example, children who had experienced previous unpleasant dental experiences would be more likely to exhibit inferior memory as they may have expected more pain or distress from subsequent procedures, leading to increased stress during the event itself. In addition, children who engaged in more discussions or conversations with their parents in advance of the event may have been less stressed during the dental procedure, which could then contribute to enhanced memory.

Thus, considerable variation in individual difference variables was expected to exist among the children, influencing the relation between stress and the children's memory of the stressful event.

Organization of Study

This dissertation is composed of five chapters. In Chapter 1, this introduction, the rationale for and significance of the study have been provided. In Chapter 2, a comprehensive literature review of the relevant body of research to date will be provided. The investigatory strategies for determining children's memories of stressful events, findings upon delayed interviews, and individual differences observed in children's remembering will be discussed. The hypotheses were defined according to the body of established knowledge and will be presented at the end of Chapter 2. In Chapters 3 and 4 the methodology, findings, and analyses from Studies 1 and 2, respectively, will be detailed. Finally, in Chapter 5 the implications of the findings will be discussed in terms of the hypotheses and potential applications in clinical and legal contexts.

CHAPTER 2

REVIEW OF LITERATURE

Theories on Children's Memories of Stressful Events

Defining and Assessing Stressful Events

Definitions of stress. It is important to note that the terminology used in this field is not standardized as yet. For example, the term *negative emotion* is used in the literature as a general descriptor of various experiences involving stress, anxiety, and fear. Thus, in the current study, the term *stress* was used to indicate negative-emotion-arousing events.

The relation between stress and memory in children is controversial, with findings differing significantly across studies. The meta-analytic review referenced above indicated that such discrepant results might be related to the nature of the stressful events examined by each group of researchers. In their 2004 review, Deffenbacher et al. distinguished between events that were expected to elicit an *arousal mode* of attention control (i.e., an orienting response or high level of focused attention) from those that were associated with an *activation mode* of attention control (i.e., a defensive response, such as the biological fight-or-flight response). According to authors, a defensive response is elicited by events that threaten physiological or psychological integrity and thus involve considerably higher degrees of distress than events that elicit an orienting response. Deffenbacher et al. argued that some studies investigating the relation between stress and memory relied on procedures that elicited an orienting response, and others used procedures that elicited a defensive

response; thus, the related findings of stress on memory are not directly comparable. For example, a low-stress study in which children were exposed to an unexpected fire alarm was found that elevated blood pressure and pulse rates were associated with the event, but none of the children cried or showed hysterical distress (Peters, 1997) and children's absolute levels of "distress" were minimal (Quas et al., 2004, 2006). In contrast, in a retrospective series of high-stress studies on children who suffered an unexpected and very painful injury, the high-stress event was invariably associated with sudden outbursts, and the children were typically described by their parents as having been "extremely upset or hysterical" (Peterson, 1999; Peterson & Whalen, 2001).

Based on their idea that high- and low-stress events have distinctly different effects on children, Deffenbacher et al. (2004) was proposed a theoretical model of how stress can affect children's or adults' memory. They suggested that as stress increases, memories of the details that participants focus on are stored so as to be readily recalled. However, excessively high stress levels lead to a sharp drop in memory performance as the mind seeks to relieve itself of negative emotion. However, as pointed out by the authors, in comparison with the robust literature on the relation between stress and memory in adults, much less is known about children. Surprisingly, in the few reviewed studies on children, there was no relation between stress and memory, for either recall accuracy or face identification. This underscores the need for more research.

Naturally stressful events. Children's recall of stressful events has been demonstrated to be robust in many studies. In highly stressful experiences, including painful medical procedures such as voiding cystourethrogram fluouroscopy (VCUG; Merritt et al., 1994; Quas, Goodman, Bidrose, Pipe, Craw, & Ablin, 1999; Salmon, Price, & Pereira, 2002) and natural disasters such as hurricanes (Fivush, Sales, Goldberg, Bahrick, & Parker, 2004),

children have repeatedly demonstrated extensive memories of the events. If memory of stressful events is qualitatively different from memory of neutral experiences for children (Christianson, 1992; Yuille & Tollestrup, 1992), findings from studies involving distinct or salient (i.e., those that are unique and stand out from one's general experience and knowledge) events are unlikely to be generalizable. On the other hand, if the differences are quantitative or nonexistent, the overall body of results may be considered as a whole to gain insights into children's memory of stressful events. Many scholars have called for the further scientific investigation of this important question (Pezdek & Taylor, 2002).

Initially, insights into stress's impact on children's memory were gained through investigations of children's remembering of medical experiences. Clinical and medical situations were recognized as naturally occurring, and even beneficial, events that share many elements consistent with forensic allegations of abuse (e.g., personal touch, feelings of betrayal, physical discomfort). Therefore, routine physical examinations (Baker-Ward, Gordon, Ornstein, Larus, & Clubb, 1993), inoculations (Goodman, Hirshman, Hepps, & Rudy, 1991), visits to the emergency room (Peterson & Bell, 1996), visits to the dentist (Vandermass et al., 1993), and experiences with invasive, painful, and frightening medical procedures (Merritt et al., 1994; Chen, Zeltzer, Craske, & Katz, 2000) have been employed to study children's recall of stressful events.

Goodman et al. (1991) studied young children (3 to 7 years old) who received an inoculation. They found that children who were more stressed recalled more accurate information than those who were less stressed. The authors surmised that stress may have beneficial effects on memory. However, after a 1-year delay, the children' recall accuracy, even for specific questions, decreased significantly, and susceptibility to suggestion increased. These results support King and Yuille's (1987) theory that an event's distinctiveness

enhances its strength in memory, but when it diminishes with time, the ability to accurately recall specific details of the event does also.

Merritt et al. (1994) also studied 3- to 7-year-olds' memories to determine their ability to recall features of a painful, invasive medical procedure, the VCUG, which involves genital touch. The authors discovered that children's recall of this highly stressful event was quite impressive, especially considering that the children had little, if any, prior knowledge about what the procedure would involve. They also found that children's overt distress behaviors during the VCUG were negatively related to the total amount of information recalled 6 weeks after the procedure took place. Another study of children's memories of a VCUG, however, did not find similar associations. Quas et al. (1999) observed both positive and negative associations with children's evident distress at different times during the procedure and their later memory.

Children's memories of dental visits, including both cleaning and operative visits, were studied by Vandermaas et al. (1993) who observed that older children had generally better memory of the visits. Regardless of whether the visit involved only a teeth cleaning or a full operative procedure, the older children gave more accurate information during free recall inquiries (responses to very general probing questions) and to specific questioning. The study was also found interesting effects of anxiety on memory, as evidenced by measures of a behavior profile rating scale on memory. Higher anxiety in older children appeared to have a negative impact on recall; in younger children, it yielded higher recall scores, indicating that the relation between stress and memory may be age dependent.

Chen et al. (2000) investigated 3- to 18-year-old children's memory of lumbar punctures (LPs), an extremely stressful event. The results indicated that observably stressed behavior, child self-reports of stress, and child self-reports of pain were all negatively

correlated with memory; in general, their findings indicated an obvious detrimental effect of stress on recall memory.

The findings remain mixed as to whether stress helps or hurts children's memory when employing these natural paradigms as to-be-remembered stressful events in research. The distinct methodological differences across studies may be responsible for the inconsistent findings gathered to date. The two main differences are the type of to-be-remembered event under investigation and the manner in which stress was assessed.

The events under study have varied considerably across studies, leading to unavoidable differences in a range of factors that may influence children's subsequent memory. For instance, to-be-remembered events have varied in levels of inherently associated complexity, duration, and controllability, and in the amount of stress that they elicit. Some studies examined children's memory of naturally occurring, highly distressing experiences to which the children were exposed independent of the research (e.g., injuries, medical procedures; Goodman et al., 1997; Merritt et al., 1994; Peterson, 1996). Although investigating children's memory for such events has provided unique insights into how high levels of stress are related to memory, it is difficult to generalize their findings across studies because the events vary. Another important variable has been the time frame associated with the stress duration (e.g., an inoculation versus an entire dental check-up). Finally, the events had variable stressors (e.g., parent's or doctor's behavior) that are difficult to control and can affect children's reactions and memory (e.g., Edelstein, Alexander, Shaver, Schaaf, Quas, & Goodman, 2004).

Controlled stressful environments. To guard against the inherent variability of naturally occurring events, controlled laboratory studies have been designed and carried out to investigate children's memory of mildly stressful events (Bugental et al., 1992; Quas &

Lench, 2007). The overall paradigm was often based upon studies of adults' memory of emotional event, in which memory was tested for emotionally evocative pictures or videos to which adults were previously exposed (Canli, Zhao, Brewer, Gabrieli, & Cahill, 2000; Kern, Libkuman, Otani, & Holmes, 2005). The experimental control available in laboratory events is a clear, evident advantage over naturally occurring stressors, although the level of stress induced in laboratory studies is typically much lower than in real world situations. In fact, it is unproven whether laboratory-based, to-be-remembered events can reliably induce consistent stress responses in children, and studies have been carried out with this noted as a presumption, and potential weakness, of the study. Thus, to achieve meaningful and accurate insights into the relations between stress and memory in children, both types of research paradigms must be integrated; the to-be-remembered events under investigation must be salient, personally significant, and reliably induce arousal in children, yet occur under controlled conditions so that clear inferences about the effects of stress on memory can be drawn.

Challenges in assessing stress levels. Researchers have relied on a variety of methods to assess children's stress levels during a to-be-remembered event. The most common approach has been indirect and relied on subjective ratings assigned by an observer of the child or a parent. For instance, in investigations of children's reactions to and memory for medical procedures, research assistants or medical staff rated children's distress during the events (e.g., Goodman, Quas, Batterman-Faunce, Riddlesberger, & Kuhn, 1997). In other investigations, parents were asked to retrospectively report how distressed their child appeared to be during a prior accident or medical procedure (Peterson, Pardy, Tizzard-Drover, & Warren, 2005). It is important to note that children may mask their true feelings (Cole, 1986; Davis, 1995), causing researchers or parents to inadvertently misinterpret their

behavior. Moreover, parents' responses to the stressor may influence their perception of the child's stress reaction.

To gain more direct insight into children's distress, some researchers asked children to self-rate their emotional reactions to particular events (Chen et al, 2000; Vandermaas et al., 1993; Merritt et al, 1994). However, children's responses may be limited in the extent to which they reflect their true experiences and may be impacted by the willingness of a child to report his or her true feelings regarding the event. Children, especially those who are young, may also not fully understand the questions posed to them by the researchers. Chen and colleagues (2000) reported having to exclude 15 of 55 children (4 to 7 years old) from a study of children's memory of LPs because the children did not appear to understand the self-report distress questions. Thus, even self-reporting measures have limitations.

Given the challenges of using different types of stress measures, it is not surprising that the diverse indices often result in findings that are uncorrelated statistically (e.g., Merritt et al., 1994; Quas, Hong, Alkon, & Boyce, 2000; Vandermaas et al., 1993; Walco, Conte, Labay, Engle, & Zeltzer, 2005). For instance, Merritt et al. (1994) found that parents' and medical technicians' reports of children's distress during an invasive medical procedure involving urethral catheterization were only marginally correlated with each other and wholly uncorrelated with the children's self-reports. Similarly, the associations between stress and memory often vary across different measures. In Merritt et al.'s study, medical technicians' ratings of children's distress were found to negatively correlate with children's memory of the medical procedure shortly after it occurred, but parents' and children's ratings did not correlate with the children's memories. The lack of consistency across indices makes it difficult to discern which measure most appropriately reflects children's experienced

distress during a particular event, and even more difficult to interpret the meaning of differences in the associations between stress and memory.

Measuring stress through physiology. To overcome the measurement challenges discussed, a small but growing body of research has included assessments of children's physiological responses in their investigations. Arguably, young children cannot volitionally control their physiological arousal to the same extent that they might control overt expression or self-report of emotion. There are several theoretically important reasons why physiological stress responses may have unique effects on children's memory. And, with some naturally occurring stressors and with laboratory-induced mild stressors, it has been possible to obtain comprehensive data concerning children's physiological stress responses as an event is unfolding. Thus, studies that incorporate physiological measures of stress have the potential to provide new insights into how children remember stressful events, which is not possible when only observers' or children's reports are considered.

Background of physiological stress responses. When studying physiological stress responses as potential predictors of children's memory, it is important to distinguish between the sympathetic and parasympathetic branches of the autonomic nervous system, both of which are activated to various degrees in response to and following exposure to stress, threat, or challenge. *Sympathetic activation* is most commonly associated with the fight-or-flight response that results when a person is faced with a stressor external to the self (Cannon, 1914). During sympathetic arousal, pupils dilate, heart rate and blood flow to muscles increase, and metabolic output is produced to prepare an individual for physical activity that may be required (Cannon, 1939; Henry, 1992; Porges, 1995). In response to sympathetic activation, an individual needs to scan the environment to attend to important information and decide an appropriate response (e.g., in classic terms, whether to fight- or-flight

response). Theoretically, attention should be focused on information related to the stressor so that the situation can be evaluated and an action can be taken (Christianson, 1992). Accordingly, sympathetic arousal during a to-be-remembered event should facilitate encoding and later memory of the event, at least for event information directly related to the stress's cause.

The *parasympathetic system* regulates internal and external demands on the body by either increasing parasympathetic activation, often called parasympathetic tone, or decreasing parasympathetic activation, often called parasympathetic withdrawal (e.g., Berntson, Cacioppo, & Quigley, 1991; Porges, 1995; Salomon, Matthews, & Allen, 2000). When no external demands (i.e., stressors) are present, activation of the parasympathetic system helps promote growth in the body by maintaining a steady and decelerated heart rate. When an external demand presents itself, the parasympathetic system retains some internal regulation processes but also withdraws its regulatory influence on the cardiac cycle, increasing vigilance and arousal and allowing the individual to respond to demanding tasks (Calkins & Dedmon, 2000). Several studies indicate that parasympathetic withdrawal compared to baseline is associated with increased vigilance during sustained attention tasks (Porges, 1992; Ruff & Rothbart, 1996; Porges, Doussard-Roosevelt, Portales, & Suess, 1994; Weber, Van der Molen, & Molenaar, 1994). Insofar as sustained attention tasks are similar to stressful events, parasympathetic withdrawal may enhance memory because of this positive association.

Other studies, however, have found the opposite pattern, namely that parasympathetic withdrawal was associated with poorer memory (Quas, Carrick, Alkon, Goldstein, Boyce, 2006). Studies have shown that children's behavioral problems were often related to difficulty with emotion regulation, especially during potentially arousing situations.

Specifically, children who exhibited consistently high levels of parasympathetic withdrawal in laboratory contexts were at increased risk for internalizing behavioral problems and for extreme social and behavioral inhibition (Boyce, Quas, Alkon, Smider, Essex, & Kupfer, 2001; Reznick, Kagan, Snidman, Gersten, Baak, & Rodenberg, 1986). Thus, parasympathetic withdrawal might lead to reduced attention to stressful environmental stimuli as a means of emotional self-regulation, but this reduced attention would also result subsequently in poor memory.

Despite the reasons to expect that the activation of the sympathetic system and withdrawal of the parasympathetic system have different implications for memory, few studies have systematically examined these possibilities in children (Quas et al., 2006). Several studies have, however, examined relations between children's physiological arousal and memory.

Physiological arousal and children's memory. Peters (1991) investigated children's memory of events that took place when either a fire alarm or a radio sounded. Children in the fire-alarm, or stressed, group had significantly higher pulse rates than children in the radio, or nonstressed, group and later provided fewer correct and more incorrect statements about their experience. Bugental et al. (1992) found that 5-year-olds who exhibited increased heart rate while watching a video of a child receiving an inoculation made more mistakes when recalling the video than did 5-year-olds who did not exhibit an increase in heart rate. However, no significant associations were found in older children. Chen et al. (2000) uncovered no significant associations between children's heart rate during LPs and their later memory for the procedure. Stein and Boyce (1995), Quas, Bauer, & Boyce (2004), and Quas et al. (2006) compared children's general physiological responses to their memory for a fire-alarm incident. Stein and Boyce found that children with consistently

high heart rates during a series of laboratory tasks reported the least amount of information about the alarm. Quas et al. (2004) found that children with greater cortisol reactivity during a series of laboratory tasks reported the least amount of information about the alarm. Particularly, autonomic biological reactivity was associated with increased accuracy among children questioned in a supportive manner but decreased accuracy among children questioned in a nonsupportive manner. Quas et al. (2006) found an interaction between age and level of parasympathetic withdrawal on children's memory: older children with consistently high levels of parasympathetic withdrawal during a set of laboratory tasks displayed poorer memory than those with lower levels of parasympathetic withdrawal, but among younger children, parasympathetic withdrawal was unrelated to memory.

Other factors affecting stress and children's recall. Despite these studies suggesting some associations between physiological arousal and memory, numerous questions remain as to what other individual characteristics of children such as temperament, quality of previous experience, parent's preparation, intelligence, and verbal ability have an effect on memory and how they may differentially influence children's behavioral and/or physiological coping reactions. These factors have implications both for what children perceive as distressing and how children subsequently respond to distressing situations.

The findings in the literature on how stress impacts children's ability to remember are largely inconsistent. Thus, researchers should consider identifying sources of individual characteristics that have the potential to moderate the ways in which stressful events are encoded and remembered, rather than solely attempting to discover linear associations between stress at encoding and memory. Such an approach is expected to provide fundamental knowledge on some of the unresolved issues in the field, particularly about the underlying mechanisms behind children's memory of stressful experiences. Furthermore, it is

imperative to investigate the specific physiological and behavioral systems driving children's responses to stressful events when attempting to understand the role that stress plays in their event memory.

Delayed Interviews and Children's Memory

Understanding the impact of delay between a child's stressful experience and an interview about the event is important for the psychological field and the judicial system. Delays in the literature have varied from 1 week (Poole & White, 1993), 6 months (Steward & Steward, 1996), to 1 year (Goodman et al., 1994). In legal settings, research into what type of information children retain after a delay can help define children's abilities to provide accurate testimony (Ornstein et al., 2006). The existing research indicates that age significantly affects rates of forgetting (Brainerd, Kingma, & Howe, 1985), with older children exhibiting less forgetting (e.g., Baker-Ward et al., 1993). Furthermore, more distinctive events are retained in children's memory for longer periods (Howe, 2000).

The type of probe used in an investigation has been shown to influence recall after a delay. Poole and White (1993) found that children's memories decayed over time and that specific questions were particularly problematic when children's memories were no longer as sharp. Such findings are consistent with *fuzzy trace theory* (Brainerd & Reyna, 1990, 1995), which states that, following a delay, verbatim memories fade. According to modern theories of memory development, memories are stored as exact input (verbatim) or as concepts or meaning (gist) and these memory representations are accessed independently (Brainerd & Reyna, 2002). Accordingly, children's memories are more likely to be based on *gist*, the general idea of or key information about a past event, rather than individual details. If

specific questions are consistent with the meaning of the gist retrieved, children may erroneously conclude that the event in question actually occurred. “Did the dentist use a tooth pillow to keep your mouth open during your dental treatment?” may be consistent with the general gist memory that the dentist used something to keep the mouth open during the procedure, leading the children to agree, though the dentist did not use this particular device.

Delayed recall in naturally stressful environments. Findings have been mixed regarding the effect of delay on recall for medical procedures. For example, reports for medical procedures or visits have been found to be quite accurate a year after the event, at least in remembering the gist of the experience (Goodman et al., 1997; Howe, Courage, & Peterson, 1995). The accuracy of 3- to 7-year-olds’ memories was impressive when they were questioned about a VCUG (Merritt et al., 1994), as they correctly identified 83% of the event features after 6 weeks and falsely acknowledged only 7% of the nonexperienced events. Moreover, accuracy rates remained stable over the 6-week period, suggesting that the event’s distinctiveness may have had a facilitative impact on memory.

Other studies have suggested that children exhibit decreased memory for medical procedures following a delay. Steward and Steward (1996) interviewed 130 3- to 6-year-old children who visited several pediatric, outpatient clinics at a state hospital. Follow-up interviews occurred after delays of 1 or 6 months. Immediately following the event, the children’s spontaneous reports via open-ended questions of body touch were highly accurate (94%), and reports revealed no developmental differences. When asked what they were touched with, a specific question type, children’s overall accuracy decreased only somewhat (72%). However, 1 month after the clinic visit, their ability to remember the body touch event was more limited, with accuracy dropping from 94% to 79%. This rate remained stable at the 6-month interview (72%). Children’s pain ratings were positively related to how

accurately they recalled the body touch, but only at the 6-month follow-up. These findings suggested that, after a 6-month delay, children's memories of being touched by medical personnel decreased significantly, although children who experienced higher levels of pain were more likely to recall body touch more accurately and completely.

Other studies have demonstrated similar problems in delayed recall when children were interviewed regarding stressful medical events. Goodman et al. (1991) reinterviewed 3- to 7-year-old children 1 year after they received an inoculation at a health clinic. In that study, the accuracy of children's free recall appeared to have declined over the year while the amount of inaccurate information remained stable. Again, children were especially inaccurate when responding to specific questions.

Repeated medical events appear to influence children's recollections of the events. Several researchers have determined that, when children experience subsequent medical procedures, a reconstructive memory or blending of memories from the original event can result (Hudson, 1990; Howe et al., 1995; Ornstein, Baker-Ward, Gordon, & Merritt, 1997). Although such blending is not believed to inhibit children's recall of the original experience, an interviewer unaware of the original experience would not be able to disentangle the blended report to obtain an accurate picture of the target event—an issue of significant concern in courtrooms today (Howe, 2000).

The research is clear that the accuracy of remembered event details declines over time, but the rate of decline can be manipulated by the types of questions asked by the interviewer and, perhaps, by the salience of the event under investigation. Furthermore, the effects of individual differences may be more pronounced after a delay, when verbatim memory has faded and children must rely on gist traces of the event. Thus, in studies examining children's

accuracy and suggestibility for stressful events, the effect of delay on their recall should be considered.

Effects of Developmental Level on Children's Recall

The stage of children's development has a broad influence on and is central to understanding how children remember stressful events. With age, children's expressions of distress may change, as may their strategies to cope with stressors. Thus, the magnitude and duration of their stress responses and their ability to provide coherent and detailed narratives expand substantially. Each of these cognitive and behavioral advances has implications for how children remember and recount prior stressful experiences. As such, it is not possible to interpret children's stress responses, memory performance, or the links between them without taking into account developmental considerations.

Effects of age on coping strategies. Older children rely on effective and adaptive coping strategies such as information seeking or mood elevation to help regulate their emotional responses to potential stressors (Compas & Boyer, 2001; Compas et al., 2001), and they rely less on reactions to others around them. It has been sufficiently established that the ability to cope effectively with stress continues to develop throughout adolescence and early adulthood (Compas, Malcarne, & Fondacaro, 1988). As children age, they use a greater range of coping strategies (e.g., resignation, distraction, cognitive restructuring, withdrawal, positive self-talk) when faced with environmental challenges commonly experienced in their lives, such as dealing with interpersonal relationships with parents, at school, or in other potentially threatening situations (Donaldson, Prinstein, Danovsky, & Spirito, 2000). In particular, older children report using more than one strategy concurrently and relying more

on cognitive strategies, especially in controllable situations, than do younger children (Brown, Kane, & Echols, 1986).

Age differences in how children cope with such challenges may affect the intensity of children's stress responses and the amount of time required to recover following these responses. Furthermore, when younger and older children are comparably distressed, given the older children's greater range of coping capabilities, they tend to remember different features of an event than their younger counterparts. Older children may focus on the consequences of an event in an effort to find meaning in the event or to identify potential topics of positive self-talk about the event. In contrast, younger children may focus on the location and availability of a caregiver to assist in coping (Wallin, Quas, & Yim, 2009). Such age-related differences in the focus of attention would be expected to affect details considered central to the memory-forming event and possibly the subsequent memory itself (Quas, Hong, Alkon, & Boyce, 2000). Finally, given young children's limited repertoire of coping strategies and cognitive resources (Case, 1991), they may need to direct their efforts toward self-regulation, resulting in fewer resources available to attend to the ongoing stressful event.

The age-associated effect on physiological stress. Children's physiological stress responses also undergo developmental change. Younger children's general predisposition to respond physiologically to stress (e.g., via parasympathetic withdrawal) may not be stable. Hence, their responses may not be consistently predictive of behavior and emotion regulation until the mid- to late-preschool years (Porges, Doussard-Roosevelt, Portales, & Suess, 1994). This theory is consistent with the observations that the same events do not necessarily trigger similar physiological reactions across age groups. With young children, in particular, physiological responses may vary for developmental reasons as opposed to stress exposure.

Alkon et al. (2003) examined age-related changes in 3- to 8-year-olds' parasympathetic responses during a baseline activity and in response to a series of laboratory-controlled challenges (see also Boyce et al., 2001). With age, children exhibited greater overall parasympathetic tone and lower overall sympathetic withdrawal, across both the baseline and experimental tasks.

A few studies have directly examined whether age interacts with children's physiological stress responses to affect their memory. Bugental and colleagues (1992) monitored 5- to 10-year-olds' heart rate during a period in which the children observed a video of a child visiting a doctor. The children in the youngest group (5- and 6-year-olds) had increased heart rates when the child in the video displayed visually negative responses but the older children didn't. Interestingly, the increased heart rate in this group was associated with increased memory errors. In the study by Quas et al. (2006), 4- to 8-year-olds' memory for a fire-alarm incident was evaluated shortly after it occurred. Parasympathetic withdrawal during the laboratory challenges and experienced a fire-alarm predicted poorer memory for the alarm incident among older children but not among younger children. Given the different events (witnessed video versus personal experience) and age ranges (5- to 10-year-olds versus 4- to 8-year olds) across the two studies, it is not possible to determine why such discordant results were obtained. However, the findings of both studies implicated the potential importance of developmental changes in initial responses, coping, and recovery in investigations of the relations between physiological arousal and memory in childhood.

Effects of age on anxiety and stress behaviors. Children's behavioral stress responses also undergo developmental change with age. Vandermass et al. (1993) found that younger children exhibited higher behavioral responses during the dental procedures than older children. Specifically, high levels of anxiety had a debilitative effect on older children's

memory but not on that of younger children. However, Baker-Ward, Ornstein, Quinonez, Milano, Langley, Lee, and Morris (2009) did not find that age interacted with children's behavioral stress responses to influence memory performance. However, the number of participants was relatively small ($N = 28$), and the age range was relatively wide (4- to 12-year-olds), and thus without further study, the conclusions must be viewed as tentative. Given that the results are inconsistent in regards to the impact of behavioral responses on children's memory, the relations between behavioral stress responses and memory in childhood needs to be carefully studied with taking into consideration of developmental changes in initial responses, coping, recovery, and memory of a stressful event.

Collectively, this body of research suggests that the effects of arousal on memory may vary with age because of age-related changes in the use and effectiveness of coping strategies, the magnitude or duration of children's physiological stress response, or children's behavioral responses. Overall, relations between children's individual differences in factors such as coping strategies, physiological and behavioral stress responses, and memory are not static across development. It is imperative, in future studies, that children across a wide age range be included to determine to the extents to which developmental stage effects differently on children's physiological/behavioral stress responses, memory performance, or the links between them.

Individual Differences on Children's Memory of Stressful Events

There has been a significant upsurge in the efforts to identify individual characteristics that are predictive of children's memory for a stressful event due to the inconsistent findings, to date, on the effects of stress on children's memory.

Some researchers contended that age differences alone are unlikely to be completely responsible for the variability of such a complex process as memory, nor can they explain the variability observed in similarly aged children's recall of alike events (Goodman, Quas, Batterman-Faunce, Riddlesberger, & Kuhn, 1997; Quas, Qin, Schaaf, & Goodman, 1997).

Individual difference variables among children's memories have been categorized generally as (a) demographic factors, such as socioeconomic status (McFarlane, Powell, & Dudgeon, 2002) or gender (Danielsdottir, Sigurgeirsdottir, Einarsdottir, & Haraldsson, 1993); (b) social-emotional factors, such as social engagement (Roebers & Schneider, 2001), self-concept and self-efficacy (Chae & Ceci, 2005), stress arousal (Eisen, Goodman, Qin, & Davis, 2002), parent–child communication pattern (Goodman et al. 1994,1997), parenting style (Crossman, 2001), child temperament (Burgwyn-Bailes et al. 2001), and the overall mental health of the child and the parents (Clarke-Stewart, Malloy, & Allhusen, 2004); and (c) cognitive factors, such as intelligence (Henry & Gudjonsson, 2003, 2004), language (Clarke-Stewart et al., 2004), theory of mind (Welch-Ross, 1999; Templeton &Wilcox, 2000), executive functioning (Roberts & Powell, 2005), creativity (Brown, 1999) and source-monitoring ability (Ackil & Zaragoza, 1995; Poole & Lindsay, 1995). These variables could explain why children, even those in the same age group, have performed so differently when remembering certain events. Moreover, a detailed understanding of such variables could benefit efforts to identify children who are particularly susceptible to providing erroneous reports following misleading suggestions. Such pursuits may help identify children for whom special interviewing precautions should be taken to maximize accurate testimony in a legal setting.

Although many authors (Bruck & Melnyk, 2004; Ornstein & Elischberger, 2004) have reviewed various predictive strategies for understanding individual difference factors on

children's memory and suggestibility, the precise individual difference factors that moderate the ways in which children's memory of stressful events is formed remain unknown. However, a number of individual characteristics have been identified as potentially important sources of variability in children's recollections of stressful events.

Effects of Cognitive Abilities. In the past, measurements of cognitive ability—be they general intelligence, working memory capacity, or developmental levels—have been included as central components in children's memory evaluations (Baddeley & Hitch 1974; Baddeley, 2003). Although researchers have since broadened their scope to incorporate a more integrated model of emotional memory (Imhoff & Baker-Ward, 1999; Peterson & Warren, 2009), individual differences in cognitive ability remain, undoubtedly, important. Cognitive measures related to memory include executive functions that are integral to general memory such as working memory and inhibitory skills that rely heavily on the frontal lobe (Diamond, Prevor, Challender, & Druin, 1997). For instance, Schaaf, Alexander, and Goodman (2008) found that children's inhibitory control explained their memory inaccuracies for emotional experiences, as determined in conjunction with other developmental measures (e.g., attachment, behavior problems). Specifically, in a structural equation model, inhibition directly and inversely predicted memory inaccuracies, as did additional pathways leading from children's behavioral problems. Furthermore, studies with children (Perez-Edgar & Fox, 2003) and adults (Edelstein, 2006) have revealed patterns of basic information processing and working memory that differ for emotional and neutral information as emotional information appeared to tax attentional and processing resources more than neutral information. Measures of general cognitive ability help explain processing and memory for emotional experiences.

According to a review by Reyna et al. (2002), previous studies have found that children who have an inferior understanding of dual representations (Welch-Ross, Diecidue, & Miller, 1997) and poorer source-monitoring skills (Schacht & Marche, 2001) exhibit higher levels of suggestibility. As such, cognitive measures seem to be certainly related to memory performance. Among various cognitive individual differences, receptive language ability, working memory capacity, and the quality of previous experience indicators were reviewed in detail as following.

Effects of receptive language abilities. Language competence has been proposed as one of the predictors of a child's capacity to recall events. This hypothesis was based on the fact that language skills are important for the verbal encoding of event details, which in turn may support memory extent and recall. Indeed, higher verbal skill levels have been associated with enhanced levels of children's recall, in particular for the details of nonstressful events (Boland et al., 2003; Simock & Hayne, 2002). Likewise, a study by Burgwyn-Bailes et al. (2001) that assessed 3- to 7-year-olds' recall of details surrounding facial surgery to correct lacerations found that children's receptive vocabulary (as measured by the Peabody Picture Vocabulary Test [PPVT]) was sufficiently predictive of younger children's recall; the relation was not observed in older children. Peterson and Warren (2009) extended this PPVT-based study to investigate the variation in language competence in a cohort of 95 children between the ages of 2 and 6 who experienced hospital treatment of an injury. This larger group study was found, however, no relations between receptive language skills and the accuracy or information content of the children's recount of the injury event or subsequent hospital treatment.

Interestingly, Clarke-Stewart, Malloy, and Allhusen (2004) found that lower language ability, as assessed by Feagans, Fendt, & Farran's (1995) Adaptive Language Inventory, was

independently predictive of 5-year-old children's susceptibility to suggestion, as determined by a 9-month recall study of a nonstressful event. Similar investigations by Roebers and Schneider (2005) concluded that 4-year-olds with relatively high language skills were more vulnerable to misleading information than their lower skilled peers, possibly because the advanced children were better able to recall the misleading information as a result of their enhanced verbal encoding abilities. Moreover, by using an interview protocol with simpler syntax and other developmentally appropriate linguistic features, Imhoff and Baker-Ward (1999) elicited increased recall and reduced suggestibility among preschoolers, highlighting the importance of proper investigative approaches when working with young children.

McGuigan and Salmon (2004) observed with 3-year-old significant positive correlations between both expressive and receptive language and total recall of a staged event. Among 5-year-olds, though, the relation held only for expressive language. Similarly, Burgwyn-Bailes et al. (2001) demonstrated that increases in receptive language skills were correlated with concomitant increases in recall of the younger children only. These collective findings suggest that language is not an effective predictor of recall ability in older children.

While a positive association between language skills of younger children and recall appears to exist, our understanding of the contribution of this variable to memory in children is far from complete. More studies are required to explore thoroughly age-related differences in the association between language ability and children's memory performance regarding stressful experiences.

Effects of working memory capacity. Working memory can refer to biological storage of information. Biological working memory (WM) is the natural physiological ability to retain and transform temporary information by the brain (Hitch & Towse, 1995). In

humans, WM facilitates the momentary maintenance and manipulability of task-relevant information and manifests as reasoning, learning, and comprehension.

Strong correlations have been found between WM capacity and the misinformation effect. Jaschinski and Wentura (2002) evaluated individuals with large WM capacity and found they were less prone to integrate misleading, postevent information into their memory. Various explanations exist as to why WM capacity can, in part, be associated with recall accuracy, especially in children.

Developmental patterns in WM and suggestibility appear to be inversely related. One of the most consistent findings in suggestibility research is that susceptibility to suggestive influence decreases with age. In particular, preschool children have been shown to be more suggestible than their older counterparts (Ceci & Bruck, 1993), and WM capability has been shown to increase with age (Case, 1995). The developmental patterns of WM and suggestibility indicate that an increase in WM capacity likely produces decreased suggestibility.

The developmental pattern of WM has been found to be highly related to information processing speed (Case, Kurland, & Goldberg, 1982). This speed of processing is believed by some, at least partially, to account for WM development with age (Hitch & Towse, 1995). The relation between the WM and the ability to process information quickly may stem from suggestibility. Case (1985) purported that any functional increases in the efficiency of mental operations would facilitate increased information storage in the WM; therefore, a greater volume of information would be available for manipulation, consequently enabling the enhancement of increasingly sophisticated cognitive tasks (Hitch & Towse, 1995).

Increased processing speed, over time, can lead to greater efficiency in mental operations that can then act upon the stored information. Resistance to suggestive

inference—a complex cognitive skill—might benefit from efficient information processing, although this has yet to be specifically examined in experimental analysis. Processing speed is known to play a significant role in WM capabilities; thus, WM may serve as a reliable indicator of an individual's quality of information processing capacity. Poor information memory competency may reflect poor information processing capacity, which can compromise an individual's ability to distinguish between true and false information, thereby making susceptibility to suggestive influence more likely. However, focused investigations are needed to clarify the potential association, if any, that exists between individual differences in children's WM capacity and their memory performance.

Effects of perceived quality of previous experiences. The quality of personal experiences that precede any stressful event experienced by an individual may impact recall memory of that new event. It has been shown that children who experience significant stress during an event are better able to recall the experience, both their stress level and event details, than children who experienced less stress (Goodman et al., 1991). Yet, children with higher rates of negative previous experiences have also exhibited decreased recall and higher levels of suggestibility (Chen, Zeltzer, Craske, & Katz, 1999). Children who have had negative experiences may come to expect more pain and stress from subsequent procedures, and thus experience substantial anxiety prior to and during the procedure, opening them up to suggestibility.

Thus, a strategy to reframe children's memories of previous LPs, so as to encourage recall of positive aspects of the procedure, was used as an approach to mediate children's stress. The outcome was improved coping and decreased distress during subsequent LPs (Chen et al., 2000). Additionally, children who frequently visit a certain doctor may, over time, develop more knowledge about what to expect during the visit. Thus, these children

may experience less anxiety prior to the visit and less stress during subsequent visits and would be expected to exhibit increased accuracy and decreased suggestibility. Indeed, a study by Quas et al. (1997) found evidence that increased knowledge about medical visits was positively related to children's memory accuracy. Chen et al. (2000) examined the association between children's (aged 3 to 18 years) expectations of pain during an LP and subsequent memory of the event details. When the authors controlled for age in this cohort, they found that children who expected to experience more pain actually recalled fewer event details, yet children's self-reports of actual pain during the procedure were not related to the event memory (see also Vandermass et al., 1993). Similarly, adults have tended to recall how much pain they expected rather than how much pain they actually reported experiencing (Kent, 1985).

The number of previous experiences a child has may also influence the strength of the resulting trace of the stressful event in the memory. The longer an individual is exposed to relevant details of an event, the stronger the memory trace is expected to be (Crowder, 1979). Repetitions of an event promote memory strength. Researchers have examined children's memory capacity for event details of both novel (Peterson & Rideout, 1998) and repeated (Chen et al., 1999) stressful procedures. Laboratory-based studies have compared children's memories and suggestibility in a single event as opposed to a repeated event. Mache (1999) presented preschoolers with a slide presentation depicting a particular event. Half of the children were exposed to the event once and immediately responded to a 20-item questionnaire about specific event details. The other half received repeated cycles of presentation then questionnaire item until all 20 questions were answered correctly. Children who witnessed the event multiple times were less susceptible to misinformation, and memory

strength was concluded to influence misinformation reporting (Marche & Howe, 1995; Pezdek & Roe, 1994).

Likewise, children who experience the same procedure multiple times may also exhibit superior recall as compared to those with fewer experiences—although, they may also make more errors in their recall of the details. It has been theorized that children, like adults, may form general representations, so-called scripts or gist-based memories, corresponding to these procedures. In this manner, children may erroneously report details about the way in which the procedure usually occurs since they are relying on a preformed idea rather than the actual event. Such scripts may influence subsequent pain and illness behavior (Ornstein et al., 1999).

Despite such speculations, research still appears equivocal. According to a study by Goodman et al. (1997) with children who repeatedly received with VCUGs, the number of prior experiences was unrelated to children's memory accuracy for the event. Quas et al. (1999) concurred, providing evidence that the amount of prior knowledge provided via parental preparation about the VCUG procedure did not affect children's memory. Yet Goodman et al. (1997) found that children's prior knowledge scores positively related to memory accuracy. Such inconsistencies may stem, in part, from the extent to which the to-be-remembered event is consistent with prior experience or knowledge. For example, children's understandings of typically occurring events during a doctor visit were found to be predictive of the specific events they remembered from an actual visit (Ornstein et al., 1997). In addition, when researchers investigated suggestibility in relation to procedures that did not match children's prior understanding, they found that children's susceptibility to false suggestions increased. It is important to note that suggestive questions consistent with children's understanding were asked (e.g., "Did the dentist wear white rubber gloves?") as

opposed to questions that did not match the children's expectation of the procedure (e.g., "Did the dentist take your temperature?"; Baker-Ward et al., 2009).

Unfortunately, the current literature does not equivocally explain how the amount of exposure or quality of prior experience with stressful procedures affects children's recollection. In particular, it remains uncertain how these experiences, either their number or quality, can affect what children recall about events and how precise that recall is. The quality of prior medical experiences may be imperative to understanding subsequent behavior on the following experiences, because it influences how the event is encoded in memory.

Accordingly, a link between the quality of previous dental experiences and children's memory is likely. Children who have had positive previous dental experiences may have comparatively lower stress reactivity during the dental procedure; as a result, they may be more aware of their conditions, and therefore, have a better memory of the experience they have undergone.

Effects of Social-Emotional Difference. Besides cognitive ones, other nonphysiologic factors are likely to contribute to the complex and dynamic process of memory and recall. In particular, variation in social-emotional factors such as temperament, stress-coping strategy, and responses to pain and anxiety, would be expected to play a role in children's memory performance for any past event. This thesis project was designed to specifically evaluate those social-emotional personality factors addressed above and determine their relation to children's memory recall of a stressful event.

Effects of temperament. Children will manifest distinct, individual responses to stressful situations, which may affect how they deal with pain and how their memories of the event are formed. Temperament is believed to be a component of these individual variations.

Persons whose reactivity is low due to certain temperament dimensions may encode, store, and retrieve memories of unique and stressful situations in different ways than people with high reactivity. Accordingly, temperament dimensions associated with more difficult or challenging behaviors may be related to higher levels of stress, and those associated with easier behaviors may be related to lower levels.

Gordon, Baker-Ward, and Ornstein (2001) reviewed that both adaptability and the tendency to approach others as opposed to withdrawal or shyness correlated strongly with children's recall. It is likely that these and other personality characteristics come into play to create a dynamic environment during the interview process that can influence recall performance (see also Greenhoot et al., 1999). Children who are more outgoing and adaptable may adjust better to being interviewed, and as a result, retrieve more information from memory. Furthermore, it seems reasonable to expect that younger children's performance would be more affected by temperament than that of school-aged children, who have had more extensive experiences with structured situations. Thus, preschoolers' recall and suggestibility might be more influenced by shyness and emotional intensity than that of older children.

Merritt et al. (1994) found that two of six temperament dimensions, adaptability and approach/withdrawal, were associated with recall and behavioral distress related to VCUG events. Children who readily adjusted to new circumstances and were more likely to approach new situations recalled more details of their VCUG experiences. The authors suggested that these significant relations were likely based on individual differences related to how the VCUG was experienced, and hence, encoded in memory.

Although it remains uncertain how temperament influences memory performance, it is plausible that temperament does not influence memory directly, but rather, is an indicator

of a child's willingness or lack thereof to verbalize and share their memories. For example, children rated by parents as adaptable and willing to approach a novel situation may simply be more expressive and readily willing to provide more memory information in general, as compared to their less adaptable and less interactive peers.

In addition, temperament may explain differences that have been observed in children coping with similar stressful situations, in keeping with the theory that experience encoding can vary substantially from child to child. For example, children with high EAS (Emotionality Activity Sociability Scale reported by parent) shyness scores displayed more disruptive behavior prior to dental treatment under general anesthesia than those with low scores (Quinonez et al., 1997). The association between temperament and better recall may be that children scoring high on negative emotionality might be more wary of their surroundings and therefore have a better remembrance of what happened during the session. Increased arousal is suggested to lead to increased memorability (Fivush, 1998).

From a biological perspective, individual differences in temperament are theorized to be genetically rooted as dispositional characteristics of reactivity and self-regulation (Rothbart, Ellis, & Posner, 2004). As such, one would expect there to be evolutionarily enduring characteristics of emotional and cognitive behavior consistently correlated with psychobiological patterns of emotional processing and reactivity. Indeed, such characteristics exist and have been identified. Vagal tone reactivity is one, which is an index of the parasympathetic nervous system's capacity to regulate sympathetic arousal (Doussard-Roosvelt et al., 2003). Circulating cortisol levels (Gunnar & Vazquez, 2006) and preschoolers (Theall-Honey & Schmidt, 2006) are a few additional examples.

One aspect of temperament that has been extensively studied is temperamental *reactivity* or *behavioral inhibition* (Marshall & Stevenson-Hinde, 2005). Behaviorally

inhibited children exhibit focused attention in novel situations and have difficulty shifting their attention (Martin & Fox, 2006). Similar patterns have been observed in behaviorally inhibited adults (Derryberry & Reed, 2002). Such effects of temperament, within the developmental context, have implications for emotional memory by orienting to and/or maintaining attention on certain aspects of a given situation. These biases in attention have been characterized as fairly enduring patterns of reactivity, and therefore, may mediate the development of emotional schemas that uniquely affect memory for emotional experiences.

Temperament is well recognized for its involvement in the regulation of physiological and behavioral patterns of emotion during events that are novel and emotionally arousing (Moehler et al., 2006). For instance, frontal cortex measurements taken while children viewed emotional video clips revealed asymmetry in the cognitive response regions and correlated with temperamental differences in the children (Theall-Honey & Schmitt, 2006). Shy children showed greater right frontal asymmetry while viewing a fear-eliciting video, indicating the motivation to withdraw. Because children were processing novel stimuli, these brain activation patterns were considered similar to those expected during encoding of novel events. A related body of research has linked children's physiological reactivity (i.e., cortisol and heart rate) to temperamental characteristics (Martin & Fox, 2006) and to their memory of emotionally arousing experiences (Quas et al, 2004, 2006).

Thus, temperament appears to be associated with recall, and it should be considered in an interview setting in which children are asked to recall a past event. Children who are more adaptable or flexible in their ability to cope with new situations could demonstrate higher total recall than those who are less flexible and the effects of temperament on children's recall would be moderated by age. Accordingly, there is likely a link between

certain aspects of temperament and children's memory. The specific dimensions remain unknown but are worthy of exploration.

Effects of stress-coping strategies. Children's coping strategies during or after a stressful experience, whether intentional or not, may strongly moderate the accuracy of children's remembering of that experience. Effective coping relies on one's ability to regulate or modulate emotion or arousal; effortful control (reflecting the child's ability to shift and refocus attention) appears to be integral to this process (Salmon & Pereira, 2002). For instance, during medical procedures some children request information from medical personnel, and others cry and resist or request parental support or comfort (Quas, Hong, Alkon, & Boyce, 2000). In the forensic context, the reactions of children are known to vary broadly during sexually abusive events and can include active resistance, feigning sleep, compliance, or mentally withdrawing and pretending that the abuse is not occurring (Quas, Goodman & Jones, 2003).

To date, very little research has been carried out to determine how particular coping strategies influence children's recall of stressful experiences. Some coping strategies that involve focusing on the experience itself (e.g., cognitive reframing and other forms of self-talk) are believed to facilitate recall, whereas strategies of avoidance that result in a shift of attention away from an unpleasant stimulus (distraction) or attempts to block out awareness of the stimulus (escape or denial) have been considered by many to contribute to poorer recall. Children's coping strategies are undoubtedly influenced by the individual's developmental stage. Linguistic and metacognitive maturity enables older children to invoke advanced cognitive strategies in addition to the behavioral strategies routinely used by younger children (Compas, Connor-Smith, Saltzman, Thomsen, & Wadsworth, 2001).

Manne, Bakeman, Jacobsen, and Redd (1993) investigated 3- to 9-year-olds' distress and related coping during different clinical stages of a venipuncture procedure: preparation, needle insertion, and completion. The older children used more coping skills, which ultimately resulted in less crying, especially during the needle insertion event. Children who were more distressed during the preparation stage tended to employ fewer coping strategies throughout the remainder of the procedure. It was unclear, however, if these findings indicated that initial intense distress generated negative memories for the entire procedure.

Pate, Blount, Cohen, and Smith, (1996) used self-reporting measures to determine whether childhood distress and coping were major predictors of subsequent distress and coping effectiveness in adult life. The authors concluded that self-reports can be affected by memory deterioration and selective recall. Along those same lines, Baker-Ward et al. (2009) found that children who reported seeking social support in coping with a stressful dental treatment (as assessed by the response, e.g., "I asked for someone who cares about me, like my mom or dad") were able to recall more total information and tended to recall more features in response to open-ended probes. Ornstein, Manning, and Pelphrey (1999) also reported finding a positive correlation between children's information-seeking behaviors during minor surgery and recall, indicating that children who sought information remembered more than those who essentially shut down and closed their eyes for the duration of the medical procedure.

Differences among children's emotional coping skills and attention focus during a stressful event and their willingness or ability to deliberate and discuss emotional events with others likely affect encoding, storage, and retrieval processes, and subsequent memory reports. Children who use the approach coping style will likely exhibit enhanced memory, as opposed to those who rely on the avoidance approach. It has long been considered that

experiential avoidance, of which a core feature is an "unwillingness to remain in contact with aversive private experiences" such as thoughts, feelings, and memories, is considered to be a stronger contributor to psychopathology than the intensity, frequency, or negative valence of these experiences (Chawla & Ostafin, 2007; Hayes & Wilson, 2003).

Understanding the development and consequences of the various manifestations of emotional coping skills clearly has significant theoretical and practical implications.

Effects of parent–child relationship on coping strategies. Several of the findings reported in the literature have indicated that a tendency to avoid emotional distress can originate from an insecure, avoidant, parent–child attachment relationship. Furthermore, such responses are associated with the child's personal memories and socioemotional functioning (Chae, Ogle, & Goodman; Laible & Panfile; Sales, 2009). Greenhoot et al. (2009) studied factors associated with one form of experiential avoidance: specific painful memories as related to the retrieval of over-general memories that is, memories referring to repeated events (e.g., 'My parents were always fighting'), or referring to events that lasted for a longer period of time (e.g., 'when I was young'), rather than recalling specific episodes in their personal past (e.g., On my ninth birthday, my parents got into a bad fight."). Their findings showed that adolescents with a history of sexual abuse and exposure to parental violence (compared to violence alone) manifested memory deficits including shorter memories, fewer negatively valenced memories and more over-general memories in response to neutral cues. These individuals exhibited greater reliance on interviewer prompting to elicit information. In addition, adolescents with childhood abuse histories produced fewer emotion-related words in response to negative cues than their counterparts lacking abuse history. Greenhoot et al. suggested that, for some individuals, retrieval of over-general, rather than specific memories, of stressful emotional experiences may be part of a broad style of emotion

avoidance arising from socialization experiences, with each avoidant instance negatively reinforced by reduction in negative effect.

The influence on memory of differing patterns of conversational avoidance between parents and their young children also warrants more detailed investigation (Greenhoot et al., 2009). We have already discussed the potential role of parental invalidation of children's conversational contributions in promoting the adoption of avoidance-based coping strategies, but other patterns are, of course, possible. Parents have reported a belief that avoidance will minimize the child's stress in both the short and long term (Salmon & Bryant, 2002). However, parents may also harbor selfish reasons for promoting children's avoidance behaviors, such as the desire to maintain secrecy of socially prohibited activities like sexual abuse (Fivush, Pipe, Murachver, & Reese, 1997). Alternatively, parents may focus on some aspects of an experience at the expense of others, for example, avoiding discussing the negative elements of a past experience or becoming particularly preoccupied with those negative aspects, actively promoting the rumination and rehearsal activities in their children (Scheeringa & Zeanah, 2001).

Research on retrieval-induced forgetting in adults has shown that such selective review has significant implications for memory (Anderson, Bjork, & Bjork, 1994). Similarly, Conroy and Salmon (2005, 2006) found that repeatedly discussing some aspects of an event at the expense of others impaired young children's abilities to recall those aspects not discussed. Schooler (1997) highlighted the potential clinical and forensic relevance of selective review in his case description of an adult who, after years of apparent forgetting, suddenly remembered sexual abuse disclosed as a child. Schooler suggested that exclusive focus on remembering other experiences of physical abuse may have reduced her accessibility to the memory of sexual abuse.

Effects of working memory on coping strategies. Working memory (WM) also has been found to play a critical role in determining whether effective coping strategies, such as cognitive reappraisal, can be adopted. Campbell et al.'s (2009) findings of individual differences in parental and self-reports of coping strategies used by adolescents suffering from leukemia support this position. Specifically, *maladaptive coping* (avoidance/disengagement) was negatively associated with WM but positively associated with difficulties in internalization. In contrast, *adaptive coping* (in particular, reappraisal) was positively associated with executive functioning (including WM) and fewer internalizing/externalizing behavioral problems.

These findings, together with those that implicated an association between avoidance and poor psychological adjustment, highlight the need for further research to directly examine the role of memory in the development of psychopathological responses. For example, avoidant strategies such as thought suppression, hiding emotions, and distancing oneself from others have been related to a variety of negative effects on memory and on psychological functioning. It is important to note, however, that much of this work has been conducted with adults and the precise linkages have not been clearly articulated (Rassin, Merckelbach, & Muris, 2000; Richards & Gross, 2006). Moreover, the associations appear to be complex; consider that greater WM has been shown to facilitate effective coping such as cognitive reappraisal (Compas et al. 2009), but it can also enable better suppression of intrusive thoughts, a less-effective coping strategy (Geraerts, Merckelbach, Jelicic, & Habets, 2007).

Undoubtedly, considerable variability exists in specific strategies for coping with stressors among individual children and across developmental levels (Compas et al., 2001), whether they stem from parental example or WM capacity. As such, children who use an

approach-type coping style might be likely to exhibit lower stress reactivity, which could lead to enhanced memory. In contrast, those who rely on an avoidance approach would be expected to exhibit higher stress reactivity, which could cause deteriorated memory.

Differences among children's emotional coping techniques and stress reactivity during a stressful event, along with comparable differences in their willingness or ability to discuss emotional events with others is very likely to affect encoding, storage, and retrieval processes, and consequently, children's subsequent memory reports. Thus, individual differences in stress-coping styles may moderate the predictive ability of children's stress responsivity and memory performance.

Effects of anxiety and pain. Anxiety is believed to affect memory of stressful situations. In particular, high *state anxiety,* which is situation specific, in adults has been associated with less accurate recall of the experienced pain's intensity (Arntz, Van Eck, & Heijmans, 1990). Among children, the results have been equivocal. A significant positive correlation has been found between state anxiety and the amount of pain that children (aged 5 to 17 years) expected and recalled from a venipuncture procedure (Lander et al., 1992). Children who reported high levels of anxiety prior to the venipuncture event, as measured by the Spielberger State-Trait Anxiety Inventory for Children (STAIC; Spielberger, Edwards, Lushene, Montuori, & Platzek, 1973), tended to overestimate the level of pain they would experience. After a 2-month delay, they were more likely to remember experiencing more pain than they reported immediately after the event.

On the other hand, Zonneveld, McGrathb, Reidd, and Sorbia, (1997) examined daily pain diaries of hospitalized children (aged 5 to 16 years) and found that anxiety was not related to the accuracy of pain recall. Another study examining children's expectations and recollections of discomfort associated with dental treatment found that state anxiety did not

affect children's self-reported discomfort (Huq, Lindsay, & Roberts, 1992). Specifically, when children's (aged 7 to 16 years) memory of their discomfort during the procedure was assessed 3 months following the procedure, even the most anxious children (as assessed by the STAIC) recalled no more discomfort than they had reported immediately after the treatment. The authors concluded that anxious children were able to recall their discomfort without distortion.

Vandermass et al. (1993) examined the effects of anxiety on memory of event details in children aged 4 to 8 years who were undergoing dental procedures. They found that age moderated the effects of anxiety on memory. Specifically, high levels of anxiety had a debilitative effect on older children's memory but not on that of younger children. However, when the child's previous experience with the dentist performing the procedure was controlled, the interaction of age and anxiety on memory was no longer statistically significant. The authors concluded that the effects of anxiety on memory are complex in nature, and several factors such as age, experience, and anxiety level are influential in the anxiety–memory relation.

In the Chen et al. (1999) study, age was also determined to mediate the effects of anxiety on recall. Children's self-reports of anticipatory anxiety and anxiety during the LP procedure were both negatively associated with total memory scores 1 week after the LP was performed. However, when age was controlled for, only the children's reports of anxiety during the LP procedure remained marginally significant. The authors suggested that this finding may be accounted for because the younger children showed more distress during LPs and had poorer memories than the older children.

Children's fear level has been related to accuracy of event details corresponding to a VCUG procedure (Merritt et al., 1994). Fear is considered to be comprised of feelings of

intense and circumscribed anxiety that often manifest in complex reactions, taking the form of escape or avoidance of the threatening situation (Barrios & Odell, 1998). Merritt et al. (1994) found that the more fearful children were judged to be by a technologist, the less they recalled of the procedure, in both immediate and delayed recall.

Increased self-esteem in adults (Gudjonsson & Singh, 1984) and increased self-efficacy in children (Mazzoni, 1998) appeared to promote resistance to suggestibility in several studies. Some researchers have suggested that anxiety levels may account for these findings (Bruck, Ceci, & Melnyk, 1997) and theorized that the anxiety associated with low self-esteem interfered with the encoding or retrieval of information.

Delayed interviews and recall of pain and anxiety. The effects of delay on recall of pain and anxiety are particularly of interest to clinicians, who often rely on children's abilities to accurately recount their memories of pain and anxiety to evaluate the feasibility of particular treatments. To this end, researchers have focused their efforts on answering questions such as "Is reliance on children's pain memories justified?" and "Over what time period are these memories reliable?" (Zonneveld et al., 1997).

Lechmann, Bendebba, and DeAngelis (1990) interviewed 91 3-8-year-olds asking them to remember two recent painful events. Children were interviewed on two occasions 7 days part in order to estimate the consistency with which children would rank order the two experiences of pain they remembered and four others identified by the authors (shot, stomachache, cut, and a bump). Five scaling procedures were employed, including the simple question, "Which hurt more?". Results showed that for children 7 years of age and under, the consistency of pain intensity ratings between the two sessions was 20–55%. Whereas children aged 8 and older recalled the relative difference in pain intensities consistently (50–100%) across all pain ratings. This comparative study design required the children to process

gist information, rather than merely relying on retrieval of a verbatim detail. Fuzzy trace theory would predict that younger children would have much more difficulty with this type of task, due to their normal reliance on verbatim memories, as was the case in this study.

Lander et al. (1992) compared experienced and recalled pain (after a 2-month delay) of 5- to 17-year-old children undergoing venipuncture. Using McGrath's illustrated faces pain scale (McGrath, deVeber & Hearn, 1985), consisting of nine facial expressions indicating different extents of emotion involved with pain, they found that 75% of children maintained accuracy within one face. Another 16% were accurate within two faces. The researchers also used a 100-mm visual analogue scale (VAS) to assess recall of pain intensity and found that 43% were accurate, 24% recalled less pain, and 33% recalled more pain than previously reported. However, the findings likely reflect differences in the measurement approaches, given that two different types of scales were used (i.e., faces scale and VAS) to measure both affective pain and pain intensity.

Zonneveld et al. (1997) conducted a comparative analysis on the accuracy of children's memories of pain after delays of 1 day and 1 week by using the 7-point Bieri's Faces Pain Scale (Bieri, Reeve, Champion, Addicoat, & Ziegler, 1990). The authors studied 5- to 16-year-old patients' recall of their average and worst pain intensity by comparing the level of recorded pain intensity with the level of recalled pain intensity at the two delay intervals. Results showed that accuracy was high and exhibited little decrement over the 1-week lapse. Not surprisingly, older children had more accurate recall of their worst pain intensity.

Children's memory of a novel pain stimulus has also been found to be reliable over a longer delay period. Badali et al. (2000) examined children's memory of pain intensity for pain experienced from a cold pressor task. Participants were asked to immerse their hand in

temperature-regulated cold water and to hold it in the basin as long as they felt physically possible. Children (aged 5 to 12 years) were asked to rate their pain immediately following the procedure and again after 1 year had elapsed. Ratings were made on the 7-point Bieri Faces Pain Scale (Bieri et al., 1990). When agreement was found between the initial and recalled ratings of pain, the results were determined to be within the statistical threshold of significance, suggesting that children could reliably recall their pain intensity ratings over time.

In summary, pediatric health psychology research suggests that, on average, children can recall previously experienced pain and distress accurately although children are likely considered to have limited capacity depending on age. What we have yet to learn is which particular factors may influence their accuracy.

CHAPTER 3: STUDY 1

METHODS

Participants

A total of 71 children between the ages of 4 and 10 years were recruited during the summer of 2009 from the Maria Junior Dental Clinic, a private practice located in a metropolitan area in Seoul, South Korea. Parents of children scheduled to undergo dental procedures at the Clinic were contacted onsite in the waiting area by a researcher to request permission to discuss possible participation in the study. If permission was granted, a researcher described the study to the parent, and explained the parental consent and permission forms in Korean. If verbal consent was given by the parents for their and their child's participation, the researcher provided the parent a copy of the written consent form translated into Korean to review, asked them to discuss the study with their child in an age-appropriate way, and answered any questions the family had. Signed consent and permission were obtained on a new form (see Appendix B). The parent kept the copy given earlier. Verbal assent was obtained from the children prior to participation. Written consent was obtained from the participating dentist as well.

Of the families who agreed to participate, eight children were dropped for various reasons, including the child's mood after the dental treatment and time limitations of the parents. The resulting sample was thus composed of 63 children: 2, 4-year-olds (M = 54.67 months, SD = 5.13); 10, 5-year-olds (M = 68.18 months, SD = 3.28); 16, 6-year-olds (M =

76.53 months, *SD* = 3.18), 12, 7-year-olds (*M* = 88.76 months, *SD* = 2.95), 11, 8-year-olds (*M* = 98.75 months, *SD* = 2.76), 8, 9-year-olds (*M* = 111.71 months, *SD* = 3.95), and 4, 10-year-olds (*M* = 123.33 months, *SD* = 0.58). The sample was composed of approximately equal numbers of girls (43.5%) and boys (56.5%). Because of the suburban location of the clinic, the sample consisted primarily of children from middle- and upper-middle-class families. No child was excluded based on gender or socioeconomic status.

Using the G power software program, power analysis calculations were conducted for the proposed statistical model. A sample size of 60 was sufficient for achieving the stated goals based on the MANOVA test, with a power of .80, an alpha level of .05, and a small effect size of .10 – .20. Thus, the target sample size was 65.

Target Event and Immediate Interview

A total of one pediatric dentist and three hygienists provided dental treatment to the participants. Prior to the investigation, discussion with the pediatric dental staff resulted in the identification of 17 component features of the dental treatment. As seen in Table 3.1, these features represented procedures that are typically administered during routine dental treatments such as fillings, sealants, crowns, or extractions. Although the detailed features may vary somewhat among the procedures, the general features that children were asked to remember were the same, and the full procedures were videotaped for later analysis to determine the precise component features that were included in each child's visit. In addition to present features, in order to explore issues of suggestibility and possible response bias, children were also asked absent features (termed absent feature questions), which were less likely to occur during the dental procedure. Because dental treatments vary somewhat from

child to child, each dental treatment was composed of a subset of the features listed in **Table 3.1**.

During the dental treatments, a researcher was asked to mark the procedures that were administered on checklists so as to have independent records of the specific elements of each child's dental treatment.

Table 3.1

Features that Could or Could Not Occur During the Children's Dental Treatments

	Name	Description
Likely to Occur	Green mask	Dentist puts a green rubber mask on a child's mouth (dentist calls it as a green raincoat)
	Water	Dentist puts squirting water tube into the child's mouth (dentist calls it as a water fountain)
	Rubber gloves	Dentist wears a rubber gloves
	Chair up and down	Chair moves up and down before and after the procedure
	Jelly on gums	Dentist puts jelly on the child's gums (hot cream)
	Air gun	Dentist uses an air blowing tool to check sensitivity
	Sucking saliva	Tool used that sucks saliva
	Mouth prop	Dentist puts a mouth prop to keep the child's mouth open
	White or silver filling	Dentist uses white or silver filling
	Special light	Special light used to dry filling (laser gun)
	Metal hat	Tooth ring
	Cotton	Cotton in mouth
	Brush one's teeth	The child is helped with teeth brushing before the procedure
Not Likely to Occur	Check head for ticks	Helpers check the child's head for ticks
	Check a hair	Helpers check the child's hair
	Put Band-Aid on toe	Helpers puts a Band-Aid on the child's toe
	Drink medicine	Helpers give the child medicine to drink
	Metal pliers	Dentist uses metal pliers to pull the child's tooth out
	Take a picture	Helpers take a picture of the child's mouth
	Check eyes or hearing	Helpers check the child's eyes or hearing
	Take a shot	Dentist gives a shot to the child
	Check height and weight	Helpers check a child's height and weight
	Hold a mirror	The child holds a mirror during the procedure
	Necklace	Helpers give a plastic necklace to the child with his or her tooth in it.
	Temperature	Helpers check the child's temperature

Sequence of events. The study did not involve the administration of any new dental procedures; rather, it observed existing, minor procedures. Thus, children's participation in this study in no way affected their treatment. Although we could not control the time required for the dental operative procedure, most procedures required approximately 15 to 20 minutes.

To obtain observable behavioral measures of mild stress reactivity (Melamed, Weinstein, Hawes, & Katin-Borland, 1975), the researchers coded each child's behavior during the dental procedure using the Behavior Profile Rating Scale (BPRS) while watching the recorded videotape of the dental procedure. In addition, the dentist rated each child's level of stress, anxiety, and compliance during the dental procedure using the Frankl behavior rating scale (Frankl, Shiere, & Fogels, 1962).

Immediately following the procedure, the children were asked to play in a playroom for about 10 minutes to calm them down. They then entered a quiet counseling room in the clinic. Once in the room, the children completed a coping measure in which they were questioned about their coping behaviors throughout the procedure. After answering all the questions, the children participated in a one-on-one memory interview using a protocol that assessed retention of the predefined event components in response to queries of increasing specificity. In addition, parents were asked to complete several measures on their children's personal characteristics involving temperament, family demographics, and prior dental experience. This initial session after the dental procedure was also videotaped. The entire interview process lasted approximately 20 to 30 minutes.

Measurements

Table 3.2 describes the different instruments used throughout the dental procedure and immediate interview session to measure the studied variables. Each individual instrument will be discussed in detail. **Table 3.3** shows which individual was responsible for the completion of each measure.

Table 3.2

Study Variables and Instruments Used to Measure Them

Variables	Instruments
Demographics	Questionnaire that asked about child's prior dental experiences and the extent of advance discussion they received about the event
Temperament	Children's Behavior Questionnaire
Behavioral stress reactivity	Behavioral Profile Rating Scale
Dentist's ratings	Noncompliance/ Anxiety (7-point Likert rating scales) Frankl Behavior Rating Scale (4-point Likert rating scales)
Memory interview	Memory for the event was experimentally elicited by using a hierarchically structured protocol that assessed retention of the predefined event components in response to queries of increasing specificity
Interviewer's ratings	Child's hesitancy and ease of management
Child's emotion	Child's self report about the memory interview
Coping strategies	KIDCOPE, HICUPS (How I Coped under Pressure Scale)

Table 3.3

Parties Responsible for Instrument Responses

Instrument	Completed By
Parental Background Questionnaire	P
Children's Behavior Questionnaire	P
Memory interview	C
Stress Coping Strategy Questionnaire	C
Frankl Behavior Rating Scale	D
Behavioral Profile Rating Scale	R

Note. C = Child, D = Dentist, P= Parent, R = Researchers.

Behavior Profile Rating Scale (BPRS). Melamed, Weinstein, Hawes, and Katin-Borland (1975) developed the BPRS to objectively measure children's behaviors in dental situations. The original scale consisted of 27 child-related behaviors considered to be indications of dental anxiety or fear. Four of the items apply to the child's behavior upon separation from the mother, and the remaining twenty-three assess office behavior (2 concerning the dentist and 21 concerning the child's behavior). Each of the 27 behaviors is weighted by a factor that reflects the degree of its disruptiveness as defined by Melamed et al. (1975). An independent observer scores the frequency of these behaviors over 3-minute intervals, with the total BPRS score achieved by multiplying the frequency at which a behavior in each category occurs by its weighted factor. These weighted frequencies are subsequently added across categories, and the sum is divided by the number of intervals. As such, the total BPRS score serves as a measure of the average frequency of fear-related behaviors per 3-minute interval.

This study used the revised BPRS, which added *scream* with a weight of 5 to discriminate from the behavior of *crying* (weighted 3) more effectively. Frequency of *information seeking* was also added and *stands up* (weighted 4) was eliminated, as children were not likely to demonstrate this behavior during a dental procedure. The recorded dental procedures were scrutinized by the researchers according to the scale shown in **Table 3.4**.

Table 3.4

The Observational Scale of Behavioral Stress Responses

Behavior Category	**Category Weight**
Inappropriate mouth closing	1
Chokes	1
Cries during injection	1
Fidgets	2
Won't sit back	2
Attempts to dislodge instrument	2
Verbal complaints	2
Verbal message to terminate	3
Refuses to open mouth	3
Rigid posture	3
Crying	3
Rolls over	4
Restraints used	4
Kicks	4
Flings arms	5
Dislodges instruments	5
Refuses to sit in chair	5
Faints	5
Leaves chair	5
Scream	5
Information seeking	Frequency

Frankl behavior rating scale (Frankl). The Frankl (Frankl, Shiere, & Fogels, 1962) is one of the most extensively used rating scales for assessing the anxiety level of children in dental settings. This scale categorizes children's behavior in specific situations along a four-point scale, based on their cooperation during the treatment. For this study, the dentist rated each child's behavior using the Frankl behavior rating scale (see **Table 3.5**). In addition, he rated each child's cooperation and anxiety with the 7-point Likert scale, ranging from *Completely compliant/ Not at all anxious* (1) to *As difficult to manage as any patient I've seen/ As anxious as any patient I've seen* (7).

Table 3.5

Criteria for the Frankl Behavior Rating Scale

Definitely negative (1)	Refusal of treatment, crying forcefully, fearful, or any other overt evidence of extreme negativism.
Negative (2)	Reluctant to accept treatment, uncooperative, some evidence of negative attitude but not pronounced (e.g., sullen, withdrawn).
Positive (3)	Acceptance of treatment, at times cautious, willing to comply with the dentist, at times with reservation, but patient follows the dentist's directions cooperatively.
Definitely positive (4)	Good rapport with the dentist, interested in the dental procedures, laughing and enjoying the situation.

Interviewers'ratings and children's self-reports of emotional condition. After the interview was completed, the interviewer rated the child's hesitancy and ease of management based on the child's attitude during the interview. To identify the child's hesitancy to disclose information, the interviewer rated the child's behavior in different situations using a 5-point Likert scale, ranging from *extremely hesitant* (5) to *not hesitant at all* (1). To identify ease of management, the interviewer rated the child's behavior in different situations using a 5-point Likert scale, ranging from *easy to manage* (5) to *extremely hard to manage* (1).

The child's self-report of their emotional state during the interview was also measured at the end of the interview. The interviewer showed each participant a sheet with three faces decreasing in happiness, with the first face being the happiest. The researcher asked the participant to point to the face that best described how upset, scared, or unhappy the child felt during the interview.

Coping strategy measures. Children's coping activities were examined using the two-process model of perceived control (Rothbaum, Weisz, & Snyder, 1982), which distinguishes among (a) *primary control*—modifying objective conditions to fit oneself;

(b) *secondary control*—modifying oneself to fit objective conditions; and (c) *relinquished control coping*—giving up or only expressing emotion (Thurber & Weisz, 1997). Baker-Ward et al. (2009) developed an original coping questionnaire based on the format of the KIDCOPE screening questionnaire (Spirito, Stark, & Williams, 1988). The 10-item KIDCOPE enables quick assessment of the frequency and effectiveness of typical coping styles including distraction, social withdrawal, cognitive restructuring, self-criticism, blaming of others, problem solving, emotional expression, wishful thinking, social support, and resignation.

The coping questionnaire used for this study employs eight of the 10 KIDCOPE items. Two items on self-blame and blaming others were excluded due to their questionable validity in dental settings. In addition, the reliability of the self-blame item has been questioned by KIDCOPE's authors (Spirito et al., 1988). Of the remaining eight items on the coping questionnaire, seven were created from direct observations of the methods that 4- to 7-year-old children employ to cope with dental stressors based on the How I Coped Under Pressure Scale (HICUPS; Ayers, Sandler, West, & Roosa, 1996). Thus the questionnaire used in this study included a total of 15 questions. They covered mood elevation (3 items), avoidant actions (3 items), activated escape (2 items), social support (3 items), information seeking (2 items), emotional expression (1 item), and resignation (1 item). The last item was open-ended, and asked children to describe any other methods of coping they may have used (see Appendix J).

Parental questionnaire. During the initial visit, parents were asked to complete a number of measures related to their children's personal characteristics, family

demographics, prior dental experiences, extent of the preparation for the visit, and children's temperament (see the questionnaire used in Appendices J and M). It should be noted that 'caregiver' might be the more strictly appropriate term for this study since there were several grandmothers who agreed to participate this study and completed these measures. However, the term 'parents' is used for an easy interpretation and the majority of the participants were indeed a child's individual parents.

Children's Behavior Questionnaire (CBQ). The CBQ was designed for use with 3- to 7-year-old children to assess temperament and is available in various lengths (36 to 195 statements). Due to the already extensive time commitment required of parents, the very short form (36 statements) of the CBQ was selected. It assesses 13 scales with 2 to 3 items each: Activity Level, Anger/Frustration, Attention Control, Discomfort, Falling Reactivity/Soothability, Fear, High Intensity Pleasure, Impulsivity, Inhibitory Control, Low Intensity Pleasure, Perceptual Sensitivity, Sadness, and Shyness. Parents (or primary caregivers) responded to each statement by providing a rating on a scale from *extremely untrue* (1) to *extremely true* (7) to reflect the child's reactions during the past 6 months. Parents were also provided with a *Not Applicable* option if the child had not been observed in the situation described.

Validation of the CBQ has been offered via a number of investigations over the past decade. The standard form has been used to study genetic and environmental influences on temperament (Goldsmith, Buss, & Lemery, 1997), longitudinal change and consistency in temperament (Murphy, Eisenberg, Fabes, Shepard, & Guthrie, 1999; Tomlinson, Harbaugh, & Anderson, 1996) and cross-cultural similarities and differences in the structure of temperament (Ahadi, Rothbart, & Ye, 1993).

Scale scores were created by averaging applicable item scores together. Three broad dimensions of temperament (12 questions each) were represented, which have been reliably recovered from this instrument: Negative Affectivity, Surgency Extraversion, and Effortful Control. Surgency Extraversion includes High Intensity Pleasure, Activity Level, Impulsivity, and Shyness. Negative Affectivity includes Discomfort, Fear, Anger/Frustration, Sadness, and Falling Reactivity/Soothability. Effortful Control includes Inhibitory Control, Attention Focusing, Low Intensity Pleasure, and Perceptual Sensitivity. **Table 3.6** illustrates each scale of the CBQ.

Background questionnaire. The answers to the background questionnaire provided information about the child's dental history, including if a child had any traumatic prior dental experiences, the numbers of previous dental visits with the participating dentist and any other dentists, whether or not the parent was present during the dental procedure and/or interview, and any efforts parents made to prepare their child for the dental visit. In addition, a standard demographic questionnaire was used to gather information about the child's and family's background (e.g., child's date of birth, parents' occupations and education level, address, phone number).

Table 3.6

Criteria for the Children's Behavior Questionnaire Subscale

Scale	**Definition**
Activity Level	Level of gross motor activity including rate and extent of locomotion.
Anger/Frustration	Amount of negative affect related to interruption of ongoing tasks or goal blocking.
Attentional Focusing	Tendency to maintain attentional focus upon task-related channels.
Discomfort	Amount of negative affect related to sensory qualities of stimulation, including intensity, rate, or complexity of light, movement, sound, and texture.
Falling Reactivity/Soothability	Rate of recovery from peak distress, excitement, or general arousal.
Fear	Amount of negative affect, including unease, worry or nervousness related to anticipated pain or distress and/or potentially threatening situations.
High Intensity Pleasure	Amount of pleasure or enjoyment related to situations involving high stimulus intensity, rate, complexity, novelty. and incongruity.
Impulsivity	Speed of response initiation.
Inhibitory Control	The capacity to plan and to suppress inappropriate approach responses under instructions or in novel or uncertain situations.
Low Intensity Pleasure	Amount of pleasure or enjoyment related to situations involving low stimulus intensity, rate, complexity, novelty, and incongruity.
Sadness	Amount of negative affect and lowered mood and energy related to exposure to suffering, disappointment, and object loss.
Shyness	Slow or inhibited approach in situations involving novelty or uncertainty.

Memory interview. The memory interviews were developed on the basis of pilot research related to the current study and consisted of questions about typical features of the dental treatment (see Appendix I). Interviews by Ornstein, Gordon, and Larus (1992) were used as models for this research because the questions were in the form of a hierarchically structured interview protocol that began with general, open-ended questions and moved to increasingly more specific probes for information not generated in response to the initial questions.

The interviews were taped and then coded according to a system that focused on the particular features of the examination carried out by the dentist and hygienists and the specificity level of the probe required to retrieve the information. For example, the first question was very general ("Tell me what happened during the dental procedure"), so that children could provide free recall. Nonspecific responses (e.g., "The dentist fixed my teeth") were probed until the response defined a feature or until it became clear that the child could not provide further information.

After nonspecific probing to the free recall question, a series of increasingly specific questions was asked to assess whether the child encoded the information. For example, the child was first asked a structured but relatively open-ended question (e.g., *"*What did the dentist use to fix your teeth?"). A number of possible target features could be offered in response to this question such as a tooth pillow, special light-to-dry fillings, metal pliers to pull a tooth out, and so on. Children who did not provide information about a specific feature were then asked a more specific question, such as "Did the dentist use the tooth pillow (mouth prop) to keep your mouth open?" The specific memory questions were organized temporally and were generally asked in the same order for each participant.

The interview also consisted of questions about atypical features of dental treatments (e.g., "Did the dentist take your temperature?", "Did the dentist cut your hair?"). These atypical features were asked to explore issues of suggestibility and possible response bias in how well they rejected the features that did not happen to them during the visit (i.e., correct rejection) or if they inaccurately accepted those features (i.e., false alarm).

Coding

Two trained researchers coded the videotaped dental event using BPRS (Behavioral Profile Rating Scale) scores. Inter-rater reliability was evaluated based on 25% of the sample, which was randomly selected. The proportion of agreement between the two raters was 0.96, which indicates a reliable degree of agreement between the two raters in judging which behaviors were present or absent.

For the memory interview responses, each interview was coded to specify the particular dental treatment features reported by the child. Codes were assigned to the memory protocols on the basis of the specificity of questioning necessary to elicit a verbal response (e.g., open-ended versus yes-no questions) and the accuracy of the child's answer. This coding scheme was also applied to the dental treatment features that had and had not been included in each individual dental treatment. In addition, a similar set of codes was used to characterize each child's responses to questions about the atypical features.

RESULTS

Overview

Descriptive, correlational, and hierarchical regression analyses for Study 1 were conducted using the Statistical Package for the Social Sciences (SPSS) software. The major questions of interest concerned the children's recall of the various features of the dental treatment (e.g., whether a mouth prop, metal ring, metal pliers were used) as a function of age, specificity of the memory prompt, stress level (e.g., dentist ratings, behavioral stress responses), and a range of individual difference variables such as presence of the previous negative dental experience, parent's advance preparation of the child for the visit, and stress-coping strategies used. Because the number of features that appeared during the children's dental treatments varied by individual, the basic recall data are reported as percentages. For each child, the particular features that were administered by the dentist and hygienists were determined from the completed checklists, and the proportions of these features recalled in response to open-ended and yes-no questions were calculated to assess the children's memories. To examine the linkage between stress levels and children's memory performance, stress levels during the dental procedure as measured by the dentist using the BPRS were calculated in combination with the dentist's assessment of each child's anxiety and compliance.

In the sections that follow, several aspects of the data are presented in detail. After a brief treatment of preliminary analyses, the formal assessment of the findings begins with an inspection of the basic recall data, examination of age differences in memory performance, and investigation of various individual differences. Correlation analyses

were also conducted to explore issues of the children's suggestibility through their responses to the absent-feature questions and to explore linkages between stress levels and children's memory performance including possible interactions with age and other individual differences.

Finally, given that the central focus of this exploratory study was to examine which selected individual difference variables could explain some of the variation in children's memories of a stressful event, a hierarchical regression analyses was performed in which measures of individual differences were used as predictors of the major dependent measures of memory performance (i.e., total recall, free recall, and suggestibility) with children's ages, behavioral stress levels, and individual differences as independent variables.

Preliminary Analyses

A series of preliminary analyses indicated no differences in recall as a function of parent's education level, the specific types of dental treatments such as fillings, extractions, sealants, and the three different hygienists' identities, and they were therefore excluded as variables of interest.

Table 3.7 illustrates the participants' history of dental treatment experiences. The above variables were not significantly different by age groups and yet these are dental treatment experiences in the specific dental offices and that the children each had dental check-ups at school. Thus, in a real sense, the older children had more prior experience with dentists. All the participants had similar amounts of dental experiences in the past year, with one to three experiences being the average. Their time of first dental experience was also quite similar; most children had their first dental treatments around

51 months. Most of the participants had some experience with this particular dentist based on the mean score of 3.21 for the question. Only four children had a past consultation with a professional psychologist due to any psychological anxiety or nervousness (two of the 6-year-olds, one of the 7-year-olds, and one of the 9-year-olds).

Table 3.7

Participants' Previous Dental Treatment Experiences by Younger/Older Age Groups

Age Groups	Mean	*SD*	*n*
How many times has your child been to a dentist in his/her life?			
Younger	3.29	0.76	28
Older	3.23	0.88	35
Average	**3.25**	**0.82**	**63**
How frequently has your child seen a dentist in the past year?			
Younger	2.39	0.50	28
Older	2.37	0.69	35
Average	**2.38**	**0.61**	**63**
Has your child visited another dentistry besides this current dentistry?			
Younger	0.61	0.50	28
Older	0.63	0.49	35
Average	**0.62**	**0.49**	**63**
How much experience has your child had with this particular dentist?			
Younger	3.18	0.77	28
Older	3.23	0.73	35
Average	**3.21**	**0.74**	**63**
Were you in the dentist's office while your child received the treatment?			
Younger	0.79	0.42	28
Older	0.71	0.46	35
Average	**0.75**	**0.44**	**63**
How old was your child (in months) when he/she visited a pediatric dentistry the first time?			
Younger	50.28	21.36	25
Older	51.45	24.26	29
Average	**50.91**	**22.76**	**54**[a]
Has your child had any experience or consultation with a professional psychologist due to			
Younger	0.07	0.26	28
Older	0.06	0.24	35
Average	**0.06**	**0.25**	**63**

Note. n = number of children, *SD* = standard deviation. [a]There were 9 missing data for this question. Some parents left the answer blank.

Age Differences on Recall

Study Aim 1: Age differences on children's remembering of stressful events.

At the memory interview, children were asked 15.98 (*SD* = 2.73) present-feature questions on average, which included events that occurred and tools used in their dental preparation process and treatment procedure. The particular questions posed varied from child to child to reflect the differences in their individual dental treatments.

The basic recall data are presented in **Table 3.8**. Total recall increased with age, ranging from 52% of the features recalled for the 4-year-olds to 95% for the 10-year-olds, F (6, 56) = 79.33, $p < .01$. This improvement with age in remembering the details of the dental treatment primarily reflects age-related changes seen in the children's free recall responses, which were defined in terms of the proportion of total components of the dental procedure that were reported in response to general probes at the immediate interview. Free recall scores ranged from 26% recall of the features for the 4-year-olds to 65% for the 10-year-olds, F (6, 56) = 3.73, $p < .01$.

Table 3.8

Children's Memory Performance by Total and Free Recall

	Age in years	*n*	Mean (*SD*)
Total recall	4	2	0.52 (0.08)
	5	10	0.71 (0.05)
	6	16	0.83 (0.03)
	7	12	0.92 (0.01)
	8	11	0.99 (0.02)
	9	8	0.96 (0.07)
	10	4	0.95 (0.04)
	Total	**63**	**0.87 (0.12)**
Free recall	4	2	0.26 (0.04)
	5	10	0.32 (0.20)
	6	16	0.45 (0.24)
	7	12	0.57 (0.21)
	8	11	0.55 (0.21)
	9	8	0.73 (0.16)
	10	4	0.65 (0.33)
	Total	**63**	**0.51 (0.25)**

Clearly, the children aged 7 years and older recalled a considerable amount of information during general probes. Thus, it was beneficial to merge the children into two age groups: younger (4-, 5-, and 6-year-olds) and older (7-, 8-, 9-, and 10-year-olds). The corresponding data per age group can be seen in **Table 3.9.** In addition, the younger age group is preschool-age children and the older age group is school-age children.

Table 3.9

Descriptive Statistics for Recall Data and Level of Questioning by Younger/Older[a] Age Groups

	Age Group	*n*	Mean	*SD*
Total recall	Younger	28	0.76	0.10
	Older	35	0.95	0.05
	Total	**63**	**0.87**	**0.12**
Free recall	Younger	28	0.39	0.23
	Older	35	0.61	0.22
	Total	**63**	**0.51**	**0.25**

Note. [a]Younger children = 4- to 6-year-olds, older children = 7- to 10-year-olds.

As has been consistently demonstrated in past research (Ornstein et al., 2006), older children provided more total information and reported a greater proportion of the features of the dental treatment in response to general probes, presented in **Table 3.9**. In this study, one-way analyses of variances yielded significant age effects in total and free recall, *F*s (1, 61) $\geq$ 14.99; *ps* < .01 respectively, indicating that older children recalled more present-features than younger children.

Age differences were not evident in the children's responses to yes-no questions, but this result should not be interpreted as indicating that developmental differences in memory performance were not relevant in considering the children's responses to forced-choice questioning. The interview was administered in such a way that yes-no questions were only asked about features that did not come up during the free recall questioning.

Overall and consistent with the previous literature, older children recalled more than younger children during total and general probes.

Children's errors. To explore issues of suggestibility and possible response bias, children's answers to the absent-feature questions, which were about features that did not occur during the dental procedure, were analyzed. In the memory interview, younger children were asked 15.50 (*SD* = 2.53) and older children were asked 16.51(*SD* = 2.87) absent-feature questions on average. These were questions asked about events or tools that were not part of their dental preparation process and treatment procedure. The particular questions posed varied from child to child, reflecting a few differences due to the individual dental treatments.

For each child, the proportion of correct rejections (*no* responses) to absent-feature questions and the proportion of false alarms (*yes* responses) to absent-feature questions were calculated. The corresponding data for age groups are displayed in **Table 3.10.** The children's overall responses to these questions were very good, with correct rejection scores, on average, .98.

Table 3.10

Descriptive Statistics for Children's Errors by Younger/Older[a] Age Groups

	Age Group	***n***	**Mean**	***SD***
Correct Rejection	Younger	28	0.96	0.05
	Older	35	0.99	0.02
	Total	**63**	**0.98**	**0.04**
False Alarm	Younger	28	0.04	0.05
	Older	35	0.01	0.02
	Total	**63**	**0.02**	**0.04**

Note. [a]Younger children = 4- to 6-year-olds. Older children = 7- to 10-year-olds.

According to **Table 3.10**, older children exhibited significantly higher rates of correct rejection and lower rates of false alarm responses to the absent-features than did younger children, Fs $(1, 61) \geq 15.67$; $ps < .01$ respectively, which is consistent with the argument that younger children tend to respond *yes* to all questions, even when a *yes* response is incorrect. Clearly, and as demonstrated by the previous literature, (e.g., Baker-Ward et al., 1993; Ceci & Bruck, 1993 for a review), there were age-related differences in the children's responses to questions about activities not included in the stressful dental treatment.

Effect of Stress on Recall

Study Aim 2: Relation between the level of stress and children's remembering.

A principal purpose of the study was to examine the effects of stress on children's remembering of a potentially traumatic, personally experienced event.

The mean ratings of anxiety suggest that the sample, as a group, was less anxious or stressful during the dental procedure than had been anticipated. The dentist's mean rating of child anxiety during the dental procedure was very low, although a full range of ratings was observed, indicating that the dentist saw her patients as moderately relaxed on average (see **Table 3.11**). In addition, the children generally reported positive emotion about the interview. On the other hand, there was high variability in the BPRS scores for children even when undergoing the same treatments; some children in the sealant treatment expressed high anxiety (BRPS scores was comparatively high: maximum BPRS score was 6.33 in the sample, and some did not exhibit any signs of anxiety (BPRS score was 0).

Table 3.11

Means, Ranges, and Standard Deviations for the Predictor Variables used in the Analyses of Anxiety

Predictor Variables	Mean (*SD*)	Range
Frankl Behavior Rating Scale score by dentist	3.75 (0.56)	1–4
Noncompliance by dentist	1.62 (1.08)	1–7
Anxiety by dentist	1.62 (1.08)	1–7
Child's self-report of emotion during the interview	4.11 (1.18)	1–5
Behavioral Profile Rating Scale score	0.89 (1.48)	0–6.33
Hesitancy to disclose by interviewer	1.30 (0.87)	1–5
Management ease by interviewer	4.69 (0.81)	1–5

Note. Interviewer's ratings (i.e., hesitancy to disclose by interviewer and management ease by interviewer) were included as the predictor variables used in the analyses of anxiety in the current study and yet those were indicators of child's emotion during the interview rather than the level of anxiety itself for the dental treatment.

To examine the relations among the various measures of anxiety employed in this study, correlations were calculated for behavioral stress responses, dentist's ratings of anxiety, and the children's emotional condition during the immediate interview. These measures were significantly correlated with each other as presented in **Table 3.12**, indicating that the anxiety variables were reliable measures of the children's negative emotions (i.e., stress) in regards to the dental treatment and the interview situation.

There were strong correlations between the dentist's ratings of the children's anxiety during the dental procedure (i.e., the noncompliance, anxiety, and Frankl scores). The interviewer's ratings of the children's anxiety during the interview were also correlated (i.e., hesitancy to disclose and ease of management ratings, r = -.81, $p < .01$). These scores indicate that the children were easy to manage during the interview, and they tended to not to be hesitant talking about what they had experienced during the dental procedure. In addition, the interviewer's ratings were correlated with the dentist's ratings (see **Table 3.12**). Thus, the children who were not sufficiently cooperative and showed higher anxiety during the dental procedure were more hesitant to disclose what they had experienced and harder to manage during the interview as well.

Table 3.12

Correlations Among Indicators of Anxiety

Anxiety Variable	1	2	3	4	5	6	7
1. Noncompliance by dentist	—						
2. Anxiety by dentist	1.00**	—					
3. Frankl score by dentist	-.87**	-.87**	—				
4. Hesitancy to disclose by interviewer	.30*	.30*	-.24	—			
5. Management ease by interviewer	-.27*	-.27*	.24	-.81**	—		
6. Child's self-report of emotion	-.17	-.17	.14	-.05	.17	—	
7. BPRS score	.27*	.27*	-.32*	.13	-.12	-.07	—

Note. BPRS = Behavioral Profile Rating Scale, Frankl = Frankl Behavior Rating Scale.
* $p < .05$, ** $p < .01$.

Based on the **Table 3.13**, the Frankl score assessed by the dentist was positively correlated with the children's free recall (r = .29, $p < .05$), indicating that children who were more cooperative and able to build good rapport with the dentist during the dental treatment had better free recall compared to children who were uncooperative and reluctant to accept the treatment. Likewise, children who were reluctant to talk about what they experienced at the dentistry (r = -.40, $p < .01$) and harder to manage during the interview (r = .35, $p < .01$) exhibited poorer free recall compared to children who were more willing to talk about what they experienced and easy to manage during the interview.

In terms of the children's errors on the absent-feature questions, the proportions of correct rejections (r = .26, $p < .05$) and false alarms (r = -.26, $p < .05$) were highly correlated with the dentist's anxiety ratings, indicating that children who showed generally higher anxiety during the dental procedure exhibited higher suggestibility than children who showed lower anxiety during the dental procedure.

Overall, the correlation results reliably indicate a linear pattern of stress negatively impacting children's remembering.

Table 3.13

Correlations Between Recall Types and Anxiety Variables

Anxiety Variable	**Total recall**	**Free recall**	**Correct rejection**	**False alarm**
Dentist's ratings (FRANKL)	-.03	.29* (.30*)	.26* (.27*)	-.26* (-.27*)
Hesitancy to disclose by interviewer	-.11	-.40** (-.43*)	-.37** (-.39**)	.37** (.39**)
Management ease by interviewer	-.04	.35** (.42**)	.27* (.33**)	-.27* (-.33**)
Child's self-report of emotion during the interview	-.09	-.08	-.03	.03
Behavioral Profile Rating Scale score	.15	-.01	-.15	.15

Note. Numbers in parentheses are controlled for age. * $p < .05$, ** $p < .01$

Individual Difference on Recall

Study Aim 3: Effects of Individual differences in the relation between stress level and children's remembering.

To explore the effect of other potential influences on the relation between stress and children's memory, individual difference variables involving background information on children's dental experiences, stress-coping styles, and a range of parental reports on the extent of advance preparation for the event, the presence of children's previous negative dental experience, and their temperament were investigated.

In the first series of analyses, each question of interest was treated as an independent predictor variable and each child's memory scores as dependent variables. There were no significant effects on memory performances seen from the following variables: the total number of times children have seen a dentist in their life, the frequency of seeing this particular dentist in the past year, whether or not the child had any dental experience at another dentistry. They were therefore excluded as variables of interest.

Parental preparations of the children for the dental visits and the previous negative dental experiences were strongly correlated with children's total and free recall as presented in Table 3.14. Previous dental history was scored 0 if children had no previous unpleasant dental experience in contrast scored 1 if children had previous unpleasant dental experiences. Parental advance preparation was scored 0 if children had none or little advance preparation by parent in regards to the dental visit, in contrast, scored 1 if

children had some or extensive advance preparation by parent in regards to the dental visit.

As seen in **Table 3.14**, parents' ratings of the extent of advance discussion they had with their children about the dental visit were correlated with children's both total and free recall than children who had little discussion (r = .45, r = .55, *ps* < .01, respectively). Moreover, more advance discussion of the dental visit was associated with higher correct rejection than children who had little discussion about the visit in advance (r = .48, $p < .01$). In addition, children who had extensive discussion with their parents in advance exhibited lower false alarm on absent features than children who had little discussion about the visit in advance (r = -.48, $p < .01$).

Table 3.14

Correlations of Recall Data and Behavioral Responses with Children's Dental History and Preparation

	Previous dental history	**Parent preparation**
Total recall	-.53** (-.33)	.45** (.29)
Free recall	-.51** (-.41)	.55** (.45)
Correct rejection	-.50** (-.38)	.48** (.39)
False alarm	.50** (.38)	-.48** (-.39)
Behavioral responses to stress	.31* (.38)	-.38** (-.44)

Note. Numbers in parentheses are controlled for age. * $p < .05$, ** $p < .01$.

For the children's previous negative dental experience, the parents' rating of the children's unpleasant previous dental experience was correlated with both total and free recall (r = -.53, r = .51, *ps* < .01, respectively), indicating that children who had not had unpleasant dental experiences previously exhibited better total and free recall than children who had had unpleasant dental experiences. The parents' rating of the children's unpleasant previous dental experience was also correlated with lower suggestibility.

Children who had pleasant previous dental experiences exhibited better correct rejection of absent-features than children who had unpleasant dental experiences (r = - .50, $p <$ .01). In addition, children who had not have unpleasant previous dental experiences exhibited lower false alarm of absent-features than children who had unpleasant dental experiences, r = .50, $p < .01$.

Additionally, the parents' rating of the children's unpleasant previous dental experience was correlated with children's behavioral responses to stress, indicating that children who had no previous unpleasant dental experiences exhibited less behavioral stress responses than children who had unpleasant previous dental experiences(r = .31, p < .05). Parents' ratings of the extent of advance discussion of the dental visit were also correlated with children's behavioral stress responses; children who had comparatively extensive discussions with their parents exhibited lower behavioral responses to stress than children who had little discussion about the visit in advance (r = -.38, $p < .01$) (see **Table. 3.14**). The correlation increased when age was controlled, indicating that the presence of advance preparation and pleasant quality of previous dental history were correlated with children's behavioral stress reactivity regardless of the children's ages.

Stress-coping strategies. Children's coping strategies were divided into two major styles based on the coping questionnaire contents as approach-oriented coping strategies including mood elevation, social support, and information-seeking strategy and avoidance-oriented coping strategies including activated escape, avoidant actions, emotional expression, and resignation.

The average score of the approach-oriented coping style was related to the children's total recall, indicating that children who self-reported that they used more approach-based coping styles exhibited higher total recall that children who did not. However, as presented in **Table 3.15**, the significant correlation was canceled out when controlled for the children's ages.

Table 3.15

Correlations of Combined Coping Styles and Specific Recall Types

Recall Type	Approach-Oriented Coping	Avoidance-Oriented Coping
Total recall	.36** (.07)	.06
Free recall	.34** (.19)	.19
Correct rejection	.28* (.13)	.01
False alarm	-.28* (-.13)	-.01

Note. Numbers in parentheses are controlled for age. * p <.05, ** p <.01.

Children who reported that they employed *mood elevation* for coping (i.e., *I thought about the good parts of going to the dentist, like getting stickers or a toy,* or *I tried to be happy and have fun*) during the dental treatment exhibited better total recall compared to children who did not use those strategies (r = .31, p < .05) (see **Table 3.16**). In addition, children who reported having used an *information seeking* coping strategy (i.e., *I watched what the dentist did very carefully, so I would know just what she was doing,* or *I asked lots of questions, so I would know just what the dentist was doing*) during the dental treatment exhibited better total recall (r = .36, p < .01) and more interestingly, they recalled more features in response to general probes compared to children who reported not using information-seeking coping strategies (r = .50, p < .01).

Indeed, the frequency of information seeking during the dental procedure as counted by the researchers from the recorded dental procedures was strongly related to children's remembering: total recall $r = .30$, free recall $r = .32$, $ps < .05$; correct rejection $r = .24$, false alarm $r =$. -24, $p = .07$; the correlation between children's self-report of using information-seeking strategies and the frequency of information seeking during the dental procedure as counted by researchers was .78.

Children who reported having used activated escape in coping (i.e., *I tried to get the dentist to stop what she was doing, like by keeping my mouth closed* or *I did something to try and get away, like jump out of the chair*) during the dental treatment recalled less features in response to general probes compared to children who did not use them ($r = -.43$, $p < .01$).

Older children (*M* (*SD*): 2.12 (.59)), used approach-oriented coping strategies during the dental procedure more often than younger children (*M* (*SD*): 1.68 (.53)), t [59] = -2.94, $p < .01$, yet there was no differences in the use of avoidance-oriented coping strategies between the two age groups.

Table 3.16

Correlations Among Specific Recall Types and Specific Coping Styles

Coping Style	**Total recall**	**Free recall**	**Correct rejection**	**False alarm**
Mood elevation	.31*	.23	.19	-.19
Avoidant actions	.16	-.04	.18	-.18
Social support	.09	-.06	.02	-.02
Activated escape	-.14	-.43** (-.39**)	-.15	.15
Information seeking	.36**	.50** (.41**)	.37** (.24)	-.37** (-.24)

Note. Numbers in parentheses are controlled for age. Emotional expression and Resignation were not correlated with any of the memory performances, thus it was excluded in the table. * $p < .05$, ** $p < .01$.

As presented in **Table 3.17**, avoidance-oriented coping strategies were associated with children's behavioral responses to stress, indicating that children who used avoidance-oriented strategies exhibited more stress-related behaviors during the dental procedure (r = .39, $p < .01$). On the other hand, children who had unpleasant previous dental experiences used fewer approach-oriented coping strategies during the studied dental visit (r = -.27, $p < .05$). Both the quality of previous dental experience and the extent of parental preparation of the child for the dental visit were negatively correlated with children's use of avoidance-oriented strategies regardless of the children's ages. (r = .30, r = -.30, *ps* < .05, respectively). Thus, the children who had unpleasant previous dental experiences or were not prepared for the visit by their parents were more likely to use avoidance-oriented coping strategies during the dental procedure.

Table 3.17

Correlations Among Coping Styles and Selected Individual Difference Factors

Individual Difference	**Approach-Oriented Coping**	**Avoidance-Oriented Coping**
Noncompliance by dentist	-.04	.13
Anxiety by dentist	-.04	.13
Frankl Behavior Rating Scale by dentist	.05	-.06
Behavioral stress reactivity	-.01	.39** (.38**)
Hesitancy to disclose	.00	-.08
Ease of management	.01	.06
Previous dental experience	-.27* (-.10)	.13 (.30*)
Parent preparation	.20	-.15 (-.30*)

Note. Numbers in parentheses are controlled for age. * $p < .05$, ** $p < .01$.

In summary, approach-oriented coping strategies were positively related to children's remembering of the stressful event, and unpleasant previous dental experiences may have contributed to children using fewer approach-oriented coping strategies.

Although avoidance-oriented coping strategies as a group were not related to children's memories, one dimension of avoidance-oriented coping strategies—activated escape—was negatively related to children's free recall. That result may be related to children's higher behavioral responses to stress, the presence of their previous negative dental experiences, or the extent to which parents' prepared the children for the dental visit.

Temperament. Children have individualized responses to stressful situations, which may affect how they deal with pain and their memories of stressful events. Based on parental report, one of the temperament dimensions—surgency, which involves high intensity pleasure, activity level, impulsivity, and shyness—was negatively correlated with children's free recall ($r = -.33$, $p < .01$). However the surgency dimension was not correlated with total recall, which suggests that a child's tendency to enjoy high activity levels and rush into new situations as assessed by parents may be associated with poorer responses to general probes when remembering a stressful event. No other subfactors of temperament, such as negative affectivity and effortful control, were associated with any outcome of children's memory performance.

Considering that temperament measures were originally designed for 3- to 7-years-olds, our analysis was conducted only on children of those ages, but still no different interesting linkages were observed.

Hierarchical Multiple Regression Findings

To explore further the extent to which the individual difference variables discussed above may explain variation in children's memory performance for stressful events, a series of hierarchical regression analyses was carried out, in each of which measures of individual differences were used as predictors of the three major dependent measures of memory performance (i.e., total recall, free recall, and suggestibility scores). The same strategy was followed in each analysis. Only the individual difference variables that correlated with the dependent measures at the 0.10 level were included as predictors. Age was always the first step in the hierarchy, given its importance in children's memory performance. Each following step examined the incremental contributions beyond age of the additional predictors.

In the second step, any of the anxiety indictors, such as Frankl and the BPRS scores, were entered after age when they met the criterion for inclusion in the model. The second step was designed in this manner so it could be determined if the stress level added significantly to the amount of variability explained by age alone. Next, in series of separate regression analyses, each of the variables identified in the correlation analyses described in the last section was entered as a third step to test whether each variable's presence could add significantly to the prediction made by earlier predictors.

Only those individual difference variables that added significantly to the amount of variability explained by the age in months and the stress levels of the children are discussed.

Total recall. As can be seen in **Table 3.18**, according to the first model, 65% of the variance in children's total recall values can be explained by the children's age in months. Each subsequent step examined the incremental contributions beyond age of the

Table 3.18

Hierarchical Multiple Regressions of the Predictor Variables on Total Recall

	Model	Standardized β	R^2	*t*	Sig.
Step 1	Constant			11.09	0.00
	Age in months	0.81	0.65	10.64	0.00
Step 2	Constant			11.22	0.00
	Age in months	0.71		8.90	0.00
	Previous experience	-0.22	0.69	-2.75	0.01
Step 3	Constant			11.51	0.00
	Age in months	0.60		6.86	0.00
	Previous experience	-0.17		-2.08	0.04
	Parental preparation	0.23	0.72	2.62	0.01
Step 4	Constant			6.11	0.00
	Age in months	0.59		6.76	**0.00**
	Previous experience	-0.17		-2.12	**0.04**
	Parental preparation	0.23		2.67	**0.01**
	Surgency	0.10	0.73	1.50	0.14

Note. R^2 = the proportion of variation explained by the model, Bold = variable that explained a significant amount of the unique variance in total recall.

additional predictors. Every available anxiety indictor was entered after age; however, they did not meet the criterion for inclusion in the model. Stress levels did not add significantly to the amount of variability explained by age alone. The children's previous dental experiences and the extent of parental preparation for the dental visit were strongly correlated with children's memory performances, so those two variables were added in Step 2 and 3, and they met the criterion for inclusion in the model. Step 2 and Step 3 explained 69% and 72% respectively of the variance in children's total recall. Finally, the last step added surgency, which was not associated with children's total recall in

correlation analyses; however, this final model explained an additional 1% of the variance in children's total recall. Each of the steps showed improved statistical significances except the last model.

Free recall. The results of the hierarchical multiple regressions for the children's free recall outcomes is presented in **Table 3.19**. The first step, ages in months, explained.

Table 3.19

Hierarchical Multiple Regressions of the Predictor Variables on Free Recall

	Model	Standardized	R^2	*t*	Sig.
Step 1	Constant			0.17	0.86
	Age in months	0.46	.21	4.03	0.00
Step 2	Constant			-1.88	0.07
	Age in months	0.45		4.07	0.00
	Frankl	0.26	.28	2.41	0.02
Step 3	Constant			-0.35	0.73
	Age in months	0.29		2.56	0.01
	Frankl	0.22		2.09	0.04
	Previous experience	-0.37	.39	-3.21	0.00
Step 4	Constant			-0.61	0.55
	Age in months	0.26		2.34	0.02
	Frankl	0.20		1.97	0.05
	Previous experience	-0.18		-1.26	0.21
	Parental preparation	0.28	.43	1.94	0.06
Step 5	Constant			-0.73	0.47
	Age in months	0.20		1.81	0.08
	Frankl	0.18		1.79	0.08
	Previous experience	-0.17		-1.20	0.23
	Parental preparation	0.22		1.54	0.13
	Information-seeking coping	0.26	.48	2.43	0.02
Step 6	Constant			1.97	0.05
	Age in months	0.24		2.42	**0.02**
	Frankl	0.12		1.38	0.17
	Previous experience	-0.23		-1.82	0.07
	Parental preparation	0.12		0.94	0.35
	Information-seeking coping	0.27		2.77	**0.01**
	Surgency	-0.34	.58	-3.72	**0.00**

Note. Frankl = Frankl Behavior Rating Scale, R^2 = the proportion of variation explained by the model, Bold = variable that explained a significant amount of the unique variance in free recall.

21% of the variance in children's free recall values. Each following step examined the incremental contributions beyond age of the additional predictors. Given that stress may impact children's memory, the dentist's ratings of the children's anxiety through Frankl scores were entered when they met the criterion for inclusion in the model. The second step explained 7% more of the variance in children's free recall values. Next, because the quality of the children's previous dental experiences and the extent of parental preparation for visit were strongly correlated with children's memory performances, those two variables were added in Steps 3 and 4 when they met the criterion for inclusion in the model. The steps explained 39% and 43% respectively of the variance in children's free recall values. Per the model, those two variables influenced free recall more than total recall.

A fifth step was added for information-seeking coping style given that information-seeking strategies were likely to account for some variances in the children's recall performance based on the correlation analysis. This fifth step explained 48% of the variance in children's free recall values. Finally, the last step was to add surgency, which was also strongly associated with children's free recall based on the correlation analysis. This final step explained an additional 10% of the variance in children's free recall values. That percentage indicates that surgency was much more influential for free, rather than total, recall values. Each step improved statistical significances of the model.

False alarm. The examination of children's memory errors is important because it provides insight into children's vulnerability to suggestible questions. Thus, the analysis was completed using the false alarm values rather than the correct rejection values because the false alarm responses were a negative measure of the children's

Table 3.20

Hierarchical Multiple Regressions of the Predictor Variables on False Alarm

	Model	Standardized β	R^2	*t*	Sig.
Step 1	Constant			5.07	0.00
	Age in months	-0.45	0.20	-3.91	0.00
Step 2	Constant			4.76	0.00
	Age in months	-0.44		-3.92	0.00
	Frankl	-0.24	0.26	-2.17	0.03
Step 3	Constant			3.19	0.00
	Age in months	-0.29		-2.50	0.02
	Frankl	-0.20		-1.85	0.07
	Previous experience	0.34	0.35	2.89	0.01
Step 4	Constant			2.40	0.02
	Age in months	-0.30		-2.69	**0.01**
	Frankl	-0.14		-1.33	0.19
	Previous experience	0.30		2.65	**0.01**
	Hesitancy to disclose	0.28	0.42	2.66	**0.01**

Note. Frankl = Frankl Behavior Rating Scale, R^2 = the proportion of variation explained by the model, Bold = variable that explained a significant amount of the unique variance in false alarm.

suggestibility. As with the previous analyses, age was the first step in the hierarchy given its importance in children's memory performance from a developmental perspective. The first step explained 20% of the variance in children's errors on recognizing absent-features, indicating that 20% of the variance could be explained by ages in months. Each following step examined the incremental contributions beyond age of any additional predictors. Considering that the children's stress levels were assessed by the dentist, that is likely to account for some variances in the children's errors. Based on the previous

correlation analysis, the Frankl score was entered after age when it met the criterion for inclusion in the model. Step 2 was designed in this manner to determine if the stress level added significantly to the amount of variability explained by age alone. The second step explained 6% more of the variance in children's false alarm responses.

Next, considering that the quality of the children's previous dental experiences was strongly correlated with children's false alarm responses, the variable was added in Step 3 when it met the criterion for inclusion in the model. The third step explained 35% of the variance. Finally, the last step added the interviewer's ratings of how hesitant children were to talk about what they remembered of their dental treatments because hesitancy may be associated with the children's anxiety during the interview. This final step explained 42% of the variance in children's false alarm responses. The complete result is presented in **Table 3.20**.

DISCUSSION

In summary, the overall results for Study 1 replicated and extended previous findings. This study provided further evidence for a negative relation between stress and strength of recall, as demonstrated by the association of the dentist's higher anxiety reports with the children's poorer remembering. First, the Frankl score assessed by the dentist was positively correlated with the children's free recall, indicating that children who were more cooperative and able to build good rapport with the dentist during the dental treatment had better free recall compared to children who were uncooperative and reluctant to accept the treatment. Likewise, children who were reluctant to talk about what they experienced at the dentistry and harder to manage during the interview exhibited poorer free recall compared to children who were more willing to talk about what they experienced and easy to manage during the interview.

In terms of the children's errors on the absent-feature questions, the proportions of correct rejections and false alarms were highly correlated with the dentist's anxiety ratings, indicating that children who showed generally higher anxiety during the dental procedure exhibited higher suggestibility than children who showed lower anxiety during the dental procedure. Overall, the correlation results reliably indicate a linear pattern of stress negatively impacting children's remembering.

Several individual differences were associated directly or indirectly with variation in the children's remembering not limited to children's developmental levels: coping style, temperament, presence of the previous negative experiences, and extent of the children's

advance preparation for the event by parents. These individual differences seem particularly imperative in understanding the relations between stress and children's remembering. Particularly, the presence of child's previous negative dental experiences and the extent of parental preparation were positively correlated with children's memory performance, indicating that previous experience and parents' preparations do matter for children's remembering. However, caution should be warranted in interpretation of these results, given that our measures of previous negative dental experience and the extent of advance parental preparation were rough. Analyses were based only on parental reports, which may not have been completely accurate, and there is no knowledge of the extent to which previous traumatic dental experiences affected children, what specific information parents provided, or the methods they used to soothe the children. Thus, no specific contents of the parents' preparations of children for the dental procedures are known; we merely know that a discussion prior to the visit took place. Whatever the content, such discussions positively affected children's remembering of the event. Further research on the content of parent–child discussions about dental experiences is needed.

According to hierarchical regression analysis, children's age in months, the presence of their previous negative dental experiences, and the extent of parental preparation for their visits explained a significant amount of the unique variance in total recall. This result was consistent with the literature that demonstrated that older children have superior recall (Ornstein et al., 2006), children with higher rates of negative previous experiences have poorer recall (Chen et al., 1999), and that parental preparation has a positive influence on children's memory performance (Salmon, Price, & Pereira, 2002).

It could be that children who have negative experiences may expect more pain or distress from subsequent procedures and cause their stress levels of to increase during the event, which may contribute to deteriorated memory. Unfortunately, the literature does not equivocally explain how the amount of exposure to or quality of prior experience with stressful procedures affects children's recollection. In particular, it remains uncertain how these experiences, both the frequency and quality of them, affect what children recall about events and how precise any recall is. The quality of prior medical experiences may be imperative for subsequent behavior because it influences how the event is encoded in memory. Accordingly, a link between the presence of previous negative dental experiences and children's memory should be investigated further. Children who have had positive previous dental experiences may demonstrate lower stress reactivity during the dental procedure, and as a result, it may lead them to be more aware of their surroundings and, therefore, have a better memory of what happened.

In addition, given that the children who tended to have higher surgency as assessed by their parents may have been less attentive during the stressful event, which may have led to their poorer recall. Given that surgency was not correlated with any other anxiety indicators, it does not seem to be a moderator or mediator of the relation between stress and memory, but it clearly affected the children's total recall. Thus, further research should be considered on how and why this temperament subdimension is related to the children's remembering of a potentially stressful event. At least, this result supports the hypothesis that there are certain individual differences that may explain some of the variability in children's remembering of a stressful event.

On the other hand, the use of an information-seeking coping strategy, and surgency presence explained a significant amount of unique variance in the free recall values. This result is consistent with the literature that demonstrates that positive coping styles facilitate children's free recall (Baker-Ward et al., 2009), and temperament may affect children's memory performance (Burgwyn-Bailes et al. 2001). Children who attempted to seek more information about the event exhibited better recall in response to general probes. An information-seeking coping strategy during a stressful event may provide the child with more information about the event and reduce his or her stress level during it, leading to enhanced memory.

The children's ages in months, previous negative experiences, and hesitancy to disclose information explained a significant amount of the unique variance in their false alarm responses. The children who had unpleasant previous dental experience and were more hesitant to talk about what they remembered made more memory errors.

The children's fundamental cognitive abilities such as language and more detailed stress level measures were not examined for Study 1. Thus, its results should be interpreted carefully when considering the impacts of stress and the individual differences on children's remembering of a stressful event. Research conducted within the context of reducing children's dental anxiety and increasing cooperation and compliance holds promise for both theory and practice in the field.

CHAPTER 4: STUDY 2

PURPOSE

The principal goals of the current study were to explore the impact of stress on memory by using a naturally occurring stressful event, an operative dental procedure, as a model situation and considering the ways in which individual characteristics may moderate that impact. Study 1, in particular, focused on children's behavioral responses to a stressful event and examined the impact of several social-emotional, individual differences on remembering: children's temperament, stress-coping strategies, personal dental histories, and parental preparation of the children for the event. Overall, higher stress levels were associated with lower levels of memory. Several individual characteristics specific to each child—the presence of previous negative dental history, the extent of advance preparation by parents of the child for the visit, and approach-oriented types of stress-coping strategies—were associated with variations in levels of stress and recall performance on their memories of the event. However, there are still unresolved issues in terms of stress measures, given that the level of stress was exclusively based on observers' ratings. Researchers or parents may interpret children's behavior incorrectly, parents may not accurately remember their child's reactions, and parents' own responses to the stressor may influence their perception of the child's stress reaction. Considered that the different stress indices are often uncorrelated statistically (Merritt et al., 1994; Walco, Conte, Labay, Engle, & Zelter, 2005), assessments of children's physiological responses to overcome some of the measurement challenges from

the different stress indices are needed. Arguably, young children cannot volitionally control their physiological arousal to the same extent that they might control overt expression or self-report of emotion.

In addition, there was no information in regard to the contributions of children's cognitive abilities to understanding the impact of stress on remembering. Thus, to expand on the findings from Study 1 by taking into consideration of those limitations, Study 2 was designed to investigate both children's physiological and behavioral responses to stress during a dental procedure and the impact of social-emotional (i.e., pain and anxiety during the event, temperament, and stress-coping strategy), and cognitive (i.e., receptive language ability, previous negative dental experiences, extent of advanced discussion about the event, and working memory capacity) factors on remembering the stressful event.

METHODS

Participants

A total of 90 children between the ages of 4 and 9 years were recruited during the summer of 2010 from the Maria Junior Dental Clinic, a private practice located in a metropolitan area in Seoul, South Korea as in Study 1. The staff of the pediatric dental clinic notified researchers of children who were scheduled for minor operative dental procedures, typically fillings or sealants, and whose families had agreed to be contacted about possible research participation. During these conversations, the study was explained, verbal agreement to participate was obtained, and the time and date of the physical examination were confirmed. Of the families who agreed to participate, the data for five children were subsequently dropped for various reasons, including the child's mood after the dental treatment and time conflicts of their parents. The resulting sample was thus composed of 85 children: 11, 4-year-olds (M = 51.55 months, SD =3.05); 11, 5-year-olds (M = 63.55 months, SD = 3.93); 20, 6-year-olds (M = 77.15 months, SD = 3.01); 21, 7-year-olds (M = 89.57 months, SD = 3.30); 10, 8-year-olds (M = 100.80 months, SD = 3.65), and 12, 9-year-olds (M = 114.83 months, SD = 4.93). The sample was composed of approximately equal numbers of girls (47%) and boys (53%). Again, due to the suburban community location of the clinic, the sample consisted primarily of children from middle- and upper-middle-class families. No child was excluded based on gender or socioeconomic status.

Target Event, Immediate Interview, and Delayed Interview

A total of one pediatric dentist and four hygienists provided dental treatment to the participants. Prior to the investigation, discussions with the pediatric dental staff resulted in the identification of 17 component features of the dental treatment. As can be seen in Table 3.1, these features represented procedures that are typically administered during routine filling or sealant dental treatments. Fifteen children went through multiple procedures including fillings and extractions or sealants and extractions. Although there were some variations between the sealant and filling procedures, the general features children were asked to remember were the same, and the full procedures were videotaped for later analysis to determine the precise component features that were included in each child's visit.

Because dental treatments vary somewhat from child to child, each dental treatment was composed of a subset of the features listed above in Table 3.1. A researcher marked each administered procedure on a checklist (see Appendix O) as they were performed so as to have independent records of the specific elements of each child's dental treatment.

Sequence of events for first visit. The current study did not involve the administration of any new dental procedures. Rather, it was observed established minor procedures, typically sealants or fillings. Thus, the children's participation in this study in no way affected their dental treatment. Although we could not control the time required for the dental operative procedure, such procedures usually required approximately 15 to 20 minutes.

As a physiological measure of stress reactivity, each child's blood pressure was taken before and after the treatment, as well as before and after the memory interview. In

addition, an electrocardiogram (ECG) was recorded for each child using the BIOPAC system during the dental procedure. Before the dental procedure, the researcher explained the use of the equipment to the child and what it measured (see Appendix C). After that, the researcher helped the child put on a fully adjustable nylon strap band with noninvasive sensor inside to the child's chest to monitor respiration and the researcher affixed noninvasive, small, adhesive disks to the child's hands and an ankle to monitor pulse rate (PR). Electrode leads were clipped onto the disks. During the dental treatment, the BIOPAC system and respiration amplifier recorded the ECG trace of cardiac activity onto a computer for later coding. At the end of the session, the researcher removed the adhesive disks from the child.

From the recorded ECG, vagal tone (VT) and heart period (HP) reactivities were calculated. These measures provide information about children's emotional reactions as events unfold and have been used in prior studies of physiological arousal and memory in children (e.g., Bugental et al., 1992; Quas et al., 2004).

During the procedure, the parents were asked to provide information concerning their family demographics as well as to complete several measures of their children's temperament and previous dental experience.

To obtain observable behavioral measures of mild stress responses, researchers coded each child's behavior during the dental procedure using the BPRS while watching the recorded video of the dental procedure. In addition, the dentist rated each child's level of stress, anxiety, and rate of compliance during the dental procedure using the Frankl.

Immediately following the procedure, the children were asked to play in a playroom for about 10 minutes to calm down. They then entered a quiet counseling room in the

clinic. Once in the room, the children completed a coping measure to characterize their coping behaviors throughout the dental procedure. In addition, the children were also asked to use a visual analogue scale to report their anxiety and pain about the dental experience (see Appendix G) and a state-and-trait anxiety questionnaire (see Appendix K). They also completed the digit span test to gauge their WM capability (see Appendix L), and a Korean version of the PPVT-III to measure their receptive language ability (see Appendix N). After answering all the questions, the children participated in a one-on-one memory interview with a protocol through which we assessed their retention of the predefined event components in response to probes of increasing specificity. For this report, the focus was on free recall, defined in terms of the proportion of total components of the dental procedure that were reported in response to general probes.

The initial session after the dental procedure was also videotaped. The entire session process lasted 55–60 minutes. The children and their parents were reminded to return in 1 week to complete the final interview.

Sequence of events for second interview. When the children returned to the dental practice after one week, we assessed their memory for the dental procedure they had experienced previously, using the same hierarchical interview that had been employed during the initial assessment. This delayed-memory interview took 25–30 minutes.

Measurements

The demographic questionnaire, dentist's ratings, interviewer's ratings, stress-coping strategy questionnaire and CBQ that were described in detail in the Study 1 Measurements section were also used in Study 2. Additional measures used in Study 2 can

be seen in **Table 4.1**, and the listing of which individual completed which measure is seen in **Table 4.2**.

Table 4.1

Instruments Used to Measure Study 2 Variables

Variables	**Instruments**
Demographics	Questionnaire that asked about child's prior dental experiences
Physiological stress reactivity	
Heart rate	BIOPAC system
Respiration rate	Respiration amplifier
Blood pressure & pulse rate	Omron HEM-780
Behavioral responses to stress	Behavioral Profile Rating Scale; Frankl behavior rating scale; dentist's Likert ratings of compliance and anxiety during the procedure.
Memory performance	Memory interview
Receptive language ability	Peabody Picture Vocabulary Test, third version
Working memory	Digit Span test
Pain and anxiety	Visual analogue scale
Hesitancy and ease of	Interviewer's rating
Emotional state	Child's mood during the interview at immediate & delayed
Stress coping strategy	KIDCOPE, How I Coped under Pressure Scale
Temperament	Children's Behavior Questionnaire
General anxiety condition	The Spielberger State/Trait Anxiety Inventory for Children

Table 4.2

Study 2 Measures and Individuals Who Completed Them

Measure	**Completed By**
1st Visit (Immediate)	
Background Questionnaire	P
Children's Behavior Questionnaire	P
Memory interview	C
Stress Coping Strategy Questionnaire	C
Peabody Picture Vocabulary Test	C
Digit Span Test	C
Frankl Behavior Rating Scale	D
Behavioral Profile Rating Scale	R
2nd Visit (1-Week Delay)	
Memory interview	C
Visual analogue scale	C

Note. C = Child, D = Dentist, P = Parent, R = Researcher.

Physiological measures of stress. The study was focused on heart period (HP; the interval between successive heartbeats that is inversely related to heart rate), vagal tone (VT; an index of the extent to which the vagus nerve parasympathetically mediates oscillations in HP; Porges, 1995), blood pressure (BP; the pressure of the blood within the arteries produced primarily by the contraction of the heart muscle), and PR (the rate of the pulse as observed in an artery, expressed as beats per minute) as indicators of children's physiological stress reactivity during the dental procedure.

As explained previously, the ECG was recorded using the BIOPAC system. Heart rate, VT, respiration, and HP were calculated during the coding process using the ECG. These variables served as indicators of the children's physiological stress responses. In addition, a researcher placed an automatic, BP monitor with a comfortable adjustable cuff (Omron HEM-780) on the child's right arm before and after the dental treatment and before and after the memory interview to measure BP.

Visual analogue scale (VAS). During the first visit, parents were asked to use a VAS (Marsac, 2008) to indicate their child's anxiety and pain regarding the dental treatment. Children used the same scale to report their anxiety and pain regarding the treatment. The children were asked to complete this scale again during the delayed interview to indicate how much pain and fright they experienced during the dental treatment the previous week. The VAS is a picture of a thermometer with a 5-point Likert scale, ranging from *extremely painful/ frightened* (5) to *not painful/ frightened at all* (1).

Spielberger State/Trait Anxiety Inventory for Children (STAIC). Children were administered the STAIC (Spielberger, Edwards, Lushene, Montuori, & Platzek, 1973) to measure their anxiety about the dental procedure. The STAIC consists of two scales that

measure transitory anxiety (state anxiety) and dispositional anxiety (trait anxiety). The inventory is suitable for children from kindergarten to Grade 6 (ages 4–12; Spiedlberger et al., 1973). However, the scale must be individually administered for children in kindergarten through Grade 2 (Papay & Spielberger, 1986). Both scales consist of 20 weighted items, with three response options available (see Appendix K for the questions). 11 trait questions and 4 state questions were selected, due to the time conflicts (Cronbach's α among the selected questions, trait = .83, state = .67). Theses scales are known to be reliable and valid (Spielberger, Gorsuch, Lushenem, Vagg, & Jacobs, 1983).

Digit Span. Memory span is defined as the number of items that a child can retain and recall, whereas digit span is the number of digits a child can retain and recall. Digit span backward is considered a measure of WM, although both attention and comprehension contribute to performance as well. Procedures for this WM assessment were considered standard. A series of lists of numbers were read out loud at a rate of one number per second. The participant was asked to recall the numbers in order. The first list consisted of three digits, and number of digits per list increased until the child began to make errors. Lists of recognizable patterns (e.g., 1, 3, 5, 7, 9) were avoided because children may remember such numbers more easily. This test can be administered both backward and forward to provide contrasting measures of short-term memory and WM (McCarthy, 1972; refer to Appendix L). The forward series was administered as a measure of basic, short-term-memory span, and the backward series was administered as an index of WM span, because the information must be manipulated while being held in memory. In total, the Digit Span task was composed of two forward series and two backward series. Based on McCarthy's procedure, the child had up to two opportunities at a given set size to

respond correctly. If correct, he or she proceeded to the next set size. Each series ended when the child failed to respond correctly to both trials of a given set size. A child's span was defined as the largest set of numbers that could be successfully recalled.

Peabody Picture Vocabulary Test, Third Edition (PPVT-III). Each child completed the Korean version of the PPVT-III (original, Dunn & Dunn, 1997; standardized Korean version, Kim, Jang, Im, & Pack, 1995), a standard measure of receptive language skills. The validity of this measure on a sample of individuals aged 2.5 years through adulthood has been firmly established (Calculator & Singer, 1992). Scoring procedures described in the manual were followed. Each child's raw language score was calculated using the protocol outlined by the PPVT-III measures. Children's raw receptive language scores from these measures were transformed into standardized scores based on the established, age-related norms. The average of the standardized scores was then calculated to yield a total language score for each child. This measure was selected because the children's language skills were believed to be of key importance in determining whether or not they could grasp the task they were asked to perform (i.e., the interview).

Coding

Behavioral response measures. Two trained researchers coded the videotaped dental procedure to determine each child's BPRS score. Inter-rater reliability was evaluated based on 25% of the sample, which was randomly selected. The proportion of agreement between the two raters was .88, which indicates a highly reliable degree of agreement between the two raters in judging which behavior was or was not present.

Memory measures. Each interview was coded to specify the particular dental treatment features reported by the child. Codes were assigned to the memory protocols on

the basis of the specificity of questioning necessary to elicit a verbal response (i.e., open-ended versus yes-no questions) and the accuracy of the child's answer. This coding scheme was applied to those dental treatment features that had and had not been included in each individual dental treatment.

Cardiovascular reactivity measures. The data from six children were excluded because the leads fell off during the dental procedure due to the children's physical activity. Thus, 79 ECGs were used for the final analysis of the physiological data. For all of the participants, the ECG signals were amplified by the BIOPAC system, and the signal was digitized using Acq*Knowledge* software from BIOPAC Systems, Inc. (Version 3.9.2., Goleta, CA).

The interbeat interval (IBI) series for each dental procedure period was screened by hand and corrected for artifacts. Such activities as bodily movements, children's tugging on electrodes, physical force to the monitor, and other such disruptions may affect IBI collection by recording artifactual points within the cardiac data. However, coding IBI series by hand reduces artifactual error. Log-transformed, HP variance in the high frequency band (0.12–0.4 Hz) was extracted in the time domain using MX Edit software (Delta Biometrics, Inc., Bethesda, MD). Even after coding every R-peak by hand, if there were still artifactual points, a researcher edited the data files by scanning the data for outlier points relative to adjacent data and replacing those points by dividing them or summing them so they would be consistent with the surrounding data. Due to difficulties in collecting cardiac data from children during a dental treatment (e.g., pulling on electrodes, equipment failure), only participants who had full and sufficient data (< 10% edited) were used in the analyses.

We used Porges's (1985) method of calculating VT and HP. Log-transformed, total cardiac variance across the entire frequency range was similarly extracted as an index of total heart rate variability. Mean HR was also calculated for each dental procedure period by transforming each IBI to heart rate and averaging across all values.

The edited R-wave series were converted to a prorated HP series with a sampling interval of 250 ms. Heart periods spanning two sampling intervals were prorated between these two intervals using a weighted-mean algorithm. For each dental procedure period, mean HP and VT were calculated. Vagal tone was calculated using a time-domain method as follows: a third-order, 21-point, moving polynomial was passed over the entire prorated HP series to filter out low-frequency variability and slow trends from the data. For a discussion of the methodological issues associated with the application of moving polynomial filters to HP data, see Porges and Bohrer (1990). Vagal tone was taken as the natural logarithm of the residual variability remaining in the HP series after application of the moving polynomial. Specifically, the natural logarithm was taken of the filtered HP series' mean variance to give VT values in units of log-transformed squares of milliseconds (Ln ms^2).

To establish the baseline period, the VT value of the 1st third of the dental procedure was calculated. It was also calculated for the latter two thirds of the procedure to determine if there were any significant changes compared with the baseline period that would indicate stress level changes. The mean VT values of the 30-second epochs within each episode were used in subsequent analyses.

Computation of change in RSA (respiratory sinus arrhythmia) and heart period. To assess VT reactivity, change in VT (Δ VT) was measured as the difference between baseline VT and VT during the middle or last episode of the event.

Following previous research (Calkins, 1997; Moore & Calkins, 2004), difference scores were computed by subtracting middle episode VT value from baseline VT value to indicate the direction of change. Positive values indicated greater VT withdrawal (the expected response), and negative values indicated an increase in VT during the dental procedure.

Change in HP (ΔHP) was measured the same way as Δ VT (baseline HP minus episode HP). Positive values of ΔHP indicated an increase in HR (the expected response) during the dental procedure, and negative values indicated a decrease in HR. This method provided an index of change relative to each child's baseline VT value.

Computation of change in mean arterial pressure and pulse rate. As discussed in the sequence of events, each child's BP and PR were taken before and after the dental treatment, while lying down on the treatment chair, and before and after the interview, while sitting on the chair in the counseling room.

The BP monitor gives two values. Systolic blood pressure (SBP) is the upper value, which indicates the force exerted against the walls of the arteries by the blood as it is being pumped from the heart. The normal range for this value would be 110–40 millimeters of mercury (mmHg). Diastolic blood pressure (DBP) is the bottom value that indicates the pressure exerted by the elastic recoil of the arteries during the relaxation phase between heart beats. The normal range for DBP is 60–90 mmHg.

To calculate the mean BP, we first calculated the mean arterial pressure (MAP). The MAP is an individual's average BP (Zheng et al., 2008). It is defined as the average arterial pressure during a single cardiac cycle. The MAP is determined by the equation [(2

x DBP) + SBP]/3. The DBP counts twice as much as the SBP because two-thirds of the cardiac cycle is diastolic.

Clinically, MAP is the perfusion pressure seen by organs in the body. The normal range for MAP is 70–110 mmHg. Larger changes in MAP (ΔMAP: the value after the dental procedure minus the value before the dental procedure started) are considered indicative of greater BP reactivity (Kamarck et al., 1994; Boyce et al., 1995). Positive values of ΔMAP indicated an increase in average BP during the dental procedure (the expected response if the child was stressed during the event), and negative values indicated a decrease in average BP.

Change in PR (ΔPR) was measured in the same way as ΔMAP. Positive values of ΔPR indicated an increase in PR during the dental procedure (the expected response if a child was stressed during the event), and negative values indicated a decrease in PR.

RESULTS

Data Analyses

After appropriate scoring, data reduction, and screening of the variables used in the analyses were completed, a series of data analyses were conducted as discussed in the following sections.

Descriptive and basic statistical analyses. As was the case in Study 1, the major questions of interest for the current study were to explore whether children's memory of a stressful experience varies as a function of the level of stress and to consider the various individual difference factors that may impact their abilities to accurately remember a stressful event. These preliminary analyses (i.e., means, standard deviations, and distributions) were conducted using the SPSS statistical package.

First, each variable was checked for outliers, missing data, and distribution. In descriptive analyses, continuous variables were presented as mean values and standard deviations; categorical variables were presented as absolute and relative frequencies. Next, the preliminary analyses for the stress scores (BPRS, Frankl, HP, VT), stress-coping strategy questionnaire score, CBQ score, background questionnaire, and immediate memory interview scores were conducted to determine any potential outliers or violations of normality. Children's memory scores were calculated based on the total correct responses on the free-recall questions. There were no participants who performed more than three standard deviations above or below the mean. Differences in memory accuracy were not revealed as a result of any ancillary variables (e.g., gender, parents' education).

Correlation analyses. Once the children's memory scores and stress levels based on both their biological and behavioral scores were determined, the correlation coefficients were used to measure the relation between stress levels and children's memory performance. Pearson correlation coefficients were analyzed to identify associations among children's age in months, level of both biological and behavioral measures of stress, anxiety variables, various individual characteristics, and memory performance. Biserial Correlation coefficients were used with variables such as children's gender, the presence of children's previous negative dental history, and the extent of parents' advance preparation for the visit.

The anxiety variables, including the children's self-reports of pain and anxiety, parents' report of their child's pain and anxiety, dentist ratings, and STAIC responses from the children, were expected to be correlated each other, given that these variables were supposed to measure the children's anxiety regarding the dental treatment. The relation between children's anxiety factors and children's memory performance were examined using chi-squares with Fisher's exact test for categorical variables and analysis of variants for continuous variables to determine group differences among them.

Multivariate regression analyses. A series of hierarchical regression analyses were carried out to examine the relation between stress and children's memory performance and the ways in which certain individual difference factors may have moderated that relation. To understand how children's memories differed when any individual difference factor varied and the other individual differences were controlled for—indicating that children's memory accuracy was varied in terms of their stress

reactivity, temperament, previous negative dental experiences and so on—a regression model was built.

Overview

The major questions of interest for the current study concern the children's recall of the various features of the dental treatment at both the immediate and delayed interviews, as a function of age, memory prompt specificity, stress level, and a range of individual difference variables that parallel those explored in Study 1. However, to examine the linkages between stress level and children's memory in depth, in addition to children's behavioral responses to stress, measures of children's biological stress reactivity were also included in Study 2 during the event, and post hoc ratings from the involved parties—dentist, researchers, parents, and the children—were also obtained. Additionally, a one-week-delayed interview was conducted to examine the children's memory retention and their rates of forgetting for the various features of the dental treatment.

In the sections that follow, several aspects of the data were presented in detail. After a brief treatment of preliminary analyses, the formal assessment of the findings begins with an inspection of the basic recall data, focusing on the effects of developmental differences from age. Rates of forgetting and children's suggestibility were examined as a function of age.

The next section is on analyses conducted to explore linkages between stress levels and memory performance, including possible interactions with a variety of anxiety variables reported by the dentist, parents, children, and the interviewer. The analyses were organized in a way that enables the exploration of the extent to which those anxiety

variables may possibly influence the relation between stress level and children's memory performance.

Finally, analyses were conducted to examine if cognitive and social-emotional individual characteristics influenced the ways in which stressful events were encoded and remembered by the children. Study 1 was designed to examine the extent to which selected individual difference variables might affect the variation in children's remembering of the dental procedure, and a series of hierarchical linear regression analyses was performed, in which individual differences variables were used as predictors of the major dependent variables of memory performance (i.e., total recall, free recall, and suggestibility). Children's age in months, various stress level indicators, and selected individual difference factors were independent variables. Study 2 was designed to examine further how those variables may have had different influences on the immediate and delayed interviews. Supplementary, exploratory factor analyses were conducted to describe the variability among the stress-coping strategies the children used during the dental procedure and the observed anxiety variables in order to better assess their varying influences on children's remembering of a stressful event.

Preliminary Analyses

A series of immediate analyses indicated no differences in recall as a function of gender, parent's education levels, and the identity of four different dental hygienists. They were therefore excluded as variables of interest. In addition, at each age level, no differences between the immediate and delayed memory performances and the behavioral and physiological stress levels were found for different treatment types (i.e., fillings, sealant, multiple procedures such as fillings and extraction or fillings and crowns). This

indicates that differences observed in memory performance and stress levels were not due to the different procedure types.

Age Differences on Recall

Study Aim 1: Age differences and delayed recall on remembering stressful events

On average, children were asked 17.40 (*SD* = 2.32) present-feature questions concerning components that occurred during the dental preparation process and treatment procedures. As was the case in Study 1, the particular questions posed varied from child to child, reflecting the differences in the individual dental treatments. Free recall values are the proportion of dental procedure components reported in response to general probes, and total recall values are the proportion reported in response to all probes. As was the case in Study 1, there were significant positive correlations between total recall and children's ages in months (r = .32, $p < .01$, r = .25, $p < .05$ at immediate and delayed interviews, respectively) and between free recall and children's ages in months (r = .51, .43, $p < .01$, at the immediate and delayed interviews, respectively). By regression slopes, age accounted for approximately 10% of the variance in total recall at immediate interview, 6% at the delayed, but 25% of the variance in free recall at the immediate interview, and 18% at the delayed interviews. These collective findings demonstrate that children's age in months was strongly associated with children's free recall. Based on the correlational data, the children were assigned to two groups for analytic purposes, a younger group, composed of 4, 5, and 6-years of age, and an older group composed of 7-, 8-, and 9-year olds. As was the case in Study 1, the younger age group is preschool-age children and the older age

group is school-age children The recall of children in both age groups is illustrated in **Table 4.3**.

Table 4.3

Descriptive Statistics for Memory Performance, Interview Type, and Level of Questioning by Younger/Older[a] Age Groups

Memory Performance	Age Group	*n*	Mean (*SD*)
Immediate total recall	Younger	42	0.80 (0.16)
	Older	43	0.87 (0.09)
	Total/Average	**85**	**0.84 (0.13)**
Delayed total recall	Younger	30	0.77 (0.18)
	Older	42	0.85 (0.10)
	Total/Average	**72**	**0.82 (0.14)**
Immediate free recall	Younger	42	0.15 (0.13)
	Older	43	0.41 (0.18)
	Total/Average	**85**	**0.28 (0.20)**
Delayed free recall	Younger	30	0.16 (0.17)
	Older	42	0.33 (0.17)
	Total/Average	**72**	**0.26 (0.19)**

Note. n = number of children. [a]Younger children = 4- to 6-year-olds, older children = 7- to 9-year-olds.

There are clear age differences in total recall and the children's memory performances in response to general probes during both assessments. A series of one-way analyses of variance yielded significant proof of age effects on total recall at the immediate, F (1, 83) = 5.31, $p < .05$, and the delayed interviews, F (1, 70) =5.53, $p < .05$, indicating that older children recalled more on general probes than younger children in both cases. In addition, a series of one-way analyses of variance yielded significant proof of age effects on free recall at the immediate, F (1, 83) = 56.13, $p < .01$, and the delayed interviews, F (1, 70) =16.46, $p < .01$, indicating that older children recalled more on general probes than younger children in both cases.

As has been consistently demonstrated (Ornstein et al., 2006), older children provided more total information and reported a greater proportion of the dental treatment features in response to general probes rather than to yes or no questions. It was once again demonstrated in this study that age differences in memory performance are consistent over a delay, though it should be considered that the delayed assessment was held only 1 week after the event. Older children provided more information than younger children at the delayed assessment, but younger children's free recall at the delayed assessment, *M* (*SD*) = 0.16 (0.17)) was as good as the ones at the immediate assessment, *M* (*SD*) = 0.15 (0.13).

Children's errors. To explore issues of suggestibility and possible response bias, the children's answers to the absent-feature questions were analyzed. On average, the children were asked 17.69 (*SD* = 2.88) absent-feature questions at each interview during the dental procedure, *M* (*SD*) = 17.74 (2.65) for younger children; 17.65 (3.12) for older children. The particular questions posed varied from child to child, reflecting differences in the individual dental treatments.

For each child, the proportion of correct rejections (i.e., "no" responses) and the proportion of false alarms (i.e., "yes" responses) to these questions were calculated. The data for the two age groups at each assessment occasion are displayed in **Table 4.4**, where it can be seen that the children's overall responses to these questions were quite good. The proportion of correct rejections ranged between 0.69 and 0.90.

Table 4.4

Descriptive Statistics for Children's Errors by Younger/Older[a] Age Groups

Error Response	Age Group	*N*	Mean (*SD*)
Immediate correct rejection	Younger	42	0.79 (0.19)
	Older	43	0.88 (0.08)
	Total/Average	**85**	**0.84 (0.15)**
Delayed correct rejection	Younger	30	0.81 (0.12)
	Older	42	0.85 (0.13)
	Total/Average	**72**	**0.83 (0.13)**
Immediate false alarm	Younger	42	0.16 (0.19)
	Older	43	0.08 (0.07)
	Total/Average	**85**	**0.11 (0.15)**
Delayed false alarm	Younger	30	0.15 (0.11)
	Older	42	0.09 (0.08)
	Total/Average	**72**	**0.12 (0.10)**

Note. n = number of children. [a]Younger children = 4- to 6-year-olds, older children = 7- to 9-year-olds.

At both the immediate and delayed interview, older children more accurately said "no" to the absent-features (i.e., correct rejections) than younger children, (the immediate interview: F (1, 83) = 9.09, $p < .01$, the delayed interview: F (1, 70) = 2.29, $p = 0.13$). Correspondingly, at both the immediate and delayed interview younger children provided more false alarms, (the immediate interview*:* F (1, 83) = 6.85, $p < .01$, the delayed interview: F (1, 70) = 6.54, $p < .01$). Clearly, age-related changes in suggestibility were observed; younger children were more vulnerable to suggestible questions than older children, as previous studies have demonstrated (e.g., Candel, Merckelbach, & Muris, 2000; see for a review: Ceci & Bruck, 1993).

In summary, older children provided more total information and reported a greater proportion of the dental treatment features in response to general probes than younger children. Although older children provided more information than younger children during

both the immediate and the delayed interview, the rates of forgetting differed across ages. Younger children remembered the similar proportion of the features in response to the general probes at the delayed interview compared to those at the immediate interview but older children remembered less in response to the general probes at the delayed interview. In addition, older children's correct rejection responses declined from the immediate to the delayed assessment; however younger children's correct rejections increased from the immediate to the delayed assessment. This indicates that the younger children accurately rejected the absent-features at the delayed interview at a level comparable to that of the immediate interview, although younger children are more vulnerable to suggestible questions overall than older children. Yet it should be noted that a week delay is not sufficient time to be considered a meaningful delay. Thus, it should not be concluded that younger children's memories are better at delayed interviews than older children's.

Overall, older children's free recall declined over the week and their suggestibility increased over the week but not so much for younger children. Yet these findings should be carefully interpreted due to the delay's short duration.

Dental History

The participants' histories of dental treatment experiences are presented in **Table 4.5**. Unlike Study 1 result, older children had been to a dentist more often than younger children, as expected, M (SD) = 3.51 (0.70) for older children; M (SD) = 3.14 (0.75) for younger children; F (1, 83) = 5.47, $p < .05$. Again, these are dental treatment experiences in the specific dental offices and that the children each had dental check-ups at school. Thus, in a real sense, the older children had more prior experience with dentists. In addition, older

children had more experiences at other dental practices than younger children, *M* (*SD*) = 0.70 (0.46) for older children, *M* (*SD*) = 0.36 (0.48) for younger children; F (1, 83) = 10.93, $p < .01$. Other variables were not significantly different by age groups.

All participants had a similar amount of dental experiences in the past year with one to three experiences being the average. Their time of first dental experience was also quite similar; most children had their first dental treatments around 41 months before the study (cf. 51 months in Study 1). Moreover, most of the participants had some experience with this particular dentist, based on the mean score of 3.15 for the question. Only five children had a past consultation with a professional psychologist due to any psychological anxiety or nervousness (three of the 5-year-olds and two of the 9-year-olds).

Table 4.5

Participants' Previous Dental Treatment Experiences by Younger/Older[a] Age Groups

Age Groups	*n*	Mean	*SD*
How many times has your child been to a dentist in his/her life? (scored 1: Not at all, 2: 1–3 times, 3: 4–6 times, 4: 7 or more times)			
Younger	42	3.14	0.75
Older	43	3.51	0.70
Average	**85**	**3.33**	**0.75**
How frequently has your child seen a dentist in the past year? (scored 1: Not at all, 2: 1–3 times, 3: 4–6 times, 4: 7 or more times)			
Younger	42	2.19	0.51
Older	43	2.33	0.78
Average	**85**	**2.26**	**0.66**
Has your child visited another dentistry besides this current dentistry? (scored 0: No, 1: Yes)			
Younger	42	0.36	0.48
Older	43	0.70	0.46
Average	**85**	**0.53**	**0.50**
How much experience has your child had with this particular dentist? (scored 1:None at all, 2:A little, 3: Some, 4: A lot)			
Younger	42	3.12	0.83
Older	43	3.19	0.79
Average	**85**	**3.15**	**0.81**
How old was your child (in months) when he/she visited a pediatric dentistry the first time?			
Younger	35	38.40	17.05
Older	35	43.31	21.92
Average	**70 [b]**	**40.86**	**19.65**
Has your child had any experience or consultation with a professional psychologist due to any psychological anxiety or nervousness? (scored 0: No, 1: Yes)			
Younger	42	0.07	0.26
Older	43	0.05	0.21
Average	**85**	**0.06**	**0.24**

Note. [a]Younger children = 4- to 6-year-olds, older children = 7- to 9-year-olds. [b]Data were missing from 15 participants for this question. Some parents left the answer blank.

In terms of the association between children's history of dental experiences and their remembering, children who had their first dental visit comparatively later than others tended to exhibit better total remembering of the current visit at both the immediate and delayed interview (r = .28, r= .26, ps <. 05, respectively). Children who had been more frequently to a pediatric dentistry in their life or more frequently seen a dentist during the last year tended to exhibit less vulnerability to suggestible questions (r =. 24, ps < .05). In addition, children who had more experiences with this particular dentist were more likely to exhibit less vulnerability to suggestible questions (correct rejections, r = .24; false alarms, r = -.25; ps <. 05, respectively) (see **Table 4.6**).

Table.4.6

Correlations Between Children's Previous Dental History and Memory Performance

Recall Type	**1**	**2**	**3**	**4**	**5**	**6**
Immediate total recall	.28* (.27*)	-.03	.20	.02	.11	-.07
Immediate free recall	.31** (23)	-.03	.13	.12	.18	.06
Immediate correct rejection	.01	.04	.24* (.15)	.24*(.24*)	.11	.24*(.32**)
Immediate false alarm	.01	-.08	-.26* (-.17)	-.19	-.09	-.25*(-.29**)
Delayed total recall	.26* (.22)	-.12	.11	.05	.20	-.07
Delayed free recall	.26* (.17)	.01	.16	.13	.02	.05
Delayed correct rejection	-.08	.17	.07	.10	-.09	.17
Delayed false alarm	-.06	-.14	-.19	-.08	.04	-.23(-.24*)

Note. 1. How old was your child (in months) when he/she visited a pediatric dentistry the first time? 2. Has your child consulted with a professional psychologist due to any psychological anxiety or nervousness? 3. How frequently has your child been to a dentist in his/her life? 4. How frequently has your child seen a dentist in the past year? 5. Has your child had any dental experience at another dentistry? 6 How much experience has your child had with this particular dentist?
Numbers in parentheses are controlled for age. *$p < .05$, ** $p < .01$.

Effect of Stress on Recall

Study Aim 2: Relation between the level of stress including biological stress reactivity and children's remembering

A principal purpose of the current study was to examine the effects of stress on children's remembering of a potentially traumatic, personally experienced event.

As seen in **Table 4.7**, the dentist's mean rating of child anxiety was 2.21 (*SD* =1.43, range: 1–7), indicating that the dentist saw the participants in the current study as moderately relaxed on average, although a full range of ratings was observed. This mean rating of children's anxiety was higher than the mean value of Study 1 as assessed by the same dentist. Both parents and children also rated the children's pain and anxiety. The mean score of the parents' reports was higher than that of the children's self-reports, indicating that parents judged children's anxiety higher than the children did.

Table 4.7

Means, Ranges, and Standard Deviations for the Anxiety Predictor Variables

Anxiety Variables	**Mean**	***SD***	**Range**
Frankl Behavior Rating Scale by dentist	3.22	0.81	1 - 4
Noncompliance by dentist	2.20	1.42	1 - 7
Anxiety by dentist	2.21	1.43	1 - 7
Immediate pain	2.89	1.40	1 - 5
Immediate anxiety	2.71	1.61	1 - 5
Delayed pain	2.50	1.33	1 - 5
Delayed anxiety	2.39	1.28	1 - 5
Immediate emotional state	3.68	1.37	1 - 5
Delayed emotional state	4.19	1.10	1 - 5
Pain by parent	3.19	0.92	1 - 5
Anxiety by parent	3.31	0.99	1 - 5
STATE score[a]	3.80	1.03	1 - 5
TRAIT score[a]	2.36	1.00	1 - 5
Behavioral stress reactivity	4.67	4.65	0 - 20
Immediate hesitancy to disclose	2.34	1.54	1 - 5
Immediate management ease	3.64	1.53	1 - 5
Delayed hesitancy to disclose	2.33	1.46	1 - 5
Delayed management ease	3.68	1.47	1 - 5
Epoch numbers[b]	34.23	22.00	9 - 111
Vagal tone (average)	5.98	1.11	3 - 8
Heart period (average)	607.32	97.87	367 - 831
Prior mean arterial pressure	83.23	9.27	64 - 106.67
After mean arterial pressure	90.40	9.76	58.33 - 111.67
Prior pulse rate	85.95	12.50	59 - 128
After pulse rate	91.62	13.86	62 - 129
Δ Vagal tone[c]	0.17	0.85	-2.36 - 3.04
Δ Heart period[c]	3.78	53.54	-166.53 - 168.13
Δ Mean arterial pressure[d]	7.17	9.64	-16.33 - 29.33
Δ Pulse rate[d]	5.67	9.16	-20 - 40

Note. Six children's physiological data were excluded due to equipment failure because of children's physical activity and computer recoding errors during the dental procedure; thus 79 data sets, in total, were used for the final analysis of children's biological stress reactivity. [a]State and Trait anxiety scores are elements of the State and Trait Anxiety Inventory for Children (Spielberger et al., 1973). Lower state anxiety scores and higher trait anxiety scores indicate higher anxiety in a child's routine life. [b]One epoch is 30 seconds, and thus 34.23 epochs is 1026.9 seconds, which is 17.11 minutes. Thus, children, on average, received dental treatment about17.11 minutes. [c]From the first to the second period: greater ΔVT or ΔHP indicates a higher stress level or arousal. [d]From after to before the event: greater ΔMAP or ΔPR indicates a higher stress level or arousal.

The mean heart period (HP) values and vagal tone (VT) values decreased in the second part of the dental procedure. Decreasing heart period indicates a greater heart rate and decreasing vagal tone value indicates a greater parasympathetic activity. Thus, when both values are decreased, it is typically indicative of greater arousal. Children's physiological stress level (i.e, heart period and vagal tone) was highest during the second part of the dental procedure and became more relaxed at the end of the dental procedure (see **Table 4.8**).

Table 4.8

Means and Standard Deviations of Heart Periods (ms) and Vagal Tones (ln ms2) Per Procedure Interval

Heart Period	**Mean (*SD*)**
First part	605.71 (98.30)
Second part	604.74 (106.13)
Third part	614.36 (102.13)
Average	**607.32 (97.87)**
Vagal Tone	**Mean (*SD*)**
First part	6.08 (1.12)
Second part	5.90 (1.29)
Third part	5.95 (1.21)
Average	**5.98 (1.11)**

According to the mean values of BP and PR presented in **Table 4.9** below, those measured after the dental procedure were higher than those measured before it, indicating that the children's stress levels, on average, were elevated during the dental procedure (mean arterial pressure, t (84) = -6.86; pulse rate, t (84) = -5.71, $ps < .01$).

Table 4.9

Means and Standard Deviations of Mean Arterial Pressures (mmHg) and Pulse Rates (min)

Timing of Measurement	**Mean (*SD*)**
Prior mean arterial pressure	83.23 (9.27)
After mean arterial pressure	90.40 (9.76)
Prior pulse rate	85.95 (12.49)
After pulse rate	91.62 (13.86)

From a developmental perspective, significant age differences were expected in a series of anxiety variables (see **Table 4.10**). In the current study, that held true: younger children had greater VT reactivity during the dental procedure than older children, F (1, 77) = 5.95, $p < .05$. In addition, younger children had greater HP reactivity during the dental procedure than older children, F (1, 77) = 3.77, $p = .056$. This finding is consistent with the previous literature (Alkon et al., 2003; Boyce et al., 2001; Quas et al., 2004, 2006). On the other hand, younger children had more behavioral responses to stress than older children, as expected, but there was no statistically significant difference between the two age groups, F (1, 83) = .77, $p > .05$.

In terms of interviewer's ratings, younger children were more hesitant to disclose than older children during the interview both at immediate, F (1, 83) = 16.78, $p < .01$ and delayed interview, F (1, 70) = 26.75, $p < .01$. In addition, younger children were harder manage than older children during the interview both at immediate, F (1, 83) = 18.75, $p < .01$ and delayed interview, F (1, 70) = 27.73, $p < .01$.

In terms of children's general anxiety condition, younger children reported higher trait anxiety than older children, F (1, 83) = 5.46, $p < .05$.

Table 4.10

Mean and Standard Deviations for Anxiety Variables by Age Groups

	Age Group	*n*	Mean	SD
Noncompliance by dentist	Younger	42	2.17	1.48
	Older	43	2.23	1.38
	Total/Average	85	2.20	1.42
Anxiety by dentist	Younger	42	2.17	1.48
	Older	43	2.26	1.40
	Total/Average	85	2.21	1.43
Frankl Behavior Rating Scale by dentist	Younger	42	3.17	0.88
	Older	43	3.28	0.73
	Total/Average	85	3.22	0.81
Working memory	Younger	42	1.81	1.32
	Older	43	3.45	0.78
	Total/Average	85	2.64	1.35
Immediate hesitancy to disclose	Younger	42	2.98	1.68
	Older	43	1.72	1.10
	Total/Average	85	2.34	1.54
Immediate management ease	Younger	42	2.98	1.63
	Older	43	4.28	1.10
	Total/Average	85	3.64	1.53
Delayed hesitancy to disclose	Younger	32	3.19	1.55
	Older	40	1.65	0.95
	Total/Average	72	2.33	1.46
Delayed management ease	Younger	32	2.81	1.55
	Older	39	4.38	0.94
	Total/Average	71	3.68	1.47
Trait anxiety score[a]	Younger	42	2.61	1.10
	Older	43	2.12	0.83
	Total/Average	85	2.36	1.00
State anxiety score[a]	Younger	42	3.62	1.08
	Older	43	3.98	0.96
	Total/Average	85	3.80	1.03
Immediate pain	Younger	42	3.17	1.55
	Older	43	2.63	1.20
	Total/Average	85	2.89	1.40
Immediate anxiety	Younger	42	2.88	1.80
	Older	43	2.53	1.40
	Total/Average	85	2.71	1.61
Immediate emotional state	Younger	42	3.67	1.51
	Older	43	3.70	1.23
	Total/Average	85	3.68	1.37

Delayed pain	Younger	32	2.69	1.42
	Older	40	2.35	1.25
	Total/Average	72	2.50	1.33
Delayed anxiety	Younger	32	2.44	1.29
	Older	40	2.35	1.29
	Total/Average	72	2.39	1.28
Delayed emotional state	Younger	32	4.25	1.11
	Older	40	4.15	1.10
	Total/Average	72	4.19	1.10
Pain by parent	Younger	42	3.33	0.95
	Older	43	3.05	0.87
	Total/Average	85	3.19	0.92
Anxiety by parent	Younger	42	3.24	1.03
	Older	43	3.37	0.95
	Total/Average	85	3.31	0.99
Parent presence	Younger	42	0.62	0.49
	Older	43	0.40	0.50
	Total/Average	85	0.51	0.50
Behavioral responses to stress	Younger	42	5.11	4.74
	Older	43	4.23	4.59
	Total/Average	85	4.66	4.66
Δ Vagal tone[b]	Younger	38	0.30	0.88
	Older	42	-0.04	0.65
	Total/Average	80	0.12	0.78
Δ Vagal tone[c]	Younger	38	0.40	0.94
	Older	42	-0.04	0.69
	Total/Average	80	0.17	0.84
Δ Heart period[b]	Younger	40	4.88	64.69
	Older	43	-21.22	56.25
	Total/Average	83	-8.64	61.51
Δ Heart period[c]	Younger	40	7.59	48.41
	Older	43	0.42	56.43
	Total/Average	83	3.88	52.52
Δ Mean arterial pressure[d]	Younger	42	7.87	9.44
	Older	43	6.48	9.89
	Total/Average	85	7.17	9.64
Δ Pulse rate[d]	Younger	42	6.31	9.79
	Older	43	5.05	8.58
	Total/Average	85	5.67	9.16

Note. [a]State and trait anxiety scores are elements of the STAIC questionnaire (Spielberger et al., 1973). Lower state scores and higher trait anxiety scores indicate higher anxiety in a child's routine life. [b]From first to third period. [c]From first to second period. [d]From before to after the procedure.

To examine the relations between a range of stress and anxiety measures recorded in Study 2, correlations were calculated among the 24 anxiety variable measures including physiological stress reactivities (i.e., ΔVT, ΔHP, ΔMAP, ΔPR), behavioral responses to stress (i.e., BPRS score), dentist's ratings, children's self-reports, parents' reports, children's feelings during both the immediate and delayed interviews as indicative of their emotional status during the memory retrieval situation, and STAIC anxiety questionnaire scores.

In terms of pulse rate and blood pressure reactivity (i.e., difference values pulse rate and blood pressure from values measured before dental procedure to values measured after dental procedure), there was a strong correlation between the change in PR and the dentist's ratings. There was also a strong correlation between the change in MAP and the dentist's ratings. Thus, children who had greater shifts in BP and PR during the dental procedure were given higher anxiety scores as judged by the dentist. These findings were consistent even when children's ages were controlled for.

Changes in PRs were also associated with children's self-reports of pain at the delayed interview ($r = .27$, $p < .05$), indicating that children who exhibited higher PR reactivity reported greater pain during the procedure than children who reported little pain when asked at the delayed interview. Changes in MAPs were associated with parents' reports of their children's pain and anxiety; if parents judged children to have experienced greater pain and anxiety during the dental procedure, those children exhibited higher blood pressure reactivity (for pain, $r = .22$, for anxiety, $r = .32$, $ps < .05$).

In addition, there were significant correlations between the children's self-reports of anxiety and their responses on the STAIC anxiety questionnaires (i.e., Spielberger State-

Trait Anxiety Inventory for Children, 1978). Higher trait scores, which are indicative of children who are generally very anxious and nervous in their routine lives, had a strong positive correlation with the children's self-reports of pain and anxiety at both the immediate (r = .26, p < .05, r = .47, p < .01) and the delayed interviews (r = .27, .34, ps < .05). Thus, children with higher trait anxiety scores generally reported greater pain and anxiety regarding the dental visit. On the other hand, higher state scores, which are indicative of children being happy and confident about their routine lives, had a strong negative correlation with the children's self-reports of pain and anxiety at both the immediate (r = -.34, p < .01 for pain, r = -.43 p < .01 for anxiety) and delayed interviews (r = -.28, p < .05 for pain, r = -.26, p < .05 for anxiety). Thus, children who saw themselves as having a more positive state in general reported less pain and anxiety for the dental visit. Additionally, children with higher trait scores revealed higher heart rate reactivity. Thus, children with higher anxiety in everyday life had higher physiological stress reactivity during the dental procedure.

In summary, some of these measures were significantly correlated with each other and some of them were not. Overall, children's behavioral responses to stress (i.e., BPRS score) was related to the rest of the anxiety variables (e.g., dentist ratings, r = .63, .62, -.56, ps < .01; Immediate child's self report of pain and anxiety, r = .45, .33, ps < .01; Delayed child's self report of pain and anxiety, r = .53, .47, ps <. 01; Parent report of child's pain and anxiety, r = .27, .27, ps < .05; Child's general state anxiety conditions, r = .27, p < .05; Vagal tone reactivity from the end period of the dental procedure to the first period of the dental procedure r = .24, p < .05; Pulse rate and blood pressure reactivity from measured before the dental procedure to measured after the dental procedure, r = .48, .37, ps < .01;

Immediate interviewer's ratings, r = .37, -.36, ps < .01; Delayed interviewer's ratings, r = .30, -.31, ps < .01) than children's physiological reactivity during the dental procedure (see **Table 4.11**).

Table 4.11

Anxiety Variables' Correlations

	1	2	3	4	5	6	7	8
1. Noncompliance by dentist	-							
2. Anxiety by dentist	1.00**	-						
3. Frankl Behavioral Rating Scale by dentist	-.93**	-.93**	-					
4. Immediate pain	.37**	.37**	-.32**	-				
5. Immediate anxiety	.42**	.41**	-.46**	.64**	-			
6. Immediate emotional state	-.31**	-.31**	.27*	-.20	-.16	-		
7. Delayed pain	.43**	.42**	-.41**	.67**	.49**	-.15	-	
8. Delayed anxiety	.54**	.53**	-.53**	.58**	.68**	-.19	.62**	-
9. Delayed emotional state	-.07	-.08	.07	-.05	-.02	.41**	-.03	.01
10.Pain by parent	.18	.17	-.20	.25*	.22*	-.22*	.22	.25*
11. Anxiety by parent	.30**	.29**	-.31**	.18	.18	-.14	.12	.11
12. Trait anxiety score	.17	.16	-.25*	.26*	.47**	-.11	.27*	.34**
13. State anxiety score	.02	.03	.03	-.34**	-.43**	.23*	-.28*	-.26*
14.Behavioral stress reactivity	.63**	.62**	-.56**	.45**	.33**	-.34**	.53**	.47**
15. Δ vagal tone from first to third period	-.06	-.07	.07	.17	-.01	.05	.28*	.04
16. Δ vagal tone from first to second period	-.11	-.11	.12	.10	-.04	.14	.18	.00
17. Δ heart period from first to third period	.10	.09	-.06	.08	-.02	-.10	.16	-.04
18. Δ heart period from first to second period	.09	.09	-.04	.09	-.01	-.17	.09	-.06
19.Δ mean arterial pressure	.42**	.40**	-.41**	.14	.00	-.18	.19	.16
20.Δ pulse rate	.27*	.26*	-.23*	.16	-.04	-.26*	.27*	.21
21.Immediate hesitancy to disclose	.34**	.33**	-.42**	.39**	.35**	-.35**	.36**	.35**
22.Immediate management ease	-.33**	-.32**	.41**	-.40**	-.34**	.35**	-.38**	-.35**
23.Delayed hesitancy to disclose	.20	.19	-.21	.41**	.29*	-.11	.20	.19
24.Delayed management ease	-.21	-.20	.22	-.41**	-.29*	.12	-.20	-.19

Note. 1. Noncompliance by dentist, 2. Anxiety by dentist, 3. Frankl Behavioral Rating Scale by dentist, 4. Immediate pain, 5. Immediate anxiety, 6. Immediate emotional state, 7. Delayed pain, 8. Delayed anxiety. *p <.05, ** p <.01.

Table 4.11

Anxiety Variables' Correlations _contiued

	9	10	11	12	13	14	15	16	17
1. Noncompliance by dentist									
2. Anxiety by dentist									
3. Frankl Behavioral Rating Scale by									
4. Immediate pain									
5. Immediate anxiety									
6. Immediate emotional state									
7. Delayed pain									
8. Delayed anxiety									
9. Delayed emotional state	-								
10.Pain by parent	.02	-							
11. Anxiety by parent	.06	.66**	-						
12. Trait anxiety score	.10	.12	.12	-					
13. State anxiety score	.24*	-.05	.04	-.50**	-				
14. Behavioral stress reactivity	-.06	.27*	.27*	.27*	.03	-			
15. Δ Vagal tone from first to third period	-.03	.22*	.21	-.05	-.02	.24*	-		
16. Δ Vagal tone from first to second period	-.15	.16	.11	-.21	.11	.14	.51**	-	
17. Δ Heart period from first to third period	-.15	.11	-.06	.10	-.09	.14	.06	-.06	-
18. Δ Heart period from first to second	-.02	.14	.08	.19	-.09	.15	.05	-.19	.56**
19. Δ Mean arterial pressure	-.07	.22*	.32**	.01	.06	.44**	.25*	.21	.07
20. Δ Pulse rate	-.15	.21	.19	.11	.00	.48**	.32**	.26*	.12
21. Immediate hesitancy to disclose	-.13	.23*	.14	.29**	-	.37**	.09	.11	.12
22. Immediate management ease	.13	-.23*	-.14	-.28**	.28*	-.36**	-.10	-.12	-.15
23. Delayed hesitancy to disclose	-.06	.10	.05	.24*	-	.30*	.17	.17	.08
24. Delayed management ease	.06	-.11	-.05	-.24*	.23	-.31**	-.17	-.17	-.08

Note. 9. Delayed emotional state, 10. Pain by parent, 11. Anxiety by parent, 12. Trait anxiety score, 13. State anxiety score, 14. Behavioral stress reactivity, 15. Δ vagal tone from first to third period, 16. Δ vagal tone from first to second period, 17. Δ heart period from first to third period. *p <.05, ** p <.01.

Table 4.11
Anxiety Variables' Correlations_contiued

	18	19	20	21	22	23	24
1. Noncompliance by dentist							
2. Anxiety by dentist							
3. Frankl Behavioral Rating Scale by dentist							
4. Immediate pain							
5. Immediate anxiety							
6. Immediate emotional state							
7. Delayed pain							
8. Delayed anxiety							
9. Delayed emotional state							
10.Pain by parent							
11. Anxiety by parent							
12. Trait anxiety score							
13. State anxiety score							
14. Behavioral stress reactivity							
15. Δ Vagal tone from first to third period							
16. Δ Vagal tone from first to second period							
17. Δ Heart period from first to third period							
18. Δ Heart period from first to second period	-						
19. Δ Mean arterial pressure	-.15	-					
20. Δ Pulse rate	.14	.43**	-				
21. Immediate hesitancy to disclose	-.02	.17	.19	-			
22. Immediate management ease	.02	-.18	-.20	-1.00**	-		
23. Delayed hesitancy to disclose	.09	.14	.20	.59**	-.59**	-	
24. Delayed management ease	-.09	-.15	-.21	-.59**	.59**	-1.00**	-

Note. 18. Δ Heart period from first to second period, 19. Δ mean arterial pressure from after to before the procedure, 20. Δ pulse rate from after to before the procedure, 21. Immediate hesitancy to disclose, 22. Immediate management ease, 23. Delayed hesitancy to disclose, 24. Delayed management ease. State and trait anxiety scores are elements of the STAIC questionnaire (Spielberger et al., 1973). Lower state and higher trait anxiety scores indicate higher anxiety in a child's routine life. *p <.05, ** p <.01.

According to the **Table 4.12**, higher behavioral stress reactivity was associated with lower total recall (r = -.28, p < .05) and free recall (r = -.33, p < .01) at the delayed interview. When children's ages in months were controlled for, the coefficients were still significant. There was no significant interaction between children's ages and behavioral responses to stress. Thus, these findings provide support for the prediction that stress negatively impacts children's remembering of a stressful event and the linkage between stress and children's remembering did not depend on the age of the child. Children's behavioral responses to stress (i.e., BPRS score) was associated with children's remembering only at the delayed interview. Subsequent correlation analyses indicated that there were no significant findings on the relation between behavioral stress reactivity and children's vulnerability to suggestible questions.

The dentist's ratings of anxiety were correlated with the children's later recall, which is a result consistent with of Merritt et al. (1994), demonstrating that the more fearful children were judged to be by a technologist, the less they recalled of the procedure. Yet this correlation was only seen for the delayed interview, indicating that children who exhibited greater anxiety and less cooperation as judged by the dentist were less likely to recall information from general probes at the delayed interview. Unlike the results of Study 1, there was no relation between the dentist's ratings and children's immediate recall. Furthermore, children who self-reported having greater anxiety about the dental procedure exhibited poorer recall for both total and general probes at both interviews, and they also made more errors on suggestible questions.

Children who reported higher levels of general anxiety in their routine lives (i.e., higher trait anxiety scores) exhibited poorer total and free recall at the immediate interview. On the other hand, children who reported lower anxiety in their routine lives (i.e., higher state anxiety

scores) exhibited superior total and free recall at the immediate interview. Children's general anxiety condition was associated with their immediate memory performance of a stressful event.

In addition, the interviewer's ratings of the child's hesitancy and the ease of management during the interview were correlated with the children's free recall at both immediate and delayed interviews. This shows that children who were more hesitant to talk about what they experienced and harder to manage in the interviewer's opinion exhibited poorer recall to general probes compared to children who were not.

Table 4.12

Correlations for Children's Memory Performance and a Range of Anxiety Variables

Anxiety Variable	Immediate Recall			
	Total recall	**Free recall**	**Correct rejection**	**False alarm**
Noncompliance by dentist	-.17	-.07	-.15	.11
Anxiety by dentist	-.15	-.05	-.14	.11
Frankl Behavior Rating Scale	.21	.17	.15	-.13
Immediate pain	-.42** (-.34**)	-.31**(-.21)	-.10	.10
Immediate anxiety	-.32**(-.27*)	-.34**(-.32**)	-.23*(-.16)	.24*(.19)
Immediate emotional state	-.02	-.04	.08	-.04
Delayed pain	-.39**(-.36**)	-.21	.18(.26*)	-.14
Delayed anxiety	-.27*(-.25*)	-.22	-.01	.03
Delayed emotional pain	-.09	-.09	-.07	.06
Pain by parent	-.19	-.08	-.09	.07
Anxiety by parent	-.21(-.21)	-.02	-.02	.03
Average Trait score[a]	-.33**(-.37**)	-.27*(-.15)	-.03	-.03
Average State score[a]	.35**(.37**)	.27*(.25*)	-.02	.11
Δ Mean arterial pressure[b]	-.16	-.04	.02	-.02
Δ Pulse rate[b]	-.04	-.04	-.08	.04
Δ Vagal tone[c]	-.16	-.08	-.05	.10
Δ Vagal tone[d]	-.21	-.14	.13	-.04(-.23)
Δ Heart period[c]	-.06	.02	-.19	.02
Δ Heart period[d]	-.02	.04	-.09	.06
Behavioral responses to stress	-.16	-.14	-.11	.08

Anxiety Variable	Delayed Recall			
	Total recall	Free recall	Correct rejection	False alarm
Noncompliance by dentist	-.24(-.21)	-.27*(-.23)	-.20	.13
Anxiety by dentist	-.23	-.26*(-.22)	-.18	.12
Frankl Behavior Rating Scale	.26*(.24*)	.27*(.22)	.18	-.16
Immediate pain	-.47**(-.42**)	-.52**(-.43**)	-.10	.08
Immediate anxiety	-.21	-.41**(-.37**)	-.29*(-.27*)	.25*(.20)
Immediate emotional state	.05	0.08	.25*(.26*)	-.10
Delayed pain	-.35**(-.32**)	-.33**(-.27*)	-.01	-.05
Delayed anxiety	-.27*(-.25*)	-.33**(-.30*)	-.14	.13
Delayed emotional pain	.03	-.08	.10	.00
Pain by parent	-.15	-.15	-.30*(-.28*)	.32**(.28*)
Anxiety by parent	-.06	-.20	-.21	.21
Average Trait score[a]	-.14	-.19	-.07	.14
Average State score[a]	.10	.19	.16	-.14
Δ Mean arterial pressure[b]	-.05	-.11	-.04	.11
Δ Pulse rate[b]	-.06	-.19	-.16	.22
Δ Vagal tone[c]	-.18	-.15	-.16	.16
Δ Vagal tone[d]	-.15	-.09	.06	.04
Δ Heart period[c]	-.19	-.09	-.18	-.02
Δ Heart period[d]	-.09	.06	.02	-.12
Behavioral responses to stress	-.28* (-.23*)	-.33**(-.25*)	-.14	.17

Note. Numbers in parentheses are controlled for age. [a]State and Trait scores are elements of the STAIC questionnaire (Spielberger et al., 1973). Lower state scores and higher trait anxiety scores indicate higher anxiety in a child's routine life. [b]From after to before the event. [c]From the first to third period. [d]From the first to second period. [e] Don't know response for present features, [f] Don't know response for absent features. ** $p < .01$, * $p < .05$.

Biological stress reactivity. For biological stress reactivity, children who had greater VT reactivity exhibited poorer recall at the immediate interview although it was marginally correlated (p = .06). The pattern was consistent with the results of previous literature (Quet et al., 2004, 2006). Considering that VT is represented as a close measure of children's emotion regulation ability, not necessarily stress reactivity, in the literature (Porges, 1994; Santucci et al., 2008), caution is required in claiming that greater VT reactivity is an indicator of increasing biological stress levels.

Another biological reactivity in the current study, HP reactivity, was not associated with any of the children's recall except for children's "don't know" responses. It was correlated at both immediate and delayed interviews, indicating that children who exhibited greater HP reactivity during the dental procedure gave more "'don't know" responses regardless of present- or absent-feature questions.

All of these results support the assumption that anxiety has a negative impact on children's remembering of a stressful event, yet each anxiety variable had a different impact on children's immediate and delayed remembering.

Behavioral responses to stress. Considering that children's behavioral responses to stress is more related to children's remembering than biological reactivity, the behavioral responses to stress was examined in more detail. The behavioral stress response scores were divided into three parts corresponding with the dental procedure's three periods as seen in **Table 4.13**. Though the dental procedures were divided into three periods based on procedure time, the specific treatments occurring in each period differed for each child, even if the same procedure was performed (e.g., one child received a sealant treatment but another child received two sealants treatment, thus taking longer). Children showed less

behavioral stress reactivity during the first period of the dental procedure and more during the second period. There were no significant differences across ages, but younger children showed a behavioral stress reactivity increase during the second period.

Table 4.13

Means and Standard Deviations of Behavioral Stress Responses per Procedure Period

Procedure Period	Age Group	*n*	Mean	SD
First	Younger	42	3.93	4.22
	Older	42	3.61	3.47
	Total/Average	84	3.77	3.84
Second	Younger	34	6.52	6.25
	Older	28	5.15	7.01
	Total/Average	62	5.90	6.58
Third	Younger	42	5.09	4.65
	Older	42	4.69	5.27
	Total/Average	84	4.89	4.95

Note. n = number of children.

As seen in the previous analyses, children's remembering at the delayed interview was correlated with their behavioral stress reactivity. Total recall was more closely related to the BPRS scores during the second and third parts of the procedure, but the children's free recall at delayed interview was related to the BPRS scores for the entire procedure, as presented in **Table 4.14**. Children's vulnerability to suggestible questions was correlated with only the BPRS scores at the first period, indicating that children who showed greater behavior responses to stress at the beginning of the dental procedure were more vulnerability to suggestible questions. These collective findings support the argument that children's behavioral stress reactivity is associated with later, rather than immediate, recall of a stressful event.

Table 4.14

Correlations Between Behavioral Responses to Stress per Period and Recall Type

Recall Type	First period	Second period	Third period
Immediate total recall	.03	-.20	-.13
Immediate free recall	-.06	-.19	-.08
Immediate correct rejection	-.08	-.15	-.06
Immediate false alarm	.04	.10	.06
Delayed total recall	-.15	-.30*(-.27)	-.30*(-.22)
Delayed free recall	-.27*(-.34*)	-.29*(-.22)	-.31**(-.30*)
Delayed correct rejection	-.32**(-.44**)	-.14	-.06
Delayed false alarm	.26*(.30*)	.21	.10

Note. Numbers in parentheses are controlled for age. ** $p < .01$, * $p < .05$.

Inspection of **Table 4.15**, the behavioral responses to stress rated by the BPRS are given to investigate each element's potential associations with biological stress indicators. Among the behavioral responses to stress present during the dental procedure, flinging arms were most related to both biological stress reactivity. Children who flung arms more often during the dental procedure also exhibited greater VT and HP reactivity. Additionally, verbal messages given by the children to terminate the procedure or action were associated with VT reactivity. Children who gave such messages more often had greater changes in VT. Kicking was related to HP reactivity, indicating that children who kicked more often to express their pain also had greater HP reactivity. Each behavior had a different association with the children's VT and HP reactivity.

Table 4.15

Correlation Coefficients for Biological Stress Reactivity and Select Behavioral Rating Profile Scale Items

Item	Δ Vagal tone[a]	Δ Vagal tone[b]	Δ Heart period[b]	Δ Heart period[a]
Verbal message to terminate	.24*	.28*	.02	.12
Refuses to open mouth (3)	.18	-.09	.29**	.05
Crying (3)	.14	-.07	.17	.23*
Rolls over (4)	.24*	-.03	.29**	.09
Kicks (4)	.04	-.05	.24*	.24*
Flings arms (5)	-.35**	-.34**	.23*	.34**
Refuses to sit in chair (5)	.14	.02	.12	.34**

Note. Numbers in parentheses are weighted scores for the behaviors. [a]From the first to third period. [b]From the first to second period. ** $p < .01$, * $p < .05$.

Table 4.16 is presented that some of the BPRS items were related to children's memory performance. In particular, crying was significantly associated with children's total and free recall at the delayed interview. Thus, children who cried more during the dental procedure had poorer memory at the delayed interview. In addition, children who kicked more often were more vulnerable to suggestible questions at both interviews. Children who gave more verbal messages to terminate the procedure also had poorer total recall at the immediate and delayed interviews. Children who screamed during the dental procedure had poorer recall at the delayed interview, and children who tried to dislodge instruments gave more false alarm responses at the delayed interview. The collective findings on behavioral stress reactivity provide evidence that children's behavioral responses to stress were negatively correlated with their immediate and delayed remembering.

In summary, inspection of the mean ratings of the anxiety variables suggests that the sample, as a group, was less anxious or stressful during the dental procedure than had been anticipated. The environment of this dental office was child-friendly with decorations of pleasant pictures and toys available at the dentistry as compared to a university pediatric dentistry that is commonly not allowed to do as much personalization. The surroundings may have helped the children come to the dentistry with lower stress levels and have their treatments without high anxiety. And yet, children's total recall decreased as anxiety scores increased, supporting the argument that stress and anxiety negatively impact children's remembering of a stressful event. Interestingly, the behavioral stress levels were strongly correlated with children's delayed memory. Yet the physiological stress levels were not significantly related to children's remembering except for a marginal relation with VT reactivity: greater VT reactivity during the dental procedure corresponded with poorer memory at the immediate interview. Behavioral problems are often related to difficulty with emotion regulation, especially during potentially arousing situations, and greater vagal withdrawal may contribute to that effect, by reducing attention to stressful environmental stimuli as a means of emotional self-regulation. This reduced attention may result in poorer remembering. However, based on the absence of relation between the biological measures of stress and children's memory, further study is needed to confirm.

Table 4.16

Correlation Coefficients Between Behavioral Profile Rating Scale Items and Children's Recall

Behavior	BPRS Raw Data							
	I TR	**D TR**	**I FR**	**D FR**	**I CR**	**D CR**	**I FA**	**D FA**
Inappropriate mouth closing	.18	.02	.06	-.09	.04	.02	-.04	-.08
Chokes	.09	.00	-.20	-.05	-.07	-.03	.05	.06
Fidgets	.05	-.12	-.01	-.22	-.22*	-.46**	.15	.24*
Attempts to dislodge instrument	-.20	-.22	-.15	-.27*	-.02	-.12	.03	.10
Verbal complaints	.04	-.13	.14	-.03	.07	-.11	-.08	.02
Verbal message to terminate	-.25*	-.39**	-.10	-.15	.10	.02	-.07	.00
Refuses to open mouth	.05	-.02	.14	-.16	-.06	-.54**	-.04	.16
Rigid posture	.10	.06	.02	-.10	-.05	-.24*	.03	.13
Crying	-.20	-.34**	-.22*	-.31**	-.17	-.24*	.16	.23
Screaming	.03	-.07	-.16	-.16	-.24*	-.16	.19	.18
Rolls over	.06	-.06	.01	-.14	-.01	-.22	-.01	.06
Restraints used	-.11	-.20	-.15	-.23	-.10	-.06	.12	.14
Kicks	.04	-.06	-.10	-.24*	-.38**	-.46**	.32**	.47**
Flings arms	-.04	-.02	-.15	-.13	-.20	-.11	.04	.13
Dislodges instruments	.11	.12	.09	-.08	-.12	-.16	.16	.29*
Refuses to sit in chair	.16	.07	.13	.13	.05	.11	-.01	-.10

Note. I = immediate, D = delayed, TR = total recall, FR = free recall, CR = correct rejection, FA = False alarm. * $p < .05$, ** $p < .01$.

Individual Difference on Recall

Study Aim 3: Effects of individual differences including cognitive differences in the relation between stress level and remembering

Study 1 demonstrated that not only does stress negatively impact children's remembering of a stressful event but several individual difference factors – including approach-oriented coping styles, surgency, previous positive dental experiences, and parents' advance preparation of the children for the event – significantly influenced children's recall, especially on general probes.

For Study 2, in an attempt to replicate and examine further the effects of those potential individual differences on children's remembering, a range of cognitive and social-emotional individual differences was explored in depth. For the cognitive individual differences, raw PPVT-III scores and raw digit-span-backward scores were investigated in a subset of the analyses to provide information on the children's receptive language abilities and WM capacities, respectively.

In the first series of analyses, each question of interest was entered as independent variables in a correlation analysis. There were no significant effects on children's memory performances for the following independent variables: children's gender, parent's education level, and the frequency of having seen a pediatric dentist in the past year. They were therefore excluded as variables of interest.

Parent's preparation and previous dental history. The extent of advance preparation and the quality of previous dental experiences were found to be important variables for understanding the relation between stress and children's memory. This replicated the results of Study 1: children who had extensive discussions about the dental

visit with parents in advance were likely to recall more in total and general probes at both interviews than children who did not. Children who had no prior unpleasant dental experience were likely to recall more in total and general probes during both interviews than children who did.

The extent of parent's preparation yielded a main effect with age, F (1, 83) = 5.52, $p < .05$, indicating that older children were more prepared by their parents before coming to the dentistry compared to younger children. The quality of past experiences also yielded a main effect with age, F (1, 83) = 3.31, $p < .01$, meaning that younger children had more previous unpleasant dental experiences than older children (see **Table 4.17**).

Table 4.17

Means and Standard Deviations for Children's Dental History and Parental Preparation By Age Groups

Individual Difference	Age Group	*n*	Mean	SD
Previous Negative Dental History	Younger	42	0.64	0.48
	Older	43	0.30	0.46
	Total/Average	85	0.47	0.50
Parent Preparation	Younger	42	0.48	0.51
	Older	43	0.72	0.45
	Total/Average	85	0.60	0.49

Note. n = number of children.

As can be seen in **Table 4.18 and Table 4.19**, unpleasant previous dental experiences were positively correlated with both children's immediate and delayed self-reports of pain when age controlled; thus, children who had unpleasant prior dental experience reported more pain during the event. On the other hand, the extent of parental preparation was negatively correlated with children's pain when age controlled, indicating

that children who had extensive parental preparation reported less pain during the event. These comparative results indicate that these two variables impacted children's stress levels during the event and may have contributed to their remembering.

In addition, there were relations between the physiological reactivity measures and these two individual difference variables. Children who had comparatively little discussion with parents were more likely to report greater pain and anxiety about the dental treatment and had greater HP reactivity. In addition, the quality of previous dental experiences had strong associations with the anxiety indicators such as children's self-reports of pain and anxiety, interviewer's ratings, and general anxiety conditions. Children with unpleasant previous dental experiences had general anxiety in their routine lives and were also judged by the interviewer as showing more anxiety during the interview. Thus, unpleasant previous dental experiences and little or no advance parental preparation may have contributed to greater levels of pain and anxiety about the dental procedure, which may have led to higher stress levels that possibly reduced attention to the surroundings and ultimately caused a poorer remembering of the event.

However, these results should be carefully interpreted as for Study 1, because our measures of the two individual difference variables were rough; the information was based on parental reports. No specific contents of parents' preparations are known, merely that a discussion prior to the visit took place, which may not have been completely accurate. Whatever the content, however, such discussions are positively associated with children's remembering of the event. There is also no information on how traumatic the previous dental experiences were.

Table 4.18

Correlations for Select Anxiety Variables, Previous Negative Dental History, and Parent Preparation

Anxiety Variable	Previous Negative Dental History	Parent Preparation
Immediate hesitancy to disclose	.38**(.27*)	-.35**(-.23*)
Immediate management ease	-.38**(-.27*)	.36**(.24*)
Delayed hesitancy to disclose	.50**(.37**)	-.47**(-.33**)
Delayed Immediate	-.50**(-.37**)	.46**(.33**)
Trait anxiety score[a]	.08	-.28*(-.35**)
State anxiety score[a]	-.25* (-23)	.22* (.20)
Immediate pain rating	.39**(.34**)	-.34**(-.30**)
Immediate anxiety rating	.14	-.21*(-.21)
Delayed pain	.29*(.26*)	-.21
Δ Heart period[b]	.06	-.24*(-.24*)

Note. Numbers in parentheses are controlled for age.
Interviewer's ratings (i.e., hesitancy to disclose by interviewer and management ease by interviewer) were included as the predictor variables used in the analyses of anxiety for the current study and yet those are indicated the quality of child's emotion for the interview rather than the level of anxiety for the event.
[a]State and trait anxiety scores are elements of the STAIC questionnaire (Spielberger et al., 1973). Lower state scores and higher trait anxiety scores indicate higher anxiety in a child's routine life. [b]From first to second period. * $p < .05$, ** $p < .01$.

Table 4.19

Correlations Among Variables Indicating Memory Performance, Children's Dental History, and Parent Preparation

Memory performance	Previous Negative Dental History	Parent Preparation
Immediate total recall	-.58**(-.46**)	.64**(.57**)
Delayed total recall	-.35**(-.29*)	.46**(.42**)
Immediate free recall	-.55**(-.52**)	.44**(.34**)
Delayed free recall	-.41**(-.30*)	.42**(.31**)
Immediate correct rejection	-.06	.15
Delayed correct rejection	.11	-.06
Immediate false alarm	-.02	-.04
Delayed false alarm	-.01	.05

Note. Numbers in parentheses are controlled for age. ** $p < .01$, * $p < .05$.

Stress-coping strategy. Approach-oriented and avoidance-oriented coping styles were the two coping style subgroups based on conceptual contents from the questionnaires and statistically confirmed from factor analysis results. In Study 1, it was demonstrated that the information-seeking coping strategy, an approach-oriented coping style, was associated with total recall. It facilitated more accurate remembering of a stressful event.

To examine if that Study 1 result was supported by the Study 2 data and to further investigate what other associations between coping styles and individual differences might exist, if any, a correlation analysis was conducted. The approach-oriented coping style was positively associated with the extent of the parent's advance preparation and unpleasant previous dental experience. Children who were extensively prepared by parents before the event employed more approach-oriented coping strategies during the dental procedure, and children who had unpleasant previous dental experience did not. On the other hand, avoidance-oriented coping strategies was associated with some anxiety variables including dentist's, interviewer's, parents' and children's reports of anxiety, indicating that children who used more avoidance-oriented coping styles reported greater pain and anxiety during the dental procedure and were judged by the dentist, interviewer, and parents as having a higher level of anxiety about the event (see **Table 4.20**).

Table 4.20

Correlations Coefficients for Coping Styles and Individual Differences

Individual Difference Variables	**Approach-oriented coping**	**Avoidance-oriented coping**
Noncompliance by dentist	.12	.48**(.54**)
Anxiety by dentist	.13	.47**(.52**)
Frankl Behavior Rating Scale	-.11	-.43**(-.43**)
Immediate hesitancy to disclose	-.17(-.24)	.35*(.23*)
Immediate management ease	.19(.26)	-.34*(-.22)
Immediate pain	-.07	.41**(.34**)
Immediate anxiety	.06	.45**(.42**)
Immediate emotion	.13	-.28*(.-21)
Delayed pain	-.01	.40**(.38**)
Delayed anxiety	.11	.43**(.38**)
Pain by parent	-.02	.35**(.39**)
Previous dental history	-.36**(-.38**)	.07
Parent preparation	.34**(.41**)	-.10

Note. Numbers in parentheses are controlled for age. ** $p < .01$, * $p < .05$.

In terms of children's memory performance, the approach-coping style was correlated with children's total recall at both interviews, as presented in **Table 4.21** below. The result was still demonstrated when age was controlled. Thus children who reported using approach-oriented coping strategies during the dental procedure exhibited better recall regardless of age or interview timing. It is possible that parents' advance preparation and no history of unpleasant previous dental experiences may have made children more likely to use more approach-oriented coping strategies during the dental procedure, which would give them better remembering of the event.

On the other hand, avoidance-oriented coping was associated with children's vulnerability to suggestible questions at the delayed interview; children who used more avoidance-oriented coping styles exhibited poorer correct rejection at the delayed interview

By using avoidance-oriented coping actions (i.e., avoidant action, activated escape, emotional expression, resignation) in a dental context, there is a possibility that the surrounding information could not be encoded long term by children's memory processes, thus contributing to errors at the delayed interview. However, caution should be used to interpret these results, because the avoidance-oriented coping style was not associated with children's errors at the immediate interview.

Table 4.21

Correlations Coefficients for Combined Coping Styles and Children's Memory Performance

Memory Performance	Approach-oriented coping	Avoidance-oriented coping
Immediate total recall	.39** (.43**)	-.12 (-.07)
Delayed total recall	.24* (.27*)	-.21 (-.18)
Immediate free recall	.04 (.15)	-.22 (-.11)
Delayed free recall	.01 (.05)	-.23 (-.18)
Immediate correct rejection	-.18 (-.15)	-.22* (-.21*)
Delayed correct rejection	-.07 (-.10)	-.40** (-.39**)

Note. Numbers in parentheses are controlled for age. ** $p < .01$, * $p < .05$.

Receptive language ability and working memory (WM) capacity. Children's general cognitive ability was not examined in Study 1, and thus children's ages in months was the only possible developmental variable that could be used as a covariate for reflecting the children's general cognitive ability. However, considering that there could be a great deal of variability in cognitive abilities even for children of the same age, Study 2 was designed to examine some general cognitive individual difference variables to study more in-depth their effects on remembering of a stressful event.

There were strong correlations between children's memory performance and cognitive individual differences as presented in **Table 4.22**, yet the correlation between

children's memory performance and WM capacity was canceled out when age was controlled. However, there was an interaction between age and WM capacity in that WM capacity was correlated with concomitant increases in free recall for only younger children at both the immediate and delayed interviews. These findings suggest that WM capacity is not an effective predictor of children's remembering of a stressful event for older children.

The receptive language scores were positively associated with children's total and free recall during both interviews. They particularly impacted children's responses to general probes, because the relation was statistically significant even with age controlled. For this cognitive ability there was also an age interaction: increases in receptive language skills were correlated with concomitant increases in free recall for younger children at both immediate and delayed interviews, but not for the older children. These findings suggest that for older children, receptive language skills are not an effective indicator of children's remembering of a stressful event.

Overall, WM capacity and receptive language ability were not associated with older children's remembering of a stressful event. However, those cognitive abilities significantly accounted for the variance in younger children's remembering of a stressful event.

Table 4.22

Correlations Between Children's Memory Performance, Working Memory Capacity, and Receptive Language Ability

	Working memory capacity			Receptive language ability		
Memory Performance	**Total/Average**	**Older children[a]**	**Younger children[b]**	**Total/Average**	**Older children[a]**	**Younger children[b]**
Immediate total recall	.23*(.05)	-.08	.21	.32**(.11)	.20	.24
Delayed total recall	.18 (.01)	-.19	.10	.26* (.09)	.06	.11
Immediate free recall	.39** (.14)	-.19	.37*	.66**(.52**)	.26	.55**
Delayed free recall	.44**(.28*)	.01	.53**	.51**(.32**)	.14	.55**
Immediate correct rejection	.26*(.02)	-.24	.19	.39**(.19)	.16	.34*
Delayed correct rejection	.03(.12)	-.17	-.07	.21(.16)	.07	.19
Immediate false alarm	-.37** (-.11)	.13	-.36*	-.40**(-.14)	-.21	-.39*
Delayed false alarm	-.23 (.05)	.11	-.15	-.35**(-.12)	-.06	-.37*

Note. Numbers in parentheses are controlled for age. [a]7- to 9-year-olds. [b]4- to 6-year-olds. ** $p < .01$, * $p < .05$.

Hierarchical Multiple Regression Findings.

The central focus of this exploratory study was the extent to which selected individual difference variables may explain some of the variation in children's remembering of a stressful event. This issue was examined by performing a series of hierarchical regression analyses, in which measures of individual differences were used as predictors of the three major dependent measures of memory performance (i.e., total recall, free recall, and suggestibility) similarly to those conducted Study 1. The same strategy was followed in each analysis. Only the individual difference variables that correlated with the dependent measure at the .10 level were included as predictors.

Age was always the first step in the hierarchy, given its importance to children's memory performance. Each following step examined the incremental contributions beyond age of the additional predictors. In the second step, the additional predictor was entered after age when it met the criterion for inclusion in the model. Step 2 was designed in this manner so that it could be determined if the additional predictor added significantly to the amount of variability explained by age alone. Next, in series of separate regression analyses, each of the variables identified in the correlation analyses described earlier was entered as a third step after age and the additional predictor variables to test whether its presence could add significantly to the prediction made by the first two predictors.

Only those individual difference variables that added significantly to the amount of variability explained by age and the additional predictors are discussed. Similarly, although the data were examined for all assessments, only the significant models are reported.

Total recall. According to **Table 4.23**, the first step demonstrated that 10 % of the children's total recall variance at the immediate and 6% at the delayed interview could be explained simply by children's ages in months, which was not higher than expected. Each subsequent step examined the incremental contributions beyond age of any additional predictors. Given that extensive parental discussions about the dental visit were highly associated with children's memory performances, the variable was entered after age when it met the criterion for inclusion in the model. The second step explained more about the variance of children's total recall at the immediate and delayed interviews, 43%, and 23% respectively. Those percentages were greatly improved, indicating that parental preparation was a strong indicator for both recalls but more so for immediate responses.

Next, given that previous negative dental experiences as reported by parents were strongly associated with children's memory performances based on the prior correlation analyses, it was added to the model in Step 3. The variable explained 48% and 24% respectively of the variance of children's total recall at the immediate and delayed interviews. This variable also influenced immediate memory more than delayed memory.

The fourth step added the approach-oriented coping strategy variable, because it was likely to account for some variances in the children's memory performances based on prior correlation analyses. This final step explained 50% and 24% respectively of the variance in children's total recall at the immediate and delayed interviews. All the variables entered in the final model explained a significant amount of unique variance in total recall at the immediate interview; however only the parental preparation variable explained a significant amount of unique variance in total recall for the delayed interview. Yet, the final model including all the variables explained a great deal of variances in total recall at both

interviews, indicating that not only children's ages but their previous dental experiences, advance preparation for the event by parents, and coping styles should be considered when trying to understand the underlying mechanisms of the relation between stress and children's remembering of a stressful event.

Table 4.23

Hierarchical Multiple Regressions of the Predictor Variables on Total Recall by Interview.

		Immediate Interview				Delayed Interview			
	Model	**Standardized β**	**R^2**	***t***	**Sig.**	**Standardized β**	**R^2**	***t***	**Sig.**
Step 1:	Constant			10.93	.00			9.84	.00
	Age in months	.32	.10	3.04	.00	.25	.06	2.15	.04
	Constant			13.77	.00			11.09	.00
Step 2:	Age in months	.13		1.55	.13	.08		.72	.47
	Parent preparation	.61	.43	6.95	.00	.44	.23	3.89	.00
	Constant			13.30	.00			9.28	.00
Step 3:	Age in months	.10		1.16	.25	.07		.57	.57
	Parent preparation	.45		4.30	.00	.39		2.86	.01
	Previous dental history	-.27	.48	-2.60	.01	-.09	.24	-.65	.52
	Constant			8.33	.00			6.22	.00
Step 4:	Age in months	.15		1.72	.09	.09		.78	.44
	Parent preparation	.40		3.94	**.00**	.36		2.56	**.01**
	Previous dental history	-.22		-2.08	**.04**	-.07		-.48	.63
	Approach-based coping	.21	.50	2.48	**.02**	.11	.24	.92	.36

Note. R^2 = the proportion of variation explained by the model, Sig. = significance. Boldfaced variables explained a significant amount of the unique variance in total recall responses.

Free recall. For the examination of children's free recall, the first step explained 25% and 18% of the variance at the immediate and delayed interviews respectively (see **Table 4.24**). Thus, children's ages in months accounted for more variance in free recall than total recall. This makes sense considering that children's free recall relies on their developmental abilities.

Because children's free recall depends on children's language abilities, the receptive language score variable were entered on Step 2 when it met the criterion for inclusion in the model. This second model explained 18% of the variance in children's free recall at the immediate interview and 7% at the delayed interview. Children's language ability explained more variances in their immediate, rather than delayed, recall. Next, given that parental preparation was strongly related to children's memory performance on the prior correlation analyses, it was added in Step 3 when it met the criterion for inclusion in the model. This step explained 47% and 32% respectively of the variance in children's free recall at the immediate and delayed interviews.

The fourth variable added was the quality of previous dental experience. It explained 53% of the variance in children's free recall at the immediate interview and 33% at the delayed interview. Both children's receptive language ability and their previous dental experience accounted for a significant amount of the unique variance in free recall at the immediate interview, yet only the receptive language ability explained a significant amount at the delayed interview. Thus, children's previous dental experiences did not impact their remembering at the delayed interview as much as at the immediate one, which is consistent with the model on total recall. It's possible that the children's previous dental

experiences may have influenced their stress levels, thereby making them more likely to affect their immediate, rather than delayed, remembering.

Finally, the children's immediate reports of pain and anxiety variables were added when they met the criterion for inclusion in the model. This final model explained 58% and 42% respectively about the variance of children's free recall at the immediate and delayed interviews. Children's receptive language ability, quality of previous dental experience, and immediate reports of pain accounted for a significant amount of unique variance in free recall at the immediate interview, yet none of these variables explained a significant amount of the unique variance in free recall at the delayed interview.

In summary, quality of their previous dental experiences, immediate reports of pain, and receptive language abilities explained a significant portion of the variance in immediate recall.

Table 4.24

Hierarchical Multiple Regressions of the Predictor Variables on Free Recall at Both Interviews.

	Model	Immediate Interview				Delayed Interview			
		Standardized β	**R^2**	***t***	**Sig.**	**Standardized β**	**R^2**	***t***	**Sig.**
Step 1:	Constant			-1.74	.09			-.91	.37
	Age in months	.50	.25	5.04	.00	.43	.18	3.87	.00
Step 2:	Constant			-4.80	.00			-2.45	.02
	Age in months	-.08		-.54	.59	.05		.25	.80
	Language	.72	.43	4.97	.00	.48	.25	2.64	.01
Step 3:	Constant			-4.35	.00			-1.87	.07
	Age in months	-.09		-.63	.53	.02		.08	.93
	Language	.65		4.46	.00	.39		2.15	.04
	Parent preparation	.20	.47	2.16	.03	.25	.32	2.10	.04
Step 4:	Constant			-2.34	.02			-.91	.37
	Age in months	-.08		-.61	.54	.01		.08	.94
	Language	.58		4.14	.00	.35		1.91	.06
	Parent preparation	.02		.18	.86	.16		1.20	.24
	Previous dental history	-.33	.53	-3.16	.00	-.17	.33	-1.20	.23
Step 5:	Constant			-1.94	.06			.62	.54
	Age in months	-.05		-.35	.73	.02		.13	.90
	Language	.54		4.03	**.00**	.27		1.54	.13
	Parent preparation	-.01		-.10	.93	.12		.91	.37
	Previous dental history	-.39		-3.67	**.00**	-.10		-.72	.48
	Immediate anxiety	.21		1.94	.06	-.24		-1.76	.08
	Immediate pain	-.28	.58	-2.86	**.01**	-.13	.42	-1.06	.30

Note. R^2 = the proportion of variation explained by the model, Sig. = significance. Boldfaced variables explained a significant amount of the unique variance in false alarm.

False alarms. Examining children's memory errors is important because they provide information on children's vulnerability to suggestible questions and how their errors might increase or decrease on delay. This analysis was completed using false alarm values rather than correct rejection values because false alarm responses are a negative measure of children's suggestibility.

Age was the first step in the hierarchy given its importance in children's memory performance from a developmental perspective. The first step explained 16% and 13% of the variance in children's false alarm responses at both the immediate and delayed interviews respectively (see **Table, 4.25**). Considering that children's self-reports of stress were likely to account for some variances in the children's errors based on the correlation analyses, their immediate report of anxiety variable was entered after age when it met the criterion for inclusion in the model. The second step explained an additional 3% and 4% more, respectively, about the variance in children's errors at the immediate and delayed interviews.

The frequency of the children's experiences with this particular dentistry may have affected their ability to reject some features that didn't happen to them, and so this variable was added in Step 3, when it met the criterion for inclusion in the model. The step explained 26% of the variance in children's immediate false alarm responses and 21% for their delayed responses. Thus, the amount of experience with this particular dentistry did affect the children's recall at both interviews. Yet this variable was not related to any of the anxiety indicators except for parents' reports of pain and anxiety, indicating that the parents believed their children's pain and anxiety were less if they had had more experience with this particular dentistry, $r = -.28$, $p < .01$ for parents' report of pain; $r = -.21$, $p = .06$ for parents' reports of anxiety.

The fourth step was the avoidance-oriented coping strategy variable, because that coping style was possibly associated with children's errors in terms of understanding suggestible questions. This final step explained 27% and 25% of the variance in children's false alarm responses at the immediate and delayed interviews respectively.

Children's ages in months and the frequency of their experiences with this particular dentistry explained a significant amount of the unique variance in children's false alarms responses at the immediate interview. Those variables and the avoidance-oriented coping style variable explained a significant amount of the unique variance in children's errors at the delayed interview, indicating that children who used that coping style during the dental procedure gave more false alarm answers at the delayed interview.

In contrast to the models for total and free recall, the variables entered in this model explained similar amounts of the variances for both interviews.

In summary, children's immediate and delayed recall may differ as a function of age, specificity of memory prompt, stress level, and a range of individual differences. Thus, integrative consideration should be used to interpret children's remembering of a stressful event with a range of potential indicators as demonstrated by these results.

Table 4.25

Hierarchical Multiple Regressions of the Predictor Variables for Children's False Alarm Responses at Both Interview.

		Immediate Interview				Delayed Interview			
	Model	**Standardized β**	R^2	***t***	**Sig.**	**Standardized β**	R^2	***t***	**Sig.**
Step 1	Constant			5.34	.01			5.41	.01
	Age in months	-.40	.16	-3.80	.01	-.36	.13	-3.14	.01
Step 2	Constant			3.96	.01			3.88	.01
	Age in months	-.37		-3.58	.01	-.33		-2.83	.01
	Immediate anxiety	.19	.19	1.86	.07	.19	.17	1.67	.10
Step 3	Constant			4.81	.01			4.40	.00
	Age in months	-.37		-3.69	.01	-.33		-2.87	.01
	Immediate anxiety	.19		1.92	.06	.19		1.70	.10
	Experience with dentist	-.25	.26	-2.53	.01	-.22	.21	-1.93	.06
Step 4	Constant			3.80	.01			3.02	.00
	Age in months	-.37		-3.63	**.01**	-.31		-2.81	**.01**
	Immediate anxiety	.17		1.57	.12	.14		1.17	.25
	Experience with dentist	-.24		-2.44	**.02**	-.19		-1.71	.09
	Avoidance-based coping	.10	.27	.92	.36	.21	.25	1.80	.08

Note. R^2 = the proportion of variation explained by the model, Sig. = significance. Boldfaced variables explained a significant amount of the unique variance in false alarm.

Exploratory Factor Analyses Findings

Exploratory factor analyses were used to describe variability among stress-coping strategies that the children used during the dental procedure, among the observed anxiety variables, and to assess different influences on children's remembering of a stressful event.

Stress-coping strategies. Stress-coping strategy data were classified according to the items on the KIDCOPE and HICUPS; How I Coped Under Pressure Scale measure (Spirito, Stark, & Williams, 1988; Ayers, Sandler, West, & Roosa, 1996). Over 15 items were combined into seven groups: mood elevation (3 items), avoidant actions (3 items), activated escape (2 items), social support (3 items), information-seeking (2 items), emotional expression (1 item), and resignation (1 item). Those seven coping styles were grouped into two major groups based on following factor analysis results: approach-oriented coping styles and avoidance-oriented coping styles.

Using principle component extraction, two factors with eigenvalues greater than 1 were extracted (see **Figure 4.2**). As presented in **Table 4.26**, Factor 1, avoidance-oriented coping style, was heavily loaded with activated escape, avoidant actions, emotional expression, and resignation. Factor 2, approach-oriented coping style was loaded with mood elevation, social support, and information-seeking. These labels reflected the overall theme regarding children's stress-coping strategy for each factor.

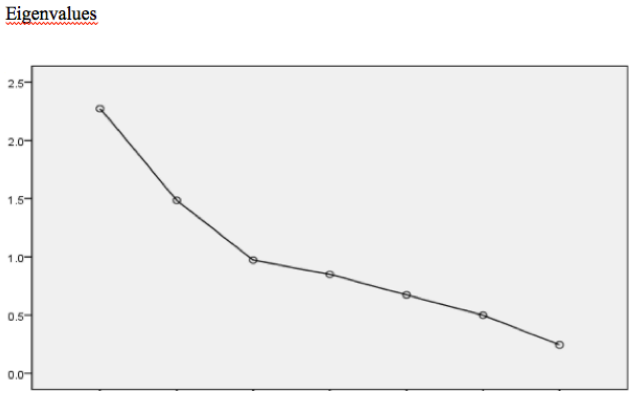

Figure 4.2 Scree plot of eigenvalues for the coping strategy variables.

Table 4.26

Factor Loading Matrix for the Coping Behaviors

Coping Behavior	Factor 1	Factor 2
Mood elevation	-	0.79
Avoidant action	0.41	0.25
Social support	0.46	0.75
Activated escape	0.88	-
Information seeking	0.29	0.40
Emotional expression	0.82	-
Resignation	-0.70	-

Note. Absolute values of factor loading < .20 are suppressed for simplicity. Factor 1 is avoidance-oriented coping style and Factor 2 is approach-oriented coping style.

Anxiety variables

There were 21 anxiety variables in the 7 identified factors with eigenvalues greater than 1.00 were extracted (see **Figure 4.3**). According to **Table 4.27**, Factor 1 was heavily loaded with the dentist's ratings and behavioral stress reactivity. Factor 2 was loaded with the interviewer' ratings. Factor 3 was loaded with the children's self-reports of pain and anxiety and their state anxiety scores. Factor 4 was loaded with VT reactivity. Factor 5 was loaded with parent's reports of the children's pain and anxiety. Factor 6 was loaded with only HR reactivity. Factor 7 was loaded with the children's self-reports of emotional state during the interview.

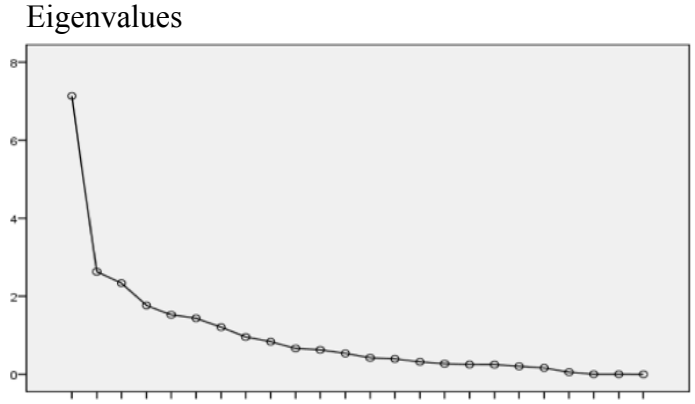

Figure 4.3 Scree plot of eigenvalues for 24 anxiety variables

Table 4.27

Factor Loading Matrix for Anxiety Variables

Anxiety Variable	Component						
	1	2	3	4	5	6	7
Noncompliance by dentist	**.96**	-.32	-	-	-.31	-	-.37
Anxiety by dentist	**.95**	-.31	-	-	-.29	-	-.35
Frankl Behavior Rating Scale by dentist	**-.91**	.33	-	-	.34	-	.40
Immediate hesitancy to disclose	.35	-.38	-	-	**-.85**	-.30	-.29
Immediate management ease	-.34	.38	-	-	**.85**	.31	.29
Delayed hesitancy to disclose	-	-.27	-	-	**-.92**	-	-
Delayed management ease	-	.27	-	-	**.92**	-	-
Trait score[a]	-	**-.61**	-.24	-	-.31	-	-
State score[a]	-	**.69**	-	-	.27	.37	-
Immediate pain	.32	**-.72**	.27	-	-.45	-	-
Immediate anxiety	.31	**-.83**	-	-	-.39	-	-.23
Immediate emotional state	-.31	-	-	-	.20	**.77**	.24
Delayed pain	.45	**-.70**	.39	-	-.26	-	-
Delayed anxiety	.55	**-.76**	-	-	-.25	-	-.23
Delayed emotional state	-	-	-	-	-	**.86**	-
Pain by parent	.28	-	.20	-	-	-	**-.91**
Anxiety by parent	.30	-	-	-	-	-	**-.89**
Behavioral stress reactivity	**.72**	-.31	.45	-	-.36	-	-.29
Δ mean arterial pressure[b]	.53	-	**.52**	-	-	-	-.35
Δ pulse rate[b]	.46	-	**.61**	-	-.22	-.28	-.20
Δ vagal tone[c]	-	-	**.78**	-	-	-	-.24
Δ vagal tone[d]	-	-	**.80**	-	-.22	-	-
Δ heart period[d]	-	-	-	**-.90**	-	-	-
Δ heart period[c]	-	-	-	**-.81**	-	-	-

Note. Absolute values of factor loading < .20 are suppressed for simplicity. [a]State and trait anxiety scores are elements of the State and Trait Anxiety Inventory for Children (Spielberger et al., 1973). Lower state scores and higher trait anxiety scores indicate higher anxiety in a child's routine life. [b]From before and after the event. [c]From the first to third period. [d]From the first to second period. Factor 1 includes dentist ratings and behavioral responses to stress, Factor 2 includes child self report of pain and anxiety and general anxiety status, Factor 3 includes pulse rate, blood pressure, and vagal tone reactivity, Factor 4 includes heart period reactivity, Factor 5 includes interviewer's ratings, Factor 6 includes child's emotional status during the interview session, Factor 7 includes parent's report of child's pain and anxiety.

According to **Table 4.28**, Factor 2, the interviewer's ratings of hesitancy and ease of management, were highly correlated with the children's memory. Factor 5, parents' reports of the children's pain and anxiety, was also highly correlated with children's memory except for correct rejection and false alarm responses. Factor 7, the children's self-reports of emotion state during the interview, was highly correlated with children's errors at the delayed interview.

In summary, stress-coping strategies grouped into two factors, negative coping styles and positive coping styles, as expected. They were labeled avoidance-oriented coping strategies and approach-oriented coping strategies in this study. According to the study's results, approach-oriented coping strategies positively contributed to children's remembering of a stressful event and avoidance-oriented coping strategies did not.

For the range of anxiety indices, the dentist's ratings and the children's behavioral reactivity accounted for the highest percentages of the total anxiety variance, yet they were not related to the children's remembering in the study.

Among the 24 anxiety variables we observed, the dentist's ratings, behavioral responses to stress, children's self-reports of pain, anxiety, and general anxiety status and some of the biological variables (i.e., PR, BP, and VT reactivity) explained over 50% of the total variance in anxiety variables. However, the children's self-reports and the interviewer's ratings were most related to the children's remembering of the stressful event.

Thus, it is reasonable to conclude that each of the anxiety variables may have different influences on children's remembering of a stressful event, and it is worthwhile to further explore the extent to which each is appropriate for investigating the relation between stress and remembering across ages.

Table 4.28

Correlations Among Factor Loading Values and Children's Recall

Recall Type	**Component**						
	Factor **1**	Factor **2**	Factor **3**	Factor **4**	Factor **5**	Factor **6**	Factor **7**
Immediate total recall	-.13	.43**(.41**)	-.22	.05	.47**(.32**)	-.07	.21
Immediate free recall	-.05	.32**(.28*)	-.07	-.07	.63**(.46**)	-.10	.02
Immediate correct rejection	-.13	.01	.09	.14	.29*	-.04	.08
Immediate false alarm	.10	.02	-.05	-.01	-.25*	.05	-.08
Delayed total recall	-.20	.31**(.29*)	-.18	.20	.34**(.24*)	-.04	.09
Delayed free recall	-.22	.35**(.32**)	-.15	.07	.68**(.58**)	-.12	.16
Delayed correct rejection	-.12	.15	.00	.10	.20	.16	.29*(.29*)
Delayed false alarm	.09	-.11	.07	.06	-.31**	-.04	-.29*(-.28*)

Note. Factor 1 includes dentist ratings and behavioral responses to stress, Factor 2 includes child self report of pain and anxiety and general anxiety status, Factor 3 includes pulse rate, blood pressure, and vagal tone reactivities, Factor 4 includes heart period reactivity, Factor 5 includes interviewer's ratings, Factor 6 includes child's emotional status during the interview session, Factor 7 includes parent's report of child's pain and anxiety.

CHAPTER 5

DISCUSSION

Conclusions

The purpose of Studies 1 and 2 was to explore linkages between stress and a range of individual difference variables on children's remembering of a naturalistic, personally experienced, stressful event. As described in Chapter 2, the study had three specific aims. In this discussion, we will explore those aims and the associated hypotheses, though there will be a fair bit of overlap due to the interrelatedness of the variables effects on each other, stress levels, and children's remembering.

Study Aim 1: Age Differences and Delayed Recall when Remembering Stressful Events

The results replicated and extended previous findings regarding age-related changes in children's memories of a stressful event. Age effects were apparent in total recall and free recall during both the immediate and delayed interviews. As has been consistently demonstrated in the literature (Ornstein et al., 1997), older children provided more total information and reported a greater proportion of the features of the dental treatment in response to general probes rather than specific questions than did younger children.

Effects of types of questioning. Although there were no age differences in the children's specific recall in response to yes/no questions, this result should not be interpreted as indicating that developmental differences in memory performance can be eliminated in the presence of appropriate task supports, which were question categories in this case. Rather, because the questioning was hierarchically determined, meaning that more specific questions were eliminated if the answers were already given in the open-ended portion of the interview, Namely, the more a child recalled information at the free recall level, the fewer specific questions were asked. Therefore, the specific recall is not independent of the free recall. Thus, the number of items measured by specific questioning varied.

The examination of children's memory performance with an emphasis on free recall is significant not only for greater credibility and sensitivity associated with this measure (Gordon & Follmer, 1994), but also for the real-world, practical perspective. Adherence to evidence-based interview strategies can optimize children's recall and take into account some of the specific difficulties experienced by maltreated children, such as difficulty in providing a free narrative account. Indeed, experimental and field research have suggested that using an interview protocol that emphasizes open-ended questioning, while reducing interviewer input, can elicit relatively detailed accounts from children without negative sequelae. For example, the interview protocol developed and evaluated by Lamb and his colleagues at the National Institute of Child Health and Development entails seeking elaboration on information the child has already reported; this approach has been found to elicit detailed and accurate reports without compromising the rate of sexual abuse disclosure (Lamb & Brown, 2006; Pipe et al., 2007). Such approaches to forensic interviewing may help overcome the difficulties faced by the maltreated child, reducing the demand for a response assumed in a

closed question and providing nonleading retrieval cues (i.e., the child's own words) that can encourage and structure a more complete search of his or her memory.

Thus, it should be aware that free recall questions would be best suited for eliciting accurate information when considering children's memory of a stressful event.

Overall comparable patterns of remembering and forgetting over time were observed; older children remember better than younger children both at immediate and delayed interviews overall and more interestingly younger children demonstrated less forgetting at delayed interviews, regardless of stress levels. More specifically, memory did not decrease significantly at the delayed interview for younger children but memory, free recall in particular, did decrease significantly at the delayed interview for only older children, indicating that older children's free recall appeared to have declined over the week while the amount of inaccurate information remained stable. In addition, older children provided significantly more correct rejections on absent features than younger children, which is the consistent results of previous literature demonstrating that younger children are more vulnerable to suggestible questions than older children (e.g., Baker-Ward et al., 1993; Ceci & Bruck, 1993 for a review). However, it is worthwhile to note that younger children seem to be able to exhibit correct rejection at later interview with the comparable level of the accuracy as the immediate interview even though younger children happen to be more vulnerable to suggestible questions compared to older children.

It must be emphasized that because one week is not comparable to the delay intervals typically experienced in legal settings, the results should not be taken to indicate that younger children's memory performance would be better at a delayed interview than immediately after experiencing an event.

Study Aim 2: Relation Between the Level of Stress and Children's Remembering

Whether or not stress levels were linked positively or negatively to children's remembering was difficult to determine. The results suggest that the answer depends not only on the way in which stress is measured but also on various individual difference variables, such as cognitive and social-emotional factors, and the extent of parents' preparation of the child for the visit, as well as the previous negative dental experiences. There is considerable controversy in the field about the magnitude and direction of the association between stress and children's memory, but the findings from Studies 1 and 2 are consistent with a negative relation between stress and remembering, which in turn supports Chen et al.'s (2000) argument that stress has debilitative effects on memory.

This association is qualified in several important respects. First the children's behavioral responses to stress and the anxiety ratings of parents, dentist, and children were negatively related to children's remembering. In contrast, measures of the children's biological reactivity, such as vagal tone reactivity and heart period reactivity, were less associated with remembering, with the exception of children's "don't know" responses, demonstrating that children who revealed greater heart period reactivity during the dental procedure exhibited more "don't know" responses, both for present and absent features at the immediate interview.

Second, the linkage between the level of stress and recall was observed most clearly in children's later remembering rather than immediate remembering, especially with regards to the linkage between the behavioral responses to stress and later recall. Thus, the present data are consistent with the argument that stress experienced during the to-be-remembered event interferes more with subsequent retrieval than with early encoding in the memory

system (Ornstein, Ceci, & Loftus, 1998). Younger children revealed behavioral responses to stress more than older children, although there was no statistical significant difference between the two groups. However, there was an age difference in biological reactivity, indicating that younger children revealed greater biological reactivity than the older children during the dental procedure, which was the consistent finding from the previous literatures (Alkon et al., 2003; Boyce et al., 2001).

Although Quas et al. (2006) found that sympathetic stress reactivity enhanced children's memory, but in the present study no reliable pattern of enhanced recall due to higher stress reactivity was observed across a range of anxiety predictors recorded from physiological and behavioral responses to stress and post-hoc reports from parents, children, and the dentist.

It has been known that sympathetic reactivity is different from parasympathetic reactivity. Quas et al. (2006) demonstrated PEP (pre-ejection period) score as an indicator of sympathetic reactivity, but in the current study sympathetic reactivity was not recorded sympathetic reactivity; rather, the children's vagal tone reactivity and heart period reactivity were recorded. Vagal tone has been used as a main indicator of child's parasympathetic reactivity and heart period is the result of multiple factors including sympathetic, parasympathetic, and homeostatic influences on the heart. Thus, the different results of stress effects between Quas et al. (2006) and the current study are difficult to compare because different measures of stress reactivity were employed in each study. At least, regarding vagal tone reactivity, which is the only biological reactivity score that both studies were demonstrated, the results are fairly consistent, indicating that children who had greater vagal tone reactivity during the event exhibited poorer remembering of the dental treatment. However, the significance of the association between vagal tone reactivity and children's

remembering was only marginal in this study and there was no interaction between stress level and age on children's remembering, in contrast to the results of Ques et al. (2006).

As such, a consideration of several other methodological differences between this project and prior research may contribute to the contrasting patterns of results. First, the stressful events are hard to compare, as one was a laboratory incident and the other was a naturally occurring event (e.g., dental operative procedures in the present study; inoculation clinics in Goodman et al., 1991; VCUG procedures in Merritt et al., 1994; a fire alarm in Quas et al., 2004, 2006). Second, memory was assessed immediately following the event and one week later, whereas in previous studies, memory was assessed after a delay ranging from one to six months (Ornstein et al., 2006; Steward & Steward, 1996). Moreover, in assessing stress levels, we recorded not only biological and behavior stress reactivity but also reports from parents, children, and the dentist, because relying exclusively on Likert ratings may not adequately assess children's stress levels. Thus, comparisons across research settings are difficult because raters used dissimilar criteria when rating children's stress levels.

Looking into the range of anxiety indicators measured in this study, the dentist's ratings of child's anxiety about the dental procedure were correlated with children's later recall, which is the consistent results of Merritt et al (1994), demonstrating that the more fearful children were judged to be by a medical technologist, the less they recalled of the procedure. In addition, children, especially the younger children, who self-reported greater anxiety about the dental procedure remembered less and were more vulnerable to suggestible questions than children who reported less pain and anxiety about the dental procedure. Their self-report of anxiety was highly correlated with their recall in response to general probes ($r = -.45$, $p < .01$). It could be surmised that children's self-report of anxiety, particularly

younger children, could be an essential criterion for predicting the level of children's memory for the details of a stressful event.

In terms of remembering of the level of pain or anxiety regarding a dental treatment, there was an age by delay interaction, such that older children were more consistent in their reports of their pain intensity after a 1-week delay, compared to younger children, whose reports of pain levels decreased significantly from the immediate interview to the delayed interview. In addition, children who reported the higher level of general anxiety in their routine life seemed to report greater pain and anxiety for the dental treatment. This result is inconsistent with the findings of Huq et al (1992) who demonstrated that state anxiety from the STAIC questionnaires did not affect children's self-reported discomfort with dental treatment. Yet given that the subjectively selected items of the state questions were employed for this study, in contrast to the study of Huq et al (1992), direct comparison of the two different results should not be advised.

In summary, there is evidence to support the argument that stress is negatively related to children's remembering of a stressful event. Among various anxiety measures, behavioral responses to stress seems to be more associated with child's memory than biological reactivity during the event. In addition, a child's self report of pain would be a reliable indicator of children's both immediate and delayed remembering of an event more than a parent's report of a child's pain. Dentist's ratings of child's level of stress would be also reliable indicators of children's later remembering of the event.

Based on the absence of relation between the biological measures of stress and children's memory, the relation between stress and children's memory of a stressful event might be mediated in part by what children do to manage the stress they experience, rather than the level of stress *per se*.

Study Aim 3: Individual Difference in the Relation Between the Level of Stress and Children's Remembering

The inconsistent findings, to date, concerning the effects of stress on children's memory have led researchers to focus on determining the ways in which individual characteristics may moderate the impact of stress on memory. Accordingly, there has been a significant upsurge in the efforts to identify individual characteristics that are predictive of children's memory capacity. Investigating a range of individual difference factors could help to explain why children, even those in the same age group, have performed so differently when remembering certain events.

Although many authors (e.g., Bruck & Melnyk, 2004; Ornstein & Elischberger, 2004) have reviewed various predictive strategies for understanding the effects of individual differences factors on children's memory and suggestibility, there is no agreement on the specific moderators of children's recall of stressful events. However, a number of individual characteristics have been identified as potentially important sources of variability in children's recollections of stressful events. In the current study, several social-emotional factors – such as children's temperament, stress-coping strategies, personal dental histories, parental preparations of children for the event – and cognitive factors – such as receptive language ability and working memory capacity – were particularly considered as potentially important sources of variability in children's recollections of stressful events.

Effects of prior experiences and advance parental preparation.

The findings in Studies 1 and 2 that the previous negative dental experiences and extent of parents' advance preparation of the child for the event, were strongly correlated

with children's remembering are very interesting. These two variables were demonstrated to impact to the intensity of children's pain in the current dental treatment, regardless of age; thus, it seems likely that these variables influence the children's level of stress during the current dental visit and impact children's remembering of the visit. These two variables were also related to children's physiological reactivity during the dental procedure, such that children who had comparatively little or no discussion with parents in advance about the visit were more likely to report higher pain and anxiety about the dental treatment and indeed revealed greater physiological reactivity during the dental procedure, in comparison with children who had extensive discussion with their parents. In addition, previous negative dental experience also appears to have strong associations with the anxiety indicators of the current dental treatment, such as the children's self reports of pain and anxiety, interview ratings, and with general anxiety condition.

It thus seems possible that unpleasant previous dental experience and comparatively little or no preparation may be linked to higher pain and anxiety during the dental procedure and may lead children to pay less attention to their surroundings, eventually resulting in poorer remembering. However, interpretations should be tentative, because the only measures of those variables were based on parental reports, which may not have been completely accurate. It is worth noting that no specific contents of parents' preparations of children for the dental procedures are known, merely that a discussion prior to the visit took place. Whatever the content, such discussions were positively associated with children's memory of the event. Given these findings, further studies should investigate in depth the effects of prior traumatic dental experiences and the specific information that may be provided by parents to soothe their children as they prepare for dental treatment.

The effects of past experiences on children's recall have been well documented within the literature (Hudson, 1990; Hudson & Nelson, 1986). Such studies have demonstrated that children give temporally ordered, relatively general, and abstract reports, rather than specific instances from one particular event when asked what happened during a familiar event. However, past experience has also led to inaccuracy recounting typical activities within such events, and novel actions have been recalled with more accuracy (Fivush, 1984; Hudson, 1990; Myles-Worsely, Cronmer, & Dodd, 1986).

Prior research has indicated that children may use general knowledge of an event even when reporting episodic instances (Ornstein et al., 2006). Indeed, all children in this study had some familiarity with the event (i.e., more than one prior visit to a pediatric dentistry; children on their first visit were excluded from the study, in addition, the school-aged children had contact with dental checkup in school). As such, they may have relied on a general script for going to the dentist, rather than attempting to recall the specific episode experienced when responding to the memory questions. However, the memory questions were designed to elicit an episodic report rather than a general one (e.g., "What happened when you went into the treatment room in this dentist's office today?" rather than "What usually happens when you visit the dentistry?"). In addition, memory was assessed immediately after the event and a week later; thus, long-term memory of a general script for what usually happens at a pediatric dentist's office may not have been accessed due to the short passage of time.

Applicability to criminal cases. As discussed in the literature review, children interviewed in forensic contexts are likely to experience complex difficulties that impair their abilities to retrieve experiences from memory and report them during an interview. Deprived of the opportunity for elaborative and emotion-rich conversations and exposed to parental

invalidation, many maltreated children are unskilled at retrieving a coherent narrative account of their experiences (Cicchetti & Toth, 2005; Greenhoot et al., 2009). This may render children vulnerable to suggestion and influence their abilities to cooperate during interviews. Indeed, this study demonstrated that advance discussions that parents may have with their children may be associated with positive gains in children's memory of stressful events. Accordingly, the extent of parents' advance preparation is likely to affect children's subsequent recall, and the importance of previous discussions could also carry great weight in validating children's eyewitness accounts (Dorado & Saywitz, 2001).

Effects of social-emotional individual difference variables.

In terms of social-emotional individual differences, the approach-based coping style, combined with mood elevation, information seeking, and social support as reported by children right after their dental treatment, was positively associated with both immediate and delayed total recall. This finding is consistent with the hypothesis that children who used approach-based coping styles during the dental procedure were more likely to exhibit enhanced memory. However, the results of Study 2 did not support the argument that the information-seeking facet, in particular, would be related to better recall, as had documented in previous research (Ornstein, Manning, & Pelphrey, 1999).

In addition, this investigation does not support the idea that avoidance-oriented coping styles are negatively associated with working memory capacity (e.g., Compas, Campbell, Robison, & Rodriguez, 2009). However, avoidance oriented coping was strongly associated with children's suggestibility at later remembering, indicating that children who used more avoidance-oriented coping behaviors during the dental procedure were more vulnerable to suggestible questions (i.e., higher false alarm) at the delayed interview. Given

that avoidance-oriented coping consists of distracting and moving oneself away from the stressful situation, the resultant higher errors on suggestible questions were expected. However, the avoidance-oriented coping strategy was associated with the children's suggestibility at the delayed interview, rather than the immediate interview, is worthy of further investigation. Perhaps, children's stress coping strategies tend to have more influences on children's later remembering than immediate remembering. The finding that the use of an avoidance-oriented strategy would be linked to children's later remembering could also be relevant for understanding children's performance in legal settings, given that children are often interviewed about salient, personally-experienced, events after a fair amount of time since the event has elapsed.

In addition, the extent of parental preparation for the visit and the children's previous negative dental experiences were strongly correlated with children's coping strategies, indicating that children who had received extensive parental preparation or had no unpleasant dental experience previously tend to report that they employed more approach oriented coping styles during the dental procedure, and apparently these techniques are likely to help to facilitate children's memory. On the other hand, the use of an avoidance-oriented coping style was associated with a range of anxiety indicators, including dentist, interviewer, parent and self-report of ratings of the anxiety regarding dental procedure, demonstrating that children who reported the use of more avoidance-oriented coping style during their dental procedure reported a greater pain and anxiety of the dental procedure and those children were also judged by the dentist that they had expressed higher anxiety level than other children.

Despite finding that the individual difference variables mentioned here were related to individual variation in children's memory, the complete absence of certain hypothesized associations is also notable. Parental reports of children's temperament were unrelated to

children's remembering and to the level of stress observed in Study 2, which is contrary to previous results (Burgwyn-Bailes et al., 2001; Merritt et al., 1994). This difference might be due to the different temperament measures used in the different studies, namely the Temperament Assessment Battery for Children (Martin, 1988) versus Children's Behavioral Questionnaire (Rothbart et al., 1994). However even among studies that used the same temperament measures, the association between temperament and recall has not been consistently observed (Imhoff & Baker-Ward, 1999).

Greenhoot et al. (1999) indicated that temperament dimensions may be more important among younger children and in interactions with the task setting (e.g., reenactment of events with props versus verbal interviews). Considering that temperament measures were originally designed for 3- to 7-years-olds, our analysis was conducted only on children of those ages, but still no interesting linkages were observed.

As such, future research should test well-focused hypotheses that specify interactions between clearly delineated aspects of memory performance and particular dimensions of temperament. In addition, those relations should be explored for how they affect children's remembering across age, such as examining how effortful control may influence older children's memory performance but how negative affectivity might be a central variable on younger children's remembering.

Effects of cognitive individual difference variables.

In terms of cognitive individual difference factors, the results of Study 2 indicate the argument that children's language abilities are strongly associated with memory performances, as previous studies have demonstrated (Burgwyn-Bailes et al., 2001; McGuigan & Salmon, 2004). Children with higher receptive language abilities revealed a

higher level of recall of the event, particularly in response to general probes, over and above the influences of age and stress levels than children with lower receptive language abilities. Language skills were more closely associated with children's errors during an immediate assessment, rather than a delayed assessment after a week: children who had relatively higher receptive language abilities made fewer errors at the immediate interview, supporting the conclusion that children's immediate suggestibility is influenced by their receptive language skills whereas their later suggestibility is more influenced by other individual difference variables, such as stress levels. Indeed, behavioral responses to stress were only associated with children's delayed recall, not immediate recall. However, it should be noted that this finding might reflect children's attention intensity when the tasks were assessed. The receptive language tasks (i.e., PPVT-3) was conducted on the day that children received the dental procedure. Children who experienced comparatively lower levels of stress during the dental procedure were more likely to be willing to actively participate in a series of tasks. Although receptive language and children's level of stress were not associated statistically, there might be a possibility that those children who were in higher level of stress might have been reluctant to fully engage in the PPVT task, regardless of their genuine receptive language ability.

There is an interesting interaction between children's age and receptive language ability that can be observed on their recall of general probes both at the immediate and delayed interviews, demonstrating that younger children's free recall – but not that of the older children – is related to receptive language ability. It could be concluded that the effect of receptive language ability on children's remembering of a stressful event is an important indicator for younger children, but that other variables should be taken into consideration when evaluating the performance of older children.

As expected, working memory (WM) capacity increased with age in this investigation; nonetheless, it did not affect children's remembering when controlled the effects of age and stress levels, with one exception; children who had a higher WM capacity revealed better free recall at the delayed interview than children who had a lower WM capacity. There was also an interesting interaction between age and WM capacity when we consider children's remembering of a stressful event. Increases in working memory capacity were correlated with concomitant increases in the free recall of younger children only, but not the older children, both at immediate and delayed interview. Thus, although the current investigation does not support Jaschinski and Wentura's (2002) findings that revealed a strong association between poorer WM and higher suggestibility, the findings suggest that there was a relation between WM capacity and children's remembering of a stressful event, particularly for younger children.

On the other hand, WM capacity was not related to any other anxiety variables and yet it should be noted that the studied event was not as controlled as events that can be staged in a laboratory environment. Therefore, as mentioned above, there is a possibility that children did not execute the WM task (i.e., the digit span) at their full capacity. Thus, the linkages between WM capacity and memory performance should be interpreted with caution.

Limitations and Strengths of the Present Study

Limitations. The findings of the present research must be interpreted in the context of a number of limitations. First, the small sample size (Study 1, N=63; Study 2, N=85) precluded an in-depth examination of the possible interactions between individual difference factors and memory performance. It is possible that stronger statistical relations would have been found among the variables studied if a larger number of children had been included. The interactions among various stress predictors as well as cognitive and social-emotional individual characteristics fin predicting children's memory performance continue to be an important area for study. Indeed, this is the current perspective among researchers in the area of emotion and memory in development (Quas & Fivush, 2009). Additionally, given the small sample size and large number of analyses conducted in the present study, the probability of type 1 error must be considered.

Second, consideration should be given to issues of generalizability. Children were recruited from a metropolitan area in Seoul, South Korea. The sample was restricted to the patients at a private dental office, which limited the diversity of patient populations. Overall, the sample for the current study is representative of South Korean, upper- to middle-income, suburban families. Therefore, replication of the study in a more diverse community is advisable and might provide a broader range of individual differences.

Third, a week-delayed interview is not comparable to real-world, forensic interview settings. The length of the delay before an interview occurs is a vital, external factor that affects strength of recollection and suggestibility (Ornstein et al., 2006). Given that delays of 2 to 10 months are common between referral for prosecution and trial or other depositions (Whitecomb, 1992), it is imperative that researchers and those involved in the judicial system

understand children's recall of stressful events over relatively long delays. Although children's memory did not decrease significantly over the delay studying Study 2, this should not be interpreted as indicating that children's performance will be effective in delayed interviews in general. The children's attention spans may have seemed enhanced at the delayed visit because they were only asked to complete a memory-based interview. The first visit included several other tasks (e.g., WM and receptive language measures), as well as the memory interview and the dental procedure.

Fourth, children had limited time available to complete their tasks. They had to wait in the dentist's office for their treatments for quite a long time, and most were eager to get out of the office as quickly as possible after the treatment was done. As a result, the short version of measures was used. Thus, a subjectively selected short form of the STAIC questionnaire and the CBQ short form were used. These short measures restricted the amount of information collected. Thus, the results from these two measures should be carefully interpreted.

Moreover, to help children relax before the interview and reduce the risk of eliciting misinformation due to social compliance during the interview, meaningful care should be devoted to developing rapport with the children, which has been shown to be a very powerful influence on children's accurate remembering (Lyon & Saywitz, 2006, Bottoms, Quas, & Davis, 2007, Saywitz, Esplin, & Romanoff, 2007). However, the serious time constraints that were operative did not allow for sufficient time to ensure such a process. Despite one interviewer conducting all the interviews to ensure that the interviewers' personal characteristics did not affect children's remembering, the time available for interviewing each child varied. As a result, the interviewer had to manage time for building rapport

differently with each child. This approach may have affected the level of children's comfort or willingness to talk about the event on an individual basis.

Finally, as no appropriately established and reliably proven measures are currently available for measuring stress-coping strategies in dental contexts across age, existing questionnaires were modified to adequately measure stress-coping strategies in children in that environment, in addition to the shortening already mentioned. Thus, results involving children's coping strategies should be interpreted with caution until additional research can be conducted using the newly established measures.

Strengths. Conducting the study in a naturalistic setting offered several benefits because the children took part in an actual stressful event as opposed to a manufactured one such as watching a video of a child undergoing stressful procedures, or experiencing a fire alarm. As such, a naturalistic study design can examine significantly stressful events, which can offer distinctive examples of how children recount personal stressful experiences. In investigating the relation between stress and memory, to-be-remembered events must be salient, personally significant, and reliably induce stress in children.

Among the various naturalistic stressful contexts, the use of a dental procedure as a discrete, situationally specific stressor is not unique to this study (see, e.g., Vandermass et al., 1993, Baker-Ward et al., 2009). However, this is one of the first studies to measure children's biological and behavioral responses as potential stress predictors in a dental treatment context. Children indeed exhibited a decrease in heart period and vagal tone – typically taken as evidence of increased arousal – during the dental treatments, as expected. Although heated discussions have taken place in the literature on reliable predictors of biological stress

reactivity (Wallin et al., 2009), there are significant advantages to measuring stress both behaviorally and biologically in a naturalistic situation, as was done here.

Given the paucity of studies that have specifically addressed the roles of stress—as driven by both biological and behavioral responses to stress as an event is unfolding —in the relation between emotion and memory in children, this current study should be replicated and extended by future studies. Researchers should account for how the factors of biological and behavioral responses to stress affect children's later remembering. In this research, we also obtained the dentist's, children's, and parents' feedback regarding child's pain and anxiety, as well as the children's reports of emotional status during immediate and delayed interviews and responses to a general anxiety questionnaire (i.e., STAIC).

This study represents a starting point for research on mechanisms underlying how each anxiety variables influences across age on remembering a stressful event. Previous studies found that different anxiety indicators were marginally correlated with each other, but were uncorrelated with the children's self-reports of anxiety (Walco, Conte, Labay, Engle, & Zelter, 2005; Merrit et al., 1994). Similarly, associations between stress and memory often varied across different measures. The lack of correlations across measures makes it difficult to discern which measure most appropriately reflect children's experienced distress during a particular event and to interpret the meaning of their differences.

In the current study, a range of stress measures – including behavioral responses to stress, dentist's ratings, children's self-reports of pain and anxiety, parents' reports of child's pain and anxiety – as well as children's' emotional status at immediate and delayed interviews, and STAIC general anxiety scores, were significantly correlated with each other, indicating that these stress variables consistently measured children's negative emotion regarding the event. Physiological stress reactivity, particularly vagal tone reactivity, was

significantly correlated with behavioral responses to stress, mother's report of pain, and child's report of pain at delayed interview, yet these correlations are reduced in comparison to those between behavioral responses to stress and other anxiety variables. Thus, future research should be devoted to understanding why physiological stress reactivity works rather differently than other anxiety variables.

This study provided descriptive results of various individual difference factors seldom investigated regarding the memory for stressful events. It was designed to obtain fundamental knowledge of the children's general cognitive abilities—namely, language and working memory abilities—as memory cannot be explained without taking into consideration these essential cognitive skills. As mentioned previously, the lower scores on some of the tasks may have been due to children's inattention – after spending considerable time in a waiting room and having gone through a dental procedure – and not their inferior abilities.

This study also provided new findings in the area of pediatric pain research, in particular those related to individual difference factors in children's memory for pain and anxiety. Thus, the finding that STAIC scores defining children's general anxiety status are associated with the recollection of pain and anxiety of a treatment is new. Children with a higher anxiety status in routine life are likely to expect more pain and anxiety in a dental treatment. Although this study used selected portions of the STAIC questionnaire, the results could provide basic information about whether or not children's dental anxiety is affected by a specific type of anxiety, rather than general anxiety overall.

Implications for Future Research

The results of this study highlight several avenues for future inquiry in the domains of children's remembering of stressful events, legal investigations, and pediatric dentistry.

Children's remembering and effects of stress. Although the findings of this study provide support for recent explorations of the ways in which stress impacts children's remembering, they also raise a number of imperative questions for future investigations. The documented within-participant linkages between stress and remembering—over and above the effects of age—suggest the importance of fine-grained analyses of stress levels and a range of children's individual characteristics. Moreover, because behavioral responses to stress had more effect at the delayed assessment than the immediate interview, there should be a serious commitment to exploring the continuing impact of stress, from encoding to later recall, with research designs that can detect stress-driven errors. Additionally, the strong, positive influences from parental preparation and approach-oriented coping styles exhibited during the dental procedure suggest the need for a meaningful investigation regarding the contents of parents' preparative discussions with their children and specific coping styles children can apply that will potentially reduce stress levels during the event. The positive relation between receptive language ability and children's free recall would be worthwhile to investigate further, as would children's general cognitive ability in relation to its effects on their remembering of a stressful event.

In research examining a range of individual difference factors as predictors of memory, additional work is needed to elucidate the precise conditions under which

individual difference factors predict memory and the underlying mechanisms of the observed associations between stress and memory. Given that the present study was exploratory, it is still unclear how the numerous anxiety variables and various individual difference factors can consistently influence children's remembering. Because much of the research to date has been preliminary and exploratory, further research is needed to confirm associations found in one or two studies to determine how generalizable they are to children of varying ages and types of to-be-remembered events.

Although not assessed in the present study, future research would benefit from larger-scale examinations that reveal the combined and independent contributions of various interrelated factors among the biologically and behaviorally different stress levels and a range of individual differences across ages. As new findings arise, researchers will be in a position to develop more complex theoretical models that can elucidate the specific factors giving rise to suggestibility in children and give those recommendations to interviewers, lawyers, and other forensic professionals.

Legal investigations. Children are increasingly required to describe witnessed or experienced acts of violence or accidents; thus, it is crucial to understand the factors associated with their changing abilities to remember and report stressful, personal experiences. In child abuse cases, particularly, as the child and the alleged perpetrator are often the only witnesses to the event, it is critical to understand the conditions under which children can provide capable accounts of stressful events that they have personally experienced.

As objective standards for judging sexual abuse accounts are rarely available, the dental procedure represents an effective paradigm for exploring what children remember

about a similar, but ethically acceptable, event. Although certain limitations, as presented in the previous section, are inherent in the comparison, the findings in this study of excellent recall from even young children to general probes, minimal forgetting in a week, and accurate responses to suggestible questions indicate that—under certain conditions—children are capable of providing accurate accounts of stressful events they have experienced. Further research addressing these issues will certainly contribute to understanding the factors associated with the development of children's abilities to report the details of salient, stressful, personally experienced events.

Further studies can also extend conclusions from this study that provide information on how individual difference factors influence children's memory performances. This research may help forensic interviewers develop a comprehensive understanding of children's psychological functioning for eliciting eyewitness testimony. Traditionally, the clinical and forensic literatures have been somewhat separate; yet understanding that a child is anxious, depressed, or experiencing intrusive memories potentially enables the interviewer to conduct a more sensitive and effective interview. Ultimately, the findings that several cognitive and social-emotional individual difference factors affect children's remembering of stressful events should facilitate our understanding of the ways in which clinical and legal professionals can tailor interviews to best meet children's needs and capabilities. Creating developmentally and individually sensitive guidelines for interviewing children in the legal system is recommended.

Pediatric dentistry. Within pediatric dentistry, several avenues for future development are evident. As most current dental procedures are not as inherently painful or anxiety-provoking as they have been historically, researchers should determine the reason

behind the persistence of dental anxiety and aim to decrease its prevalence. Given that children's recalled pain scores tended to be consistent over time, providing dentists with information about their previous negative dental experiences or children's general anxiety status may be significant for the development of appropriate interventions to reduce dental anxiety before treatment.

The examination of other psychological correlates of anxiety might help identify those children with the most negatively distorted predictions of future pain and memories of past pain. Such studies should help to develop appropriate interventions to reduce negatively inflated memories. Investigations of children's memories at varying ages might help determine the age at which children are able to accurately predict and recall procedural stress or anxiety, if there is one.

Consideration should be given to directly targeting memories as part of a psychologically based, dental-anxiety-management intervention. Such interventions may help children have more positive attitudes about dental procedures and exhibit less stressed and more approach-based coping behaviors during them. Learning more about the ontogeny of children's abilities to understand and remember events that are physically painful, stressful, or both will further contribute to our basic understanding of children's cognitive development and inform research on and practice of children's clinical care in dental settings. In addition, studies examining how children's memory of a stressful event operates may bring about methods of changing children's perceptions of medical experiences.

Considering that approach-oriented coping strategies were strongly correlated with children's remembering of a stressful event in this study, the efficacy of programs for developing effective coping strategies aimed at increasing approach-oriented and decreasing avoidance-oriented types to reduce anxiety and pain perception across ages for dental

procedures should be assessed. In addition, teaching approach-oriented coping strategies (e.g., mood elevation, information seeking, social support) may be applicable in different stressful environments. Future studies should take a closer look at the relation between certain coping strategies and dental anxiety to determine whether specific coping styles have a stronger relation to dental anxiety. Identifying specific coping styles should help clarify exactly which coping styles should be targeted to improve the experience in the dental office (i.e., reducing anxiety and pain perception and enhancing cooperation with the dental treatment) and how coping styles may work differently across ages.

Finally, future research should also examine the circumstances under which it is helpful rather than hindering to have a parent present at a dental appointment. In this project, it was found that parental presence during the dental procedure was not associated with children's stress levels or memory performance, or any specific coping strategies that children used or from which they benefited. However, because parents can, in principle be trained to encourage children to apply approach-oriented coping during a treatment, their presence may be significantly helpful in reducing children's stress or anxiety levels as part of a strategy to teach children those methods. This may also enhance cooperation with a dentist during treatment, ultimately leading to fewer unpleasant dental experiences. Researchers should also examine these findings in a broader medical context; such strategies could be helpful in many circumstances, including routine visits to physicians.

Thus, there are numerous possibilities for further research to confirm the findings reported here, to determine the extent to which they are generalizable, and to deepen our understanding of the relation between stress levels and children's remembering. In addition to psychological fields, such research would be valuable in both the gathering of children's eyewitness testimony and improving pediatric dentistry experience.

Appendix A. Dentist's written consent

THE UNIVERSITY OF NORTH CAROLINA
AT CHAPEL HILL
DENTAL MEMORY STUDY

Seungjin Lee
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Peter A. Ornstein
F. Stuart Chapin Professor
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(01)-919 962-2537 FAX
e-mail: pao@unc.edu

June~July, 2010

Dear Dentist:

We are part of a group of researchers at the University of North Carolina at Chapel Hill who are interested in children's memory and coping strategies. In an effort to understand how children remember and cope with events that may be mildly stressful to them, we are studying minor dental procedures. We are interested in the coping behaviors that children engage in to control the possible stress associated with dental procedures. We hope this information will help dentists such as you better manage your child patients, especially those who might become distressed. In addition, we are interested in relating this knowledge to the legal system in which children are asked to provide testimony.

If you agree to participate in this study, we will videotape the dental procedures you conduct on participating children (those with parental permission). Our research assistants will code these videotapes to assess children's level of stress. We will also ask for your assessment of each participating child's distress level during the procedure. When the study is complete, we will provide you with a written report of the overall results.

All records from this study will be stored in our locked laboratory at the University of North Carolina at Chapel Hill.

To ensure confidentiality, the records of each child and dentist will be identified only by a number.

Only those researchers working directly on the project will have access to research materials.

Participants *will not* be identified by name in any presentation, report or publication about this study. Of course, participation in this study is completely voluntary, and you may choose not to participate, you may choose not to do specific parts of the study, and you may withdraw at any time without consequence.

Please fill out the consent form below, indicating your decision concerning participation in this study, and your decision about allowing videotapes of children's dental procedures that also include you in the picture to be shown for training and educational purposes. You should keep one copy for your files.

If any questions or concerns arise in connection with your participation, please feel free to contact us by phone: SL: (82)-010-5072-6698/(01)-919-265-3919; PAO: (01)-919/962-4138) or via email (seungjin@email.unc.edu; pao@unc.edu;). If you so desire, you may inspect any of the materials that we use in this research.

You may also contact the Institutional Review Board at the University of North Carolina at Chapel Hill, USA, at (01)-919-966-3113 or by email to IRB_subjects@unc.edu at any time during your participation in this study if you have questions or concerns about your rights as a participant. If contacting IRB, please refer to study number 10-0885.

Thank you very much for your consideration.

Sincerely yours,

Seungjin Lee
Ph.D. Graduate Student

Peter A. Ornstein, Ph.D.
F. Stuart Chapin Professor

I, _____consent to participate in the study of memory conducted by Seungjin Lee and Dr. Peter Ornstein. I understand that I can withdraw at any time without consequence.

_____ _____
Signature of dentist **Date**

I, _____consent to the use for training and educational purposes of videotape segments of children receiving dental procedures that include me in the picture. I understand that my name will not be used, and that I can participate in this study, but still not agree to the showing of myself in video segments.

____Yes, I agree **____No, I do not want video segments of me to be shown**

_____ _____
Signature of dentist **Date**

_____ _____
Signature of researcher **Date**

PLEASE KEEP ONE COPY OF THIS FORM FOR YOUR RECORDS

Appendix B. Parents' written consent

THE UNIVERSITY OF NORTH CAROLINA
AT CHAPEL HILL
DENTAL MEMORY STUDY_KOREA

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June~July, 2010

Dear Family:

We are part of a group of researchers at the University of North Carolina at Chapel Hill who are interested in children's memory and coping strategies. In an effort to understand how children remember and cope with events that may be stressful to them, we are studying minor dental procedures. We are interested in relating this knowledge to the legal system in which children are asked to provide testimony. In addition, we are interested in the coping behaviors that children engage in to control the possible stress associated with dental procedures. We hope this information will help dentists better manage their child patients.

We hope that you will agree to have your child take part in this study which has three stages:

1. We will videotape your child's dental procedure and take a measure of your child's heart rate during the dental procedure. We will take a measure of your child's blood pressure at the beginning and at the end of the dental procedure.
2. Following the dental procedure, we will ask your child to answer a few questions about how he/she coped during the procedure. We expect these questions to take no longer than 10 minutes. We will then conduct a brief initial interview (approximately 30 minutes) with your child where we will ask your child what he or she remembers about the dental procedure (e.g., "What happened during your visit to the dentist?" "Did the dentist use a tooth smoother on your teeth?"). We will take a measure of your child's blood pressure at the beginning and at the end of the initial interview. You will also be asked to complete some questionnaires about your child that will take about 40 minutes.
3. You and your child will be asked to return to the same dentist's office about one week later at a scheduled time for the final interview with your child. That interview will be videotaped to provide an accurate record of your child's recall of the details of the procedure.

For all procedures, your child may choose not to answer a question for any reason. You may choose not to answer any of the questions on the measures you complete, for any reason.

As a token of our appreciation, your child will receive a small gift after the final interview for taking part in this study. To compensate both you and your child for your time, you will also receive an English book and CD following completion of the final interview. In addition, we will

email you a written report of the study's overall results, after the study is complete, in about a year, if you want.

All records from this study will be stored in our locked laboratory at the University of North Carolina at Chapel Hill. Further, to ensure confidentiality, the records of each child will be identified only by a number. Only those researchers working directly on the project will have access to research materials. Participants *will not* be identified by name in any presentation, report or publication about this study.

Of course, participation in this study is completely voluntary, and you may choose not to have your child take part; in addition, if your child does participate, he or she may withdraw at any time without consequence. Please talk with your child about this study. Then, please fill out the consent and permission form below, indicating your decision and your child's decision concerning participation in this study. You should keep one copy for your files.

If any questions or concerns arise in connection with your participation, please feel free to contact us by phone (SL (82)-010-5072-6698); PAO: (01)-919/962-4138; SL: (01)-919/265-3919, or via email (seungjin@email.unc.edu; pao@unc.edu).
If you desire, you may inspect any of the materials that we use in this research. You may also contact the Institutional Review Board (IRB) at the University of North Carolina at Chapel Hill, USA, at (01)- 919-966-3113 or by email to IRB_subjects@unc.edu at any time during your participation and your child's participation in this study if you have questions or concerns about your rights, or your child's rights, as participants. If contacting IRB, please refer to study number 10-0885. Thank you very much for your consideration.

Sincerely yours,

Seungjin Lee	Peter A. Ornstein, Ph.D.
Ph.D. Graduate Student	F. Stuart Chapin Professor

_____ I agree to participate in this study, and I give permission for my child, _____, to participate in the study of memory conducted by Seungjin Lee and Dr. Peter Ornstein. I understand that both I and my child can withdraw at any time without consequence.

_____ _____
Signature of Parent or Guardian Date

Email address if you want to receive a copy of the overall results:
_____

We also request permission to use the video of your child for training and educational purposes. Please indicate if you are willing to allow us to use the video in this manner. Your child can still be in the study even if you do not want us to show the video for training and educational purposes.

☐Yes ☐No _____
Signature of Parent or Guardian

_____ _____
Researcher Signature Date

Appendix C. Children's verbal consent

* For children aged 4-6

Hi, my name is [researcher], and I am here especially to see you today! My friend [other researcher 2] is also here to see you, and she is going to make a video of your teeth being fixed today. We have some special things for children to wear—these little disks, and this arm cuff. [show adhesive disks and pressure cuff] You don't have to wear them if you don't want to. After you are all done getting your teeth fixed, you get to come down the hall to my special room so we can talk. Your mom/dad said that you could do all these things if you want, but you can still choose not to wear the little disks and the arm cuff, or not to do any of the things with me. If you decide to wear the little disks and cuff, you can change your mind, and I will take them off if you just let me know. And you will get to come again, next week, talk with me some more and play some games, and then you will get a prize to take home. Does that sound ok to you? Do you want to try on the little disks and the arm cuff?

* For children aged 7-9

Hi, my name is [researcher 1], and I am here especially to see you today! My friend [other researcher 2] is also here to see you, and she is going to make a video of your teeth being fixed today. We have some special things for children to wear—these little disks, and this arm cuff. [show adhesive disks and pressure cuff] You don't have to wear them if you don't want to. After you are all done getting your teeth fixed, you get to come down the hall to my special room so we can talk. Your mom/dad said that you could do all these things if you want, but you can still choose not to wear the little disks and the arm cuff, or not to do any of the things with me. If you decide to wear the little disks and cuff, you can change your mind, and I will take them off if you just let me know.

We are trying to learn more about how dentists help children like you, so we will ask you lots of questions about what you think. While we are talking, if I ask you a question that you don't want to answer, it is ok for you to tell me that you don't want to talk about it. And, if you want to take a break at any time while we are talking, or even stop talking with me, that is fine too. You won't get in any trouble. You will get to come again, next week, to talk with me some more and play some word and memory games, and then you will get a prize to take home. Does that sound ok to you? Do you want to try on the disks and the cuff?

Appendix D. Dentist Ratings of Child (Frankl)

Dentist Ratings of Child

ID#_____

These ratings will be taken at standard intervals throughout the procedure.

Non-compliance:

1	2	3	4	5	6	7
Completely compliant			Compliance is typical for a child of this age			As difficult to manage as any patient I've seen

Anxiety:

1	2	3	4	5	6	7
Not at all anxious			Anxiety is typical for a child of this age			As anxious as any patient I've seen

Frankl Behavior Rating Scale

Rating	Check	Attitude	Definition
1		Definitely Negative	Refusal of treatment, crying forcefully, fearful or any other overt evidence of extreme negativism
2		Negative	Reluctant to accept treatment, uncooperative, some evidence of negative attitude but not pronounced, i.e./sullen, withdrawn
3		Positive	Acceptance of treatment, at times cautious, willingness to comply with the dentist, at times with reservation but patient follows the dentist's directions cooperatively
4		Definitely Positive	Good rapport with the dentist, interested in the dental procedures, laughing and enjoying the situation

Appendix E. Background Questionnaire

Parental Questionnaire

Your name: _____

Your relation to participating child: _____

Your address: _____

Your phone number: _____

Participating child's name: _____

Date of birth (mm/dd/yy): _____

Your marital status: _____

Your occupation:_____ Spouse's occupation: _____

Your highest level of education completed: _____

Your spouse's highest level of education completed:_____

1. Has your child ever had an unpleasant dental experience?

a. Yes b. No

If "yes" please describe:

_____

_____

____

2. How frequently has your child been to a dentist is his/her life?
   a. Not at all
   b. 1-3 times
   c. 4-6 times
   d. 7 or more times

3. How frequently has your child seen a dentist in the past year?
   a. Not at all
   b. 1-3 times
   c. 4-6 times
   d. 7 or more times

4. Has your child had any dental experience on the other dentistry?
   a. Yes
   b. No

5. How much experience has your child had with this particular dentist?
   a. None at all
   b. A little
   c. Some
   d. A lot

6. Did you discuss the dental visit with your child before you came to the dentist today?

a. Yes, briefly
b. Yes, in some detail
c. Yes, extensively
d. No

7. What treatment is your child getting today?

a. General check-up
b. Extraction
c. Filling / Sealant
d. The other

8. Are you going to be with your child during the dental procedure?

a. Yes
b. No

9. When did your child have the first dental experience? _____ months

10. Has your child had any experience to have a consultation with a professional psychologist due to any psychological anxiety or nervousness?

a. Yes
b. No

11. When was the most recent visit to this dentistry for your child? _____months ago
What was the treatment at that time?

a. General check-up
b. Extraction
c. Filling / Sealant
d. The other

Appendix F. Child Behavioral Questionnaire (Temperament)

Children's Behavior Questionnaire

Today's Date _____

Instructions: Please read carefully before starting:

On the next pages you will see a set of statements that describe children's reactions to a number of situations. We would like you to tell us what your child's reaction is likely to be in those situations. There are of course no "correct" ways of reacting; children differ widely in their reactions, and it is these differences we are trying to learn about. Please read each statement and decide whether it is a "true" or "untrue" description of your child's reaction within the past six months. Use the following scale to indicate how well a statement describes your child:

Circle #	If the statement is:
1	extremely untrue of your child
2	quite untrue of your child
3	slightly untrue of your child
4	neither true nor false of your child
5	slightly true of your child
6	quite true of your child
7	extremely true of your child

If you cannot answer one of the items because you have never seen the child in that situation, for example, if the statement is about the child's reaction to your singing and you have never sung to your child, then circle NA (not applicable).

Please be sure to circle a number or NA for every item.

1. Seems always in a big hurry to get from one place to another.
   l 2 3 4 5 6 7 NA

2. Gets quite frustrated when prevented from doing something s/he wants to do.
   l 2 3 4 5 6 7 NA

3. When drawing or coloring in a book, shows strong concentration.
   l 2 3 4 5 6 7 NA

4. Likes going down high slides or other adventurous activities.
   l 2 3 4 5 6 7 NA

5. Is quite upset by a little cut or bruise.
   l 2 3 4 5 6 7 NA

6. Prepares for trips and outings by planning things s/he will need.
   l 2 3 4 5 6 7 NA

7. Often rushes into new situations.
   l 2 3 4 5 6 7 NA

8. Tends to become sad if the family's plans don't work out.
   l 2 3 4 5 6 7 NA

9. Likes being sung to.
   l 2 3 4 5 6 7 NA

10. Seems to be at ease with almost any person.
    l 2 3 4 5 6 7 NA

11. Is afraid of burglars or the "boogie man."
    l 2 3 4 5 6 7 NA

12. Notices it when parents are wearing new clothing.
    l 2 3 4 5 6 7 NA

13. Prefers quiet activities to active games.
    l 2 3 4 5 6 7 NA

14. When angry about something, s/he tends to stay upset for ten minutes or longer.
l 2 3 4 5 6 7 NA

15. When building or putting something together, becomes very involved in what s/he is doing, and works for long periods.
l 2 3 4 5 6 7 NA

16. Likes to go high and fast when pushed on a swing.
l 2 3 4 5 6 7 NA

17. Seems to feel depressed when unable to accomplish some task.
l 2 3 4 5 6 7 NA

18. Is good at following instructions.
l 2 3 4 5 6 7 NA

19. Takes a long time in approaching new situations.
l 2 3 4 5 6 7 NA

20. Hardly ever complains when ill with a cold.
l 2 3 4 5 6 7 NA

21. Likes the sound of words, such as nursery rhymes.
l 2 3 4 5 6 7 NA

22. Is sometimes shy even around people s/he has known a long time.
l 2 3 4 5 6 7 NA

23. Is very difficult to soothe when s/he has become upset.
l 2 3 4 5 6 7 NA

24. Is quickly aware of some new item in the living room.
l 2 3 4 5 6 7 NA

25. Is full of energy, even in the evening.
l 2 3 4 5 6 7 NA

26. Is not afraid of the dark.
l 2 3 4 5 6 7 NA

27. Sometimes becomes absorbed in a picture book and looks at it for a long time.
l 2 3 4 5 6 7 NA

28. Likes rough and rowdy games.
l 2 3 4 5 6 7 NA

29. Is not very upset at minor cuts or bruises.
l 2 3 4 5 6 7 NA

30. Approaches places s/he has been told are dangerous slowly and cautiously.
l 2 3 4 5 6 7 NA

31. Is slow and unhurried in deciding what to do next.
l 2 3 4 5 6 7 NA

32. Gets angry when s/he can't find something s/he wants to play with.
l 2 3 4 5 6 7 NA

33. Enjoys gentle rhythmic activities such as rocking or swaying.
l 2 3 4 5 6 7 NA

34. Sometimes turns away shyly from new acquaintances.
l 2 3 4 5 6 7 NA

35. Becomes upset when loved relatives or friends are getting ready to leave following a visit.
l 2 3 4 5 6 7 NA

36. Comments when a parent has changed his/her appearance.
l 2 3 4 5 6 7 NA

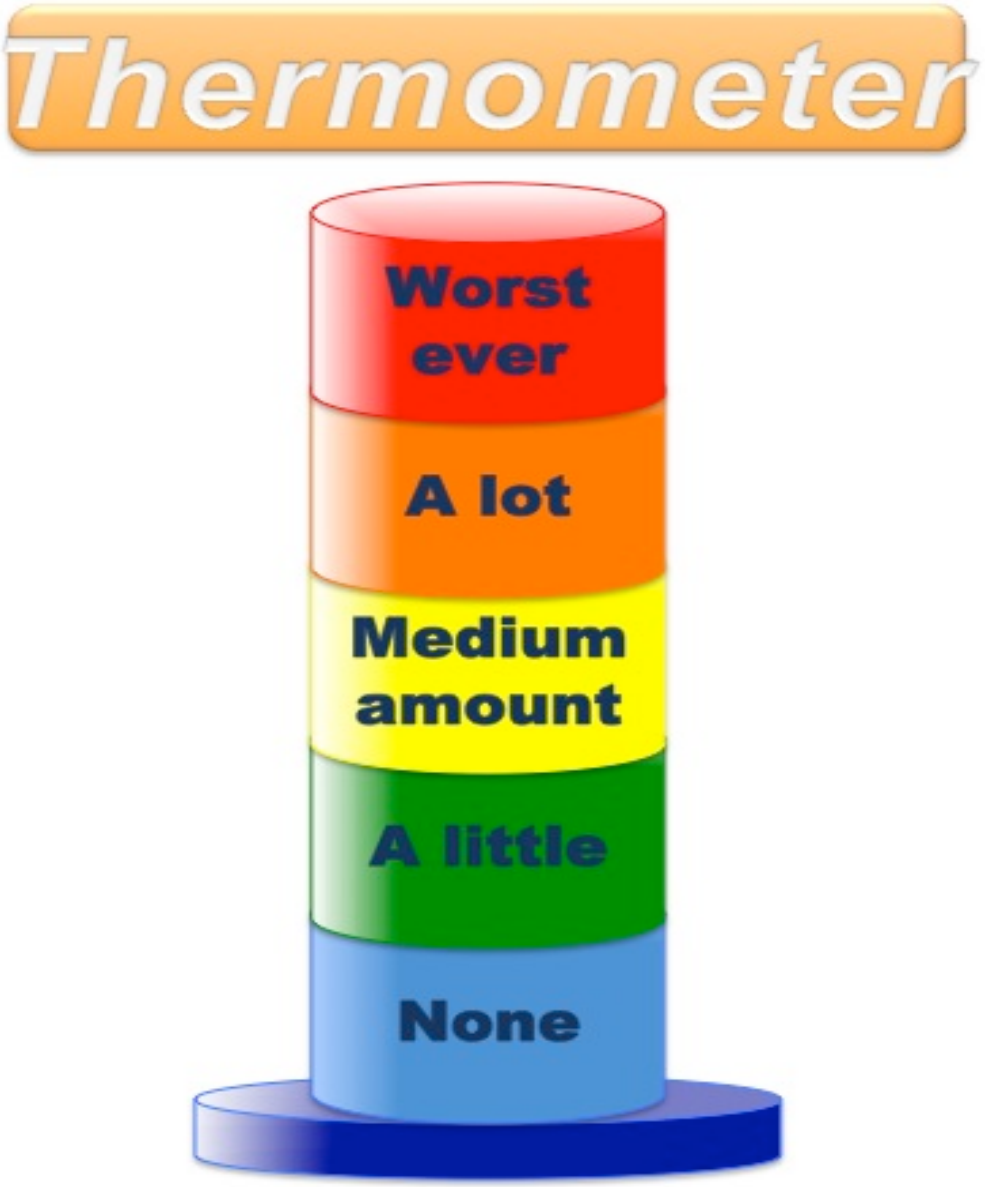
Please check back to make sure you have completed all items by marking a number or "NA"

Appendix G. Parent and Child report of Child's Anxiety and Pain

Visual analogue scale (VAS)

The VAS is a picture of a thermometer on 1~5 scale, on which parents respond to the question "How nervous or frightened was your child about being with the dentist?" and then "How much pain do you think your child experienced with the dentist today?"

<Example of visual analogue scale>



Appendix H. Behavior Profile Rating Scale

Behavior Profile Rating Scale (Melamed et al., 1975)

Child's Behavior	Weight
Inappropriate mouth closing	1
Chokes	1
Cries during injection	1
Fidgets	2
Won't sit back	2
Attempts to dislodge instrument	2
Verbal complaints	2
Verbal message to terminate	3
Refuses to open mouth	3
Rigid posture	3
Crying	3
Restraints used	4
Kicks	4
Stands up	4
Rolls over	4
Flings arms	5
Dislodges instruments	5
Refuses to sit in chair	5
Faints	5
Leaves chair	5

Appendix I. Memory Assessment

Sample Interview Protocol

Prior to the beginning of the interview, the examiner establishes rapport with the child, and explains the purpose of the video camera. The examiner tells the child, that his/her parents have given permission for the child to talk with the examiner. The child and the examiner test the video camera to "make sure that it works."

Introduction: I would like you to tell me about your visit to the dentist. I do not know what happened during your visit to the dentist, so I would like you to tell me everything that you can remember about your visit. I am going to ask you lots of questions, but because I do not know what happened, some of the questions may be about things that didn't actually happen. You should just answer my questions as best you can. If you do not understand a question, just say "I don't understand what you mean." And if you do not know the answer to a question, it is okay to say 'I don't know." Are you ready to get started?

Follow-up interview. My job is to find out how much children can remember about things that happen to them. Remember before when you talked about your visit to the dentist to my friend? Well today, I want you to tell me about what happened at the dentist because I don't know what happened. I am going to ask you lots of questions. Some questions will be about things that did not actually happen. You should just answer my questions as best you can. If you do not understand a question, just say "I don't understand what you mean." And, if you do not know the answer to a question, it is okay to say "I don't know." Are you ready to get started?

Free recall:
Tell me everything that happened during your dentist visit.
Follow-up:
-What can you tell me about things that happened when you went to the dentist?
-I'm really interested in what happened when you went to the dentist and I don't know anything about what happened. Please tell me all the things you can remember about your visit to the dentist.
-What else can you tell me about your visit to the dentist?

_____

_____

_____

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_____

_____

_____

For each feature named, ask:

a. You said that _____, tell me more about that.
b. What else can you tell me about_____

Ask these questions as many times as necessary. When the child appears to have exhausted memory for the feature, move on to the next feature reported.

You are doing great. Now let's talk about the things the dentist and helper did to get your teeth ready to be fixed. Tell me everything that the dentist and helper did to get your teeth ready to be fixed.

_____

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_____

For each feature named, ask:

a. You said that the dentist/helper _____, tell me more about that
b. Tell me what else she did *or* Anything else?

Ask these questions as many times as necessary. When the child appears to have exhausted memory for the feature, move on to the next feature reported.

Cued recall:

Now I have some more questions to ask you. Sometimes I might ask you about something you told me about already. If I do that, it doesn't mean that you were wrong the first time, it's just that I have all these questions on my piece of paper and I have to ask all of them.

1. Did the dentist or helper put something around your neck? Y N

   Yes: What did she put around your neck?_____

   _____

   No or DK: Did the dentist or helper put a paper towel around your head? Y N

   No or DK: Did the dentist or helper put a paper towel around your neck? Y N

2. Did the dentist or helper take your temperature? Y N

   Yes: How did she do that?_____

   _____

3. Did the dentist's helper put some things on her face? Y N

   Yes: What things did she/he put on her face?_____

   _____

   No or DK: Did the dentist's helper cover his/her mouth with anything? Y N

   Yes: What did she/he cover her mouth with?_____

   _____

   No or DK: Did she cover her mouth with a mask? Y N

   No or DK: Did she cover her mouth with her hand? Y N

4. Did the dentist's helper cover his/her eyes with anything? Y N

   Yes: What did she cover her eyes with?_____

   _____

   No or DK: Did she cover her eyes with her hand? Y N

   No or DK: Did she cover her eyes with some eyeglasses? Y N

5. Did the dentist's helper put something on her hands? Y N

   Yes: What did she put on her hands?_____

   _____

   No or DK: Did she put rubber gloves on her hands? Y N

   No or DK: Did she put mittens on her hands? Y N

6. Did the dentist or her helper check your head for ticks? Y N

   Yes: How did she do that?_____

   _____

7. Did the dentist put some things on your face? Y N

Yes: What things did she put on your face?_____

_____

No or DK: Did the dentist cover your mouth with anything? Y N

Yes: What did she cover your mouth with?_____

_____

No or DK: Did she cover your mouth with a mask? Y N

No or DK: Did she cover your mouth with her hand? Y N

No or DK: Did the dentist's helper cover your eyes with anything? Y N

Yes: What did she cover your eyes with?_____

_____

No or DK: Did she cover your eyes with her hand? Y N

No or DK: Did she cover your eyes with some eyeglasses? Y N

8. Did the dentist's helper put something on your hands? Y N

Yes: What did she put on your hands?_____

_____

No or DK: Did she put rubber gloves on your hands? Y N

No or DK: Did she put mittens on your hands? Y N

9. Did the dentist or helper check your ears? Y N

Yes: How did she do that?_____

_____

10. Did anything happen to the chair that you were sitting in? Y N

Yes: What happened to the chair that you were sitting in?_____

_____

No or DK: Did the dentist or her helper move the chair up or down? Y N

No or DK: Did the dentist or her helper spin the chair you were sitting in? Y N

11. Did the dentist or her helper put anything on your big toe? Y N

Yes: What did she put on your big toe?_____

_____

No or DK: Did the dentist or her helper put a Band-Aid on your big toe? Y N

No or DK: Did the dentist or her helper put a toe hugger on your big toe? Y N

12. Did the dentist or her helper cut your hair? Y N

Yes: How did she do that?_____

_____

13. Did you hold something in your hand? Y N

Yes: What did you hold in your hand?_____ Y N

_____

No or DK: Did you hold a mirror in your hand? Y N

No or DK: Did you hold a flashlight in your hand? Y N

14. Did the dentist put something special on your gums? Y N

Yes: What did she put on your gums?_____

_____

No or DK: Did she paint some jelly on your gums? Y N

No or DK: Did she draw on your gum with a crayon? Y N

15. Did the dentist or her helper ask you to drink some medicine? Y N

Yes: How did she do that?_____

_____

16. Did anything happen that hurt you? Y N

Yes: What happened that hurt you?_____

_____

No or DK: Did the dentist pinch your gums? Y N

Yes: How did she do that?_____

_____

No or DK: Did she give you a shot in your arm? Y N

No or DK: Did she give you a shot in your gums? Y N

17. Did the dentist's helper give you a drink of water? Y N

Yes: How did she give you a drink of water?_____

_____

No or DK: Did she give you a drink of water from the thirsty bird? Y N

No or DK: Did she give you a cup of water? Y N

18. Did the dentist ask you to chew on some pink stuff? Y N

Yes: How did she do that?_____

_____

Now that we've talked about some things that the dentist and helper did to help get your teeth ready to be fixed, I want to ask you some more questions about things that the dentist and her helper might have done to actually fix your teeth.

Tell me what the dentist and her helper did to fix your teeth.

_____

_____

_____

_____

_____

_____

_____

_____

For each feature named, ask:

a. Tell me more about that.
b. Tell me what else she did.
c. Ask "how" for each of the features mentioned.

Ask these questions as many times as necessary. When the child appears to have exhausted memory for the feature, move on to the next feature reported.

Cued recall:

21. Did the dentist or her helper put some things in your mouth? Y N

Yes: What things did she put in your mouth?_____

_____

No or DK: Did the dentist or her helper put some cotton in your mouth? Y N

No or DK: Did the dentist or her helper put some gum in your mouth? Y N

Did you bite on a piece of paper? Y N

Did you bite on a piece of plastic? Y N

22. Did the dentist or her helper find out if you could hear okay? Y N

23. Did the dentist use some special tools to fix your teeth? Y N

Yes: What special tools did she use to fix your teeth?_____

_____

No or DK: Did the dentist use a special mouth prop (tooth pillow) to hold your mouth open? Y N

No or DK: Did the dentist use a stick to hold your mouth open? Y N

Did the dentist saw on your teeth? Y N

Did the dentist use a special tooth smoother (drill) to fix your teeth? Y N

Did the dentist's helper blow on your teeth with a special air gun? Y N

Did the dentist's helper blow on your teeth with her mouth? Y N

24. Did the dentist put anything on your teeth to fix them? Y N

Yes: What did she put on your teeth to fix them?_____

_____

No or DK: Did the dentist put a rubber band on your tooth? Y N

No or DK: Did the dentist put a little metal hat (tooth ring) on your tooth? Y N

No or DK: Did the dentist put some white filling on your tooth (like cream cheese)? Y N

No or DK: Did the dentist put a gold filling in your tooth? Y N

25. Did the dentist use something to dry your filling? Y N

Yes: What did she use to dry your filling?_____

_____

No or DK: Did she use a hair-dryer to dry your filling? Y N

No or DK: Did she use a special light to dry your filling? Y N

26. Did the dentist use something to pull your tooth out?

Yes: What did she use to pull out your tooth?_____

No or DK: Did the dentist pull your tooth out with metal pliers? Y N

No or DK: Did the dentist pull your tooth out with her fingers? Y N

27. Did the dentist or her helper find out if you could see okay? Y N

Thank you so much for helping me learn what happened at the dentist. You did a really great job and we are all done with all of the questions.

Appendix J. Stress Coping Strategy Questionnaire

Coping Activities Questionnaire

Prior to the beginning of the interview, establish rapport with the child, and explain the purpose of the video camera. The child and the examiner test the video camera to "make sure that it works."
Introduction: My job is to find out what children do to feel better while they are at the dentist. I am going to ask you some questions about your visit to the dentist today. I am going to tell you what some other children have done to feel better at the dentist. You may have done some of these things, do. I'll ask you about several different things, and then I may ask you how much you did it and if it helped. If you don't understand a question, just say "I don't understand what you mean." I really appreciate your talking with me.
OK, here's the first thing: Some children think about the good parts of going to the dentist, like getting stickers or a toy. Is that something you did?

[If child says yes:] How much did you do that at the dentist? Did you do it some, a lot, or the whole time?
How much did it help? Not at all, a little, some, or a lot?
[If child says no, move on to next item.]

Follow this format with each approach listed below.

		Used				Helped			
		1	2	3	4	1	2	3	4
1	I thought about the good parts of going to the dentist, like getting stickers or a toy.								
2	I tried to be happy and have fun.								
3	I told myself that my visit to the dentist would be over soon.								
4	I tried to forget about what the dentist and her helper were doing, by just not thinking about it.								
5	I thought about someone who cares about me, and what they would say or do to make me feel better.								
6	I wished that I wasn't at the dentist anymore.								
7	I tried to get the dentist to stop what she was doing, like by keeping my mouth closed.								
8	I did something to try and get away, like jump out of the chair.								
9	I asked for someone who cares about me, like my mom or dad								
10	I held someone's hand so I would feel better.								
11	I watched what the dentist did very carefully, so I would know just what she was doing.								
12	I asked lots of questions, so I would know just what the dentist was doing.								
13	I just closed my eyes and kept them closed.								
14	I just let my feelings out, maybe by crying or yelling.								
15	I didn't do anything, nothing would have helped.								

What other things did you do to feel better while you were at the dentist?_____

Appendix K. STAIC-TRAIT QUESTIONNAIRE

	STATE-**TRAIT** QUESTIONNAIRE	Hardly ever	Sometimes	Often
2	I feel like crying			
3	I feel unhappy			
6	I worry too much			
7	I get upset at home			
8	I am shy			
9	I feel trouble			
13	I notice my heart beats fast			
14	I am secretly afraid			
16	My hands get sweaty			
18	It is hard for me to fall asleep at night			
19	I get a funny feeling in my stomach			

	STATE-TRAIT QUESTIONNAIRE			
1	I feel	very nervous	nervous	Not nervous
2		Very happy	happy	Not happy
3		Very sure	sure	Not sure
4		Very good	good	Not good

Appendix L. Working Memory Task

Digit Span (DIG)

General Description

Both a forward and a backward version of the Digit Span Task will be used so as to provide contrasting measures of short-term memory and working memory. The forward series is taken as a measure of basic short-term memory span, and the backward series is seen as an index of working memory span because information must be manipulated while being held in memory. In total, the task is composed of two forward series and two backward series. Based on McCarthy's procedure, the child has up to two opportunities at a given set size to respond correctly. If correct, he/she proceeds to the next set size. Each series ends when the child fails to respond correctly on both trials of a given set size. A child's span is defined as the largest set of words that can be successfully reported.

Reference: McCarthy, D. A. (1972). Manual for the McCarthy scales of children's abilities. New York: Psychological Corporation.

Task Procedure

Instructions Used With Numerical Memory Task (Forward Series)

"Now let's see how well you can say numbers. Listen. Say 2- 6." (This practice is used as an introduction and will not be scored.) After the child responds, the experimenter will continue with the forward series, which contains six sets (Trial 1) by saying, "**Now say these numbers**." The experimenter will present the digits in the series one at a time, at the rate of one digit per second.

If the child successfully completes an item in Trial 1, the experimenter proceeds to the next item. If the child fails an item in Trial 1, the experimenter uses the item from Trial 2 which has the same item number as Trial 1. This allows the child another opportunity to successfully complete an item. If the child completes the item from Trial 2, the experimenter proceeds with the next item number in Trial 1. If the child fails an item from Trial 2 of Assessment 1, the experimenter goes on to the first item of Assessment 2.

After completing the two forward series, proceed to the two backward series with the following directions.

Instructions Used with Numerical Memory Task (Backward Series)

"Now I want you to say some more numbers. This time I want you to say them backwards. For example, if I say 3-5, you would say 5-3. Do you understand? What do you say when I say 7-2?"

If the child responds correctly, the experimenter continues with the backward series.

If the child does not respond correctly, the experimenter will say, **"No, you would say 2-7. I said 7-2. To say it backwards, you would say 2-7."** Then, experimenter will give one more backwards example, **"Now try this—what would you say if I said 4-1?"** If child gets it correct, go on… if not, explain the correct answer again, and then go on anyway…"**Now let's try some more."**

The experimenter will present the backward series in the same manner as the forward series, giving a second trial only if the first trial is failed.

Appendix L. Working Memory Task Sheet

ID#_____ Date_____

Score: Correct/Incorrect

Assessment 1 (Forward Series)
Practice: "Say 2 - 6"

Length	**Trial 1**	Correct/Incorrect	**Trial 2**	Correct/Incorrect
2	5-8		4-9	
3	6-9-2		5-8-3	
4	3-8-1-4		6-1-8-5	
5	4-1-6-9-2		9-4-1-8-3	
6	5-2-9-6-1-4		8-5-2-9-4-6	
7	8-6-3-5-2-9-1		5-3-8-2-1-9-6	
8	3-6-1-8-4-2-7-5		7-9-1-3-5-4-6-2	
9	1-4-7-5-8-3-2-9-6		9-1-6-8-2-7-4-5-3	
Total				

Assessment 2 (Forward Series)

Length	**Trial 1**	Correct/Incorrect	**Trial 2**	Correct/Incorrect
2	6-1		2-5	
3	2-7-4		9-1-5	
4	4-3-9-6		1-7-6-8	
5	5-2-1-7-4		8-5-9-3-2	
6	9-3-1-7-5-4		4-7-6-2-1-3	
7	1-2-4-8-3-5-9		7-9-4-3-2-5-8	
8	4-8-3-7-1-2-6-5		3-5-7-6-9-4-8-1	
9	8-4-2-7-9-1-5-6-3		6-8-1-7-4-5-3-2-9	
Total				

Assessment 3 (Backward Series)
Practice: "If I say 3-5, you would say 5-3. What do you say when I say 7-2?"

Length	**Trial 1**	Correct/Incorrect	**Trial 2**	Correct/Incorrect
2	9-6		4-1	
3	1-8-3		2-5-8	
4	5-2-4-9		6-1-8-3	
5	1-6-3-8-5		6-9-5-2-8	
6	4-9-6-2-1-5		3-8-1-6-2-9	
Total				

Assessment 4 (Backward Series)

Length	**Trial 1**	Correct/Incorrect	**Trial 2**	Correct/Incorrect
2	6-2		1-5	
3	3-7-4		7-3-2	
4	9-1-6-4		8-5-2-6	
5	7-3-5-8-2		4-7-1-9-5	
6	5-9-4-6-8-3		1-8-2-6-3-9	
Total				

Appendix M. INTERVIEWER RATINGS

INTERVIEWER RATINGS

Hesitancy to Disclose 1-5
(**Distinct from memory**)

1	2	3	4	5
Not Hesitant		Moderately Hesitant		Extremely Hesitant

1 = Short latency to respond
Provides elaboration (when the child has the information)
Volunteers information
Consistent style of responding throughout interview (no questions with greater discomfort than others)

3 = Some hesitancy on some questions
Responds only to interviewer prompts
Does not volunteer information
Attempts to respond to interviewer prompts throughout interview

5 = Resists interviewer questions *throughout the interview*
May cry or be visibly upset
Withdraws from interview
**Automatic "5" if the interviewer terminates the interview because of the child's level of upset

Ease of Management 1-5 [Rating based on child's participation in the interview after rapport has been established; an initially low to warm up child is not penalized for initial hesitancy.

1 = Interviewer's active efforts required to keep child on task *throughout session* (e. g., extensive repetition of instructions, redirection of behavior) to complete interview needed)
Child extremely distracted.
Frequent encouragement necessary.
May ask frequent questions about length of interview ("How much more?")
May have difficulty in remaining seated.
**Automatic "1" if interview must be terminated because of the child's lack of compliance. [Termination because of child's level of upset is not the basis of a "1" on ease of management]

3 = Redirection needed at some times during the interview but not required throughout entire interview.

Some level of encouragement necessary.
Child returns to task when redirected to do so.
Child's activity level and interruptions are typical of age.

5 = Child maintains focus on interview task throughout session, even if she experiences difficulty in reporting information or changes affect in response to some questions.
Little or no redirection of behavior required.
Encouragement required at only some points in the interview.

Is the parent present during the interview?

1. Yes
2. No

Examiner: We've been talking about a lot of things that happened during your dental visit. How does it make you feel to talk about your dental visit? Show me which face is the most like how you feel.

5 = Extreme smiley face
3 = Neutral face
1 = Extreme frowny face

Examiner: [Rating 1 or 2] You picked a face that wasn't happy. There are lots of ways to feel unhappy. Show me which face is most like how you feel. This is a scared face. This is a sad face. This is an angry face. Which one is most like how you feel when you talk about the dentist?

Examiner: Some things about getting teeth fixed make most children a little [child's emotion]. But other things make them happy. What did the dentist do that make you happy? [Prompt: Did you get a prize? Did the dentist say something nice?] . . . . And we all like having healthy teeth, and that's why we get our teeth fixed.

Appendix N. Language Ability Task

Peabody Picture Vocabulary Test

General Description

The Peabody Picture Vocabulary Test is a standardized achievement measure of receptive vocabulary. The child is shown four pictures and asked which one best describes a given word.

General Task Procedure

The experimenter has the booklet propped up so that the child is looking at Training Plate C**.** Say, "**See, there are four pictures on this page. Each of them is numbered (**point out the numbers). **I will say a word; then I want you to tell me the number of the word. Let's try one. What number is the picture that best tells the meaning of parrot?"** If the child correctly responds "2," then say "**Good! Let's try another one. What number is scissors?"** If the child correctly responds "1," then say "**Good!"** and flip the page. Say, "**Now look at the four pictures on this page. Which number is mowing?"** If the child correctly says "3,"say "**Good! Let's try another one. What number is riding?"** If the child correctly responds "2," say "**Good**, **now let's move on."**

If the child incorrectly responds to any of the practice items, say "**You tried, but [insert item] is number [insert correct response]."** Then say, "**Let's try again. What number is the picture that best shows the meaning of [insert same item]?"** Continue to help the child until he or she makes a correct response, then move on to the next training item.

Once the experimenter has gone over the training items say, "**Now I am going to show you some other pictures. Each time I say a word, you say the number of the picture that best tells the meaning of the word. As we go through the book, you may not be sure you know the meaning of some of the words, but look carefully at all of the pictures anyway and choose the one you think is right."**

Then, turn to **SET 9**, and begin by saying, "**What number is sorting?"** Continue in this manner for each word in the set. Write down the child's response to each number in the set, and circle the "E" if the child responds incorrectly. At the bottom of the set, write down the number of items that the child got incorrect. If the child missed one item or less a basal has been established, and the experimenter should proceed to the next set. Follow the same procedure for the next sets. When the child has missed eight items or more in a set, a ceiling has been reached, and the experimenter should stop administration of the task after completion of that particular set.

If a basal of one item or less incorrect is not reached in SET 9, then move back to SET 8. Continue moving back sets until the basal is established. Once it is, skip back ahead to SET 10 and continue until a ceiling has been reached.

Appendix O. Examiner's Checklist

DENTAL PROCEDURE EXAMINER CHECKLIST

- **ID: _____ Date: _____**
- **Dental Procedure Time:**
- **NOTE:**

Chest Band for respiration	
ECG wires	
Paper towel around child's neck	
Dentist wears mask	
Helper wears mask	
Dentist wears glasses	
Helper wears glasses	
Dentist wears gloves	
Helper wears gloves	
Chair moves up and down	
Green mask	
Jelly on gums (Hot cream)	
Water gun	
Metal ring (hat)	
Mouth pillow (prop)	
Cotton	
Metal pliers	
Child is asked to bite on plastic/paper/stick	
Sucking saliva tools	
Child gets white (or silver grounds) filling	
Special light used to dry filling	
Brush teeth	
Air gun	
Gaggle	

- **Mother's presence during the dental procedure: Y / N**
- **Blood Pressure/ Pulse Rate values:**

Before the dental procedure: _____/_____/_____

After the dental procedure: _____/_____/_____

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