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CORTISOL REACTIVITY ACROSS THE DAY AT CHILD CARE: EXAMINING
THE CONTRIBUTIONS OF CHILD TEMPERAMENT AND ATTACHMENT TO
MOTHER AND LEAD TEACHER

A Dissertation

Presented to

The Faculty of Social Science

University of Denver

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy

by

Lisa S. Badanes

August 2009

Advisor: Dr. Sarah E. Watamura

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Title: CORTISOL REACTIVITY ACROSS THE DAY AT CHILD CARE:
EXAMINING THE CONTRIBUTIONS OF CHILD TEMPERAMENT AND
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Advisor: Dr. Sarah E. Watamura

Degree Date: August 2009

ABSTRACT

Previous work has shown that full-day center-based child care is associated with increased physiologic stress for many young children (e.g., Tout, de Haan, Campbell, & Gunnar, 1998; Watamura, Sebanc, & Gunnar, 2002). Specifically, increasing cortisol from morning to afternoon at full-day child care in contrast to decreasing cortisol across the day for these same children at home has been repeatedly demonstrated for toddlers and preschoolers. Factors that have been related to rising cortisol across the day at child care include the child's age (rising cortisol at child care between 2 and 5 years, but not for infants or older children, Dettling, Parker, Lane, Sebanc, & Gunnar, 2000; Watamura, Donzella, Alwin, & Gunnar, 2003), and global classroom quality (higher quality classrooms having fewer children showing rising cortisol across the day, e.g., Sims, Guilfoyle, & Parry, 2006). Some studies have also identified relations with particular temperaments (e.g., Watamura, et al., 2002). Furthermore, recent work suggests that rising cortisol at child care may be associated with health risk in the form of lower antibody levels (Watamura, Coe, Laudenslager, & Robertson, 2009) and that early child care may be associated with attenuated cortisol in adolescence (Roisman, et al., 2009).

This study extended the previous work on stress reactivity at child care by addressing: 1) whether children's attachment to their primary caregiver was associated with how they respond to the challenge of child care; 2) whether negative child

temperament alone or in combination with insecure attachment was associated with how they respond to the challenge of child care; and 3) whether the nature of children's attachment to their teacher explained how they respond to the challenge of child care. Saliva samples were collected on three child care days at mid-morning and mid-afternoon. Temperament was assessed by both parents (CBQ; Putnam & Rothbart, 2006) and teachers (T-CBQ; Gunnar, Tout, de Haan, Pierce, S., & Stanbury, 1997) and attachment security was measured using the AQS (Waters, 1995) with the primary caregiver and lead teacher.

Children rated as high in both security and dependency to their primary caregiver were more likely than secure children with low dependency or insecure children to show rising cortisol across the day at child care. In addition, children who scored lower on the teacher sorted AQS sociability factor (but not on the CBQ or T-CBQ temperament factors) were more likely to show rising cortisol across the day at child care. Finally, higher security with teachers was associated with falling cortisol across the day at child care. These results suggest that in the process of acquiring a solidified working model of secure attachment to primary caregivers, children who are secure but still dependent may be more stress reactive to out-of-home care. Furthermore, as these results demonstrate that secure relationships with teachers may buffer children from flat or rising cortisol at child care, they suggest a concrete avenue for intervention.

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Chapter One

Introduction

Over the past 30 years there has been a dramatic increase in the employment of mothers outside of the home. As a result, a majority of preschool-aged children in the United States now experience out-of-home child care (Cappizzano, Adams, & Sonenstein, 2000). A common type of nonparental care for this age group is center-based child care. Previous work has shown that full-day, center-based child care is associated with increased physiologic stress or challenge for many young children (e.g., Tout, de Haan, Campbell, & Gunnar, 1998; Watamura, Sebanc, & Gunnar, 2002; Watamura, Donzella, Alwin, & Gunnar, 2003). Specifically, increasing cortisol from morning to afternoon at full-day child care, in contrast with decreasing cortisol across the day for these same children at home, has been repeatedly demonstrated for toddlers and preschoolers (Dettling Gunnar, & Donzella, 1999; Dettling, Parker, Lane, Sebanc, & Gunnar, 2000; Watamura et al., 2002; 2003; Watamura, Kryzer, & Robertson, 2009). Although a focus on stress reactivity at child care is relatively new, efforts to understand this phenomenon have demonstrated that caregiving quality is important for predicting the proportion of children who exhibit a rising pattern of salivary cortisol across the day at child care (Sims, Guilfoyle, & Parry, 2006). Evidence also supports the existence of a developmental trend such that toddlers and preschoolers (roughly 2-5 years of age) show the rising pattern while infants and older children do not (Dettling et al., 1999; Watamura

et al., 2002). It is less clear whether particular child characteristics might be important for predicting which children are most likely to respond to the challenge of child care with physiologic reactivity. In particular, the theoretically important construct of attachment to both primary caregivers and teachers as a potential contributing factor remains relatively understudied.

The current study utilized an ecological systems framework (Bronfenbrenner, 1994) to extend the work on stress reactivity at child care by addressing: 1) whether children's attachment to their primary caregiver was associated with how they respond to the challenge of child care; 2) whether negative child temperament alone or in combination with insecure attachment was associated with how they respond to the challenge of child care; and 3) whether the nature of the child's attachment to their teacher explained how they respond to the challenge of child care. The first two questions were aimed at further specifying which children find child care stressful, taking into account the fact that children's stress reactivity develops within the interacting mesosystems of home and child care. The third question was aimed at identifying whether care providers are able to buffer children from rising cortisol at child care. Furthermore, the current study extends the literature by examining these questions in a sample of families who are racially and ethnically diverse, that included families experiencing poverty, and that included both English-and Spanish-speaking families. The following sections describe the rationale for each component in the model (see Figure 1), beginning with a discussion of the proposed importance of the dependent variable of rising cortisol across the day, followed by the theoretical and empirical evidence

suggesting a role of attachment, and finally concluding with a discussion of the relatively mixed evidence regarding the role of temperament in stress reactivity.

Cortisol Reactivity

The Hypothalamic-Pituitary-Adrenal Axis

Human and non-human animals have an interconnected set of complex physiological systems for managing physical, cognitive, and socio-emotional challenges. One of these systems is the hypothalamic-pituitary-adrenal (HPA)–axis. In humans, the primary hormonal product of this system is the steroid hormone cortisol (Hennessy & Levine, 1979). As part of the body’s normal regulatory functions, cortisol follows a circadian rhythm, with adults and children demonstrating the highest values at waking, followed by a steady decline across the day, returning to its lowest levels at approximately midnight (Kirschbaum, Kudielka, Gaab, Schommer, & Hellhammer, 1999; Watamura, Donzella, Kertes, & Gunnar, 2004). Before age three infants and toddlers show a clear morning peak and evening nadir, with flatter patterns of cortisol production from mid-morning to mid-afternoon (Larson, White, Cochran, Donzella, & Gunnar, 1998; Watamura, Donzella, Kertes, & Gunnar, 2004; Watamura, Badanes, Le Bourgeois, & Bradshaw, 2009). When assessed at home under baseline conditions, the mature adult rhythm is clearly evident by 36-months of age for children experiencing low-stress environments (Watamura, Badanes et al., 2009).

Different Indexes of Cortisol Reactivity

Much of the research with cortisol either examines elevations in response to a specific stressor or elevations in basal levels across some portion of the day. Both research designs have demonstrated that the cortisol response (and recovery) is

particularly sensitive to situations that involve novelty, uncontrollability, or social threat (Kirschbaum & Hellhammer, 1994). For example, a recent meta-analysis of 208 studies with adults by Dickerson and Kemeny (2004) suggests that the largest cortisol changes and longest recovery times (in laboratory settings) are due to stressors which are both uncontrollable and which contain social-evaluative components. However, a focus only on elevations in response to stressors may yield an incomplete picture of stress management in childhood.

A number of recent studies have also shown that low cortisol or a flat daytime pattern of cortisol production, also known as “hypocortisolism” (Heim, Ehlert, & Hellhammer, 2000), occurs in 10-15% of adults (Stone, Schwartz, Smyth, Kirschbaum, Cohen et al., 2001). While elevations to discrete stressors followed by rapid recovery likely reflects normal functioning of the system in the face of challenge, hypocortisolism is theorized to reflect attenuation resulting from early severe or chronic stress exposure, and is therefore of more concern (Gunnar & Vazquez, 2001). In support of this assumption, a number of studies have demonstrated basal hypocortisolism in children who have experienced early trauma (Hart, Gunnar, & Cicchetti, 1996) who show PTSD symptoms (Goenjian, et al., 1996), and in adolescents suffering from depression (Kaufman, 1991).

In humans, a complete understanding of the potential negative effects of prolonged versus acute elevations in cortisol early in life is lacking. The limited evidence available suggests an association between high cortisol levels and negative behaviors in children and adolescents (Tout et al., 1998; Sondejker, et al., 2008). Recent work has also demonstrated lower antibody production among children attending full-day child care

who show elevated cortisol levels (Watamura, Coe, Laudenslager, & Robertson, 2009). Demonstrating the significance of early interpersonal experiences on later cortisol reactivity, Roisman, et al. (2009), found that adolescents at age 15 who had higher levels of maternal insensitivity and who spent more time in child care during the first 3 years of their life had lower awakening cortisol levels at age 15.

Cortisol Patterning at Child Care

Since the first report of rising cortisol across the day at child care over a decade ago (Tout, et al., 1998), numerous studies have replicated these results. An important feature, first reported by Dettling and colleagues (1999), is that the majority of children who show rising cortisol across the day at child care also show decreasing cortisol across the day at home (Dettling, et al., 2000; Watamura et al., 2003; Watamura et al., 2002; Watamura, Kryzer et al., 2009). Two recent meta-analyses suggest that the combined effect size for morning to afternoon cortisol increases was .18, with important moderating factors that include both characteristics of the child care day, such as multiple social interactions in a large group setting, and characteristics of the individual child, such as age and temperament (Geoffroy, Côté, Parent, & Séguin, 2006; Vermeer & van IJzendoorn, 2006).

While there are no data to date directly linking cortisol levels at child care with long term stress reactivity in human children, it has become increasingly evident through rodent and nonhuman primate studies that short and long-term alterations can occur in HPA-functioning as a result of early social experiences (Levine, 1994). In rodents, licking and grooming by the dam 4 to 14 days after birth serves to buffer cortisol reactivity in their pups (Suchecki, Rosenfeld, & Levine, 1993). Removal of the pups from

their mother for 12-24 hours reliably produces cortisol elevations, however, mimicking the dam's licking and grooming behaviors (e.g., with a wet paintbrush) can help keep cortisol levels at baseline during this separation. Cross-fostering studies show that these effects are transmissible via non-genomic means through differences in maternal care behavior (Weaver et al., 2004). Furthermore, many of the negative effects of early stress can be remedied by later environmental enrichment if stress exposure is brief (Francis, Diorio, Plotsky & Meaney, 2002), demonstrating the plasticity of this system and its sensitivity to environmental conditions.

Factors Associated With Rising Cortisol at Child Care

Efforts to understand the significance (if any) of afternoon elevations in cortisol at child care, including which characteristics of group care are related to the observed increase in cortisol over the child care day are ongoing. Early work has addressed whether explanations other than stress or challenge, such as changes associated with age or napping behaviors, might elucidate the rising pattern at child care. For example, both Dettling et al. (1999) and Watamura et al. (2003) demonstrated a curvilinear developmental course for the rising pattern such that infants in child care and school-aged children older than 5 years of age do not show the reversed pattern as compared to two-, three-, four-, and five-year-old child care attendees. These researchers, however, could only speculate as to why it is that two- to five-year-old children find child care challenging as opposed to the other two developmental groups.

With regard to napping, Watamura et al. (2002) investigated whether napping at child care might explain rising cortisol in a sample of preschoolers. This work was motivated by the fact that the highest values of basal cortisol are seen after morning

awakening. The results, however, did not support an association between napping during the child care day and rising cortisol in the afternoon because cortisol values were actually lower immediately following the rest period. By 4pm (and at least 30 minutes after the rest period had ended) elevated cortisol was once again evident. Although the case could be made that 4pm elevations following the post-nap drop could still be due to an awakening resurgence in cortisol, there was no difference in cortisol levels in the afternoon for children who napped versus those who only rested, including for the same children on nap and no-nap days. Because cortisol elevations were seen as soon as normal classroom activities resumed, the authors concluded that cortisol reactivity was better accounted for by the interactional demands and the cognitive and social challenges of child care.

In addition to age, several studies have demonstrated that global classroom quality is an important index for predicting children's physiologic stress reactivity at child care. Tout et al. (1998) found that 73% of the children studied showed a rising cortisol pattern across the day in centers scoring higher on the Early Childhood Environment Rating Scale (ECERS) (Harms & Clifford, 1980) as compared to 96% of children in the lower quality centers. Global classroom quality includes both environmental factors such as materials and schedules, as well as relational factors such as the positivity of interactions between adults and children and among children and appropriate stimulation of development by caregivers. Although the subscales of the ECERS are typically highly correlated, further work has demonstrated the specific importance of the relational aspects of classroom quality. For example, Watamura, Kryzer et al. (2009) showed that better classroom interpersonal climates were related to less of a difference between home

and child care cortisol levels. Similarly, in a home-based child care setting, Dettling et al. (2000) found that children's cortisol patterning across the day was related to the amount of focused attention and stimulation the child received from their teacher. Finally, Sims et al. (2006) have shown in an Australian sample selected to represent a range of quality assessed via a standard national instrument, that characteristics of warmth, individualized programming, and continuity of care may be important factors influencing cortisol. These studies suggest that responsive, sensitive, and developmentally appropriate caregiving environments at child care may provide coping resources to the child facing stress and challenge at child care. In addition, individualized care within this setting could reduce, at least in part, many of the demands that are characteristic of the child care day. That is, the teacher who is able to provide more focused attention may be able to create an environment that reflects more developmentally appropriate (but not overwhelming) types of challenges (Watanabe, Kryzer et al., 2009). Yet child care centers differ markedly in their overall quality of care with variations in factors such as caregiver-child ratios, school "readiness" activities, parental involvement, safety protocols, and developmentally appropriate practices (Howes, 1983; NICHD Early Child Care Research Network, 1996; NICHD Early Child Care Research Network, 2000). It is important to note that only a few studies to date have included a range of different quality sites within the same study (e.g., Sims et al., 2006; Tout et al., 1998), thereby possibly limiting our ability to explain some of the variance that occurs at the classroom level.

Current theories on elevated cortisol at child care generally favor, when properly controlling for naps, meals, medications, and atypical events, a combination of both long hours spent in care and psychosocial challenge as reliable sources of stress at child care

(Watamura & Ahnert, 2009). While these characteristics of child care are important for understanding why child care might pose a challenge for many preschoolers, it is still unclear why some children show cortisol increases across the child care day and others do not. Working from an ecological systems approach with the assumption that how a child approaches a psychosocial challenge (like child care) is a function of their relationship history, personal characteristics, as well as aspects of the challenge itself, the current study aimed to identify some of the risk and protective factors that might then suggest potential avenues for intervention.

Attachment Security and Stress Reactivity in Preschoolers

Attachment Theory

Compared to the young of many species, human infants are born relatively immature. As a result, they are highly dependent on their primary caregivers for survival. The attachment system, with the behavioral goal of seeking and maintaining proximity to the attachment figure during physical or psychosocial stress, is thought to have evolved over time by promoting survival (Bowlby, 1969/1982). While nearly all children are thus expected to form an attachment to one or more caregivers, attachment theory further proposes that the nature of the child's early attachment relationships has a fundamental influence on development (Ainsworth, 1969; Bowlby, 1969/1982, 1973, 1980). From this perspective, differences in the organization of secure-base behavior emerge as a result of differences in the nature and quality of the patterns of interactions with a caregiver over the first few years of life. These differences support the construction of distinct working models of attachment relationships and the self (Cassidy, Kirsch, Scolton & Parke, 1996; Sroufe, 1985). These cognitive representations are theorized to carry forward to

subsequent relationships and influence social development and psychosocial adjustment because of their influences on expectations about the self and the self in relation to others (Waters, Vaughn, Posada & Kondo-Ikemura, 1995).

Children's attachments to their caregivers have been broadly characterized along the dimension of security versus insecurity. Secure attachment is associated with high levels of maternal sensitivity and responsiveness. Secure children are expected to develop working models of caregivers as trusting and supportive, and to therefore seek out caregivers for help and support in times of need and use them as a secure base from which to explore (Bretherton & Munholland, 1999). Insecure attachment, in contrast, is associated with low levels of maternal sensitivity and responsiveness. Insecure children are expected to form working models of caregivers as untrustworthy, and therefore they consistently do not seek them out for help in times of need, and as a result may be unwilling or unable to use them as a secure base from which to explore (Sroufe, Egeland, & Carlson, 1999).

The Impact of Child Care on Maternal Attachment

As maternal labor force participation has changed in western industrialized nations and concomitant increases in non-maternal child care between birth and kindergarten have been documented, questions about the potential effects of child care on children's development have fueled research in many different domains. Early work focused on whether child care participation altered the developing mother-child attachment relationship (Belsky, 1990). Initial reviews of studies during the 1960's and 1970's did not produce support for negative effects on the quality of the developing attachment relationship between mother and child (see Belsky & Steinberg, 1978).

However, in the late 1980's and early 1990's the debate reemerged with new evidence suggesting that child attendance in out-of-home care, especially beginning before the age of one year, may lead to the development of insecure attachment relationships (see Clarke-Stewart, 1989).

Because many of the studies conducted in the 1980's and early 90's were inconclusive, suffering from relatively small and restricted samples, the National Institute of Child Health and Human Development (NICHD) Study of Early Child Care and Youth Development was initiated. This project utilized a prospective design, recruiting mothers during pregnancy, using a large, multi-site sample (1,364 children at 10 sites across the United States). The research team for this project, the Early Child Care Research Network, has provided us with a better understanding of the influence of *infant* out-of-home child care on development in a number of publications, and as the data are public many other authors have utilized them to address subsequent questions. In this sample, non-maternal child care, in and of itself, was not found to adversely affect or to promote the security of infant attachment to their mother (assessed via the Strange Situation, Ainsworth & Wittig, 1969) at age 15 months (NICHD Early Child Care Research Network, 1997). Instead, when the caregiving environment was of poor quality, when the child spent more than 10 hours per week in care, or when they had experienced multiple child-care settings before the age of 15 months, insecure attachment to mother was more likely to develop (NICHD, 1997). The negative effect of these different variables on maternal attachment security was more likely to occur if mothers of these at-risk children were also low in caregiving sensitivity. These results were mirrored in the Haifa study of 758 economically diverse Israeli infants (Sagi, Koren-Karie, Gini, Ziv, & Joels, 2002),

where they found that poor child care quality, reflected by high infant-caregiver ratios, accounted for increased levels of attachment insecurity among center-care infants.

Attachment to Teachers

Although mothers and fathers typically serve as the primary attachment figure for the toddler or preschooler, several studies suggest that young children in families that use out-of-home child care also form attachment relationships with their teachers (Howes & Hamilton, 1992; Pianta, Nimetz, & Bennett, 1997). Through their daily interactions of supervision and instruction, teachers and young children develop close relationships characterized by proximity seeking, reassurance, and other secure base behaviors (Barnas & Cummings, 1994; Howes & Ritchie, 1999). As with parents, we should expect variability in the degree of sensitivity and responsiveness that teachers offer each child within their care. Goossens and van IJzendoorn (1990) rated teachers in one-on-one free play sessions and found them to be more sensitive than the mothers of the same one-year olds. However, this sensitivity appeared to decrease significantly in whole group child care settings where the caregivers' attention is divided (Goossens & Melhuish, 1996).

Concordance Rates with Primary Caregiver and Teachers

In order to understand the relative impact that preschooler attachment to teachers might have on the HPA-axis reactivity at child care, it is essential to understand the process by which attachment formation occurs for this dyad. Insight into the child and teacher relationship could be gained by examining concordance rates with the child's primary caregiver. Reported concordance rates of attachment classification between mothers and teachers are varied. Concordance most likely occurs because of the finding that early teacher-child relationships are often predicted by maternal attachment

classification (Howes & Matheson, 1992; Sroufe, Fox, & Pancake, 1983). In other words, children may apply the models of relationships they develop to their primary caregiver to subsequent caregiving relationships. For example, Ainslie (1990) found a high concordance rate of attachment security between parents and teachers. Similarly, Goossens and van IJzendoorn (1990) demonstrated that the proportion of children classified as securely attached did not differ between infant-mother and infant-teacher dyads. However, it is also assumed that attachment classifications are a reflection of the specific history of interaction within a given dyad (Ainsworth, Blehar, Waters, & Wall, 1978), and just as the quality of attachment to the mother is usually somewhat independent of the quality of attachment to the father (Goossens & van IJzendoorn, 1990), we can assume that the same partial independence will hold true for teachers. This partial independence is commonly ascribed to differences in the interactional style of both of these attachment figures (Bretherton, 1985). We should therefore also expect that teachers form qualitatively different types of attachment relationships with different children in their care. These factors may explain why Howes & Hamilton (1992), using Ainsworth and Wittig's (1969) Strange Situation Paradigm and Water's and Deane's (1985) Attachment Q-Sort, reported discordance in attachment security between mothers and teachers.

Results from a recent meta-analysis of almost 3,000 children (Ahnert, Pinquart, & Lamb, 2006) suggest that the security of children's relationships with mothers, fathers, and teachers is modestly, but significantly intercorrelated. This would suggest that children construct somewhat intertwined internal working models of significant relationships. Overall, however, secure relationships with care providers were more

common in home-based rather than center-based caregiving facilities. Groups in home-based settings are smaller, possibly allowing for the formation of dyadic bonds similar to that with parents. Child care providers in these different settings might provide for different attachment needs. Therefore, differences in concordance rates might not necessarily reflect differences in caregiver sensitivity, but might be more reflective of differences in the type of environment.

Insecure Attachment Classifications and Care Providers

The nature of the child care environment itself might make it harder for teachers to form secure attachment relationships with all of the children in their classroom. Teachers must care for multiple children at once and are trained to give precedence to certain demands for their attention on the basis of who most urgently needs it (Smeets & Goossens, 1988). This unequal division of attention might have particularly damaging effects to the attachment relationship for children who are already at risk for developing insecure attachments to their teachers; namely, those children who have already begun to develop an insecure working model. In support of this claim, it has been found that when the teacher-child relationship is of high quality, the effect of maternal insecurity may be mitigated (O'Connor & McCartney, 2005). Variables thought to influence higher quality teacher-child relationships include more hours spent at child care (Goossens & van IJzendoorn, 1990), teacher experience (Stuhlman & Pianta, 2002), female child gender (Birch & Ladd, 1997), non-minority children (Hamre & Pianta, 2001), and higher family resources (Ladd, Birch, & Buhs, 1999).

Attachment and Cortisol Reactivity

The availability of coping resources and effective coping behavior play an important role in determining whether potentially threatening events stimulate elevations in cortisol (see Stansbury & Gunnar, 1995). Attachment security reflects one potential coping resource. Through their contingent and sensitive interactions with their primary caregivers, secure children may develop regulatory capacities that allow them to modulate stress reactions more effectively. Children who are securely attached may be better equipped to deal with the stressors associated with child care because they are better able to manage their emotional arousal within a social interaction (Parker & Gottman, 1989), have more positive interactions with their peers (Cohn, 1990), are more behaviorally and emotionally empathetic (Kestenbaum, Farber, & Sroufe, 1989), and are rated by teachers as having higher levels of social skills (Sroufe, 1983). However, because young children do not yet cope with impending threat very well on their own, of particular importance in coping with a potential threat is whether a responsive caregiver is present (Bowlby, 1973; Gunnar & Brodersen, 1992). For example, infants receiving their wellness inoculations were more likely to demonstrate cortisol elevations in response to the injection when they were insecurely attached to the parent bringing them to the appointment (Gunnar, Brodersen, Nachmias, Buss, & Rigatuso, 1996). Interestingly, even though all of the children in this study showed a behavioral response to the shots, only those children who did not have the support of a parent to whom they were securely attached mobilized the physiologic reaction of elevated cortisol to cope with the threat.

Much of the previous work demonstrating associations between attachment security and HPA-axis activation has been conducted with infants using Ainsworth's Strange Situation paradigm (Ainsworth & Wittig, 1969; e.g., Ahnert, Gunnar, Lamb, & Barthel, 2004; Hertzgaard, Gunnar, Erickson, & Nachmias, 1995; Nachmias, Gunnar, Mangelsdorf, & Parritz, 1996). We know less, however, about the associations between attachment security and cortisol responses to prolonged or repeated separations in preschoolers. Only one study published to date has assessed attachment security and cortisol levels after daily separations from a primary caregiver, and this was with infants. In this work (Ahnert et al., 2004), salivary cortisol was assessed in the morning on days 1, 5, 9 and 5 months after child care entry (mean age = 14.9 months old) and dyads were coded for secure base behaviors. Compared with insecure infants, secure infants had lower cortisol levels during the adaption phase to child care when the mother was present. However, infants from both attachment types demonstrated increased cortisol levels during the separation phase. These results suggest that infant physiologic stress reactivity during the transition to non-parental care in the mornings is buffered by secure attachment to the primary caregiver when the caregiver is present. Importantly, they also suggest that securely attached toddlers do not necessarily regulate stress more effectively than insecurely attached toddlers in the *absence* of their mothers.

Of course, infants and toddlers are not always in the presence of their primary caregiver during a stressful situation. In a laboratory study that allowed for the manipulation of supportive caregiving behaviors, infants who received individualized care from a babysitter that was less friendly, playful, and responsive during half-hour separations from their mothers demonstrated cortisol elevations, whereas the infants

cared for by a more interactive and responsive babysitter showed no cortisol elevations (Gunnar, Larson, Hertzgaard, Harris, & Brodersen, 1992). Dettling and colleagues (2000) also demonstrated that children's cortisol patterns across the day at family child care were lower when they received more focused attention and stimulation from their caregivers, behaviors that parallel those of a secure attachment relationship.

Child Temperament and Stress Reactivity in Preschoolers

Children differ in their responses to novel situations and social challenges. While some children may react to a novel situation by approaching it with excitement, others might hesitate and demonstrate caution or fear. Child temperament has been considered a central focus in the development of children's personality, affect, and social behavior (Rothbart, Ahadi, & Evans, 2000). There are at least five different and somewhat independent theoretical perspectives on temperament. Most work examining the relationship between temperament and stress reactivity at child care has utilized the Rothbart and Derryberry (1981) temperament theory because it incorporates behavioral and biological tendencies. This theory defines temperament as constitutionally based individual differences in reactivity, styles of action, and self-regulation (Calkins, Fox, & Marshall, 1996; Rothbart, Derryberry, & Hershey, 2000), and does not limit the domain of temperament to emotional experience and expression. These endogenously organized traits (Bates & McFayden-Ketchum, 2000) are thought to appear early in life and remain stable. However, research shows low to moderate consistency across time depending on the age of measurement with later assessments yielding more stability (DeFries, Plomin, & Fulker, 1994). The Rothbart & Derryberry (1981) perspective allows for valid and reliable assessments of temperament that are generalizable to a community sample.

Furthermore, these measures can be assessed using either parent or teacher reports.

Although the review below will indicate inconsistencies in the literature using this temperament perspective and stress reactivity, to maintain consistency with prior work in this area, the current study utilized the Rothbart & Derryberry (1981) perspective as well as the temperament items from the Attachment Q-Sort (Waters, 1995).

Temperament and Stress Reactivity

Theories of individual differences in HPA-axis reactivity emphasize the potential role of temperament. Shy, anxious, or fearful individuals are expected to be more likely to produce elevations in cortisol in response to novel or socially challenging situations (Kagan, Reznick, & Snidman, 1987; Rosen & Schulkin, 1998). There are several potential explanations for a temperament/ HPA-axis relationship in preschoolers including that: 1) children with a fearful or negative temperament might have a lower threshold for stress and challenge to mobilize a physiologic response; 2) temperament might influence how a child evaluates a stressor and those with negative temperaments might interpret more stimuli to be stressful; 3) children with negative temperaments might become involved in more stressful interactions because of their tendency toward negativity, resulting in larger and more frequent elevations in cortisol; and 4) children with negative temperaments may evoke different patterns of responses from adults, for example, increasing the chance that adults will respond to them negatively or restrict their growth by limiting their exposure to novelty or challenge.

Research on children's temperament characteristics and activity of the HPA-axis provides mixed evidence for which temperament dimensions are most reliably related to cortisol. In their 1999 study, Dettling et al. found that shyness in boys, and impulsivity

and low self-control in both sexes were associated with greater increases in cortisol across the child care day. Watamura et al. (2003) demonstrated that teacher-rated social fearfulness predicted larger increases in cortisol across the day at child care. In a different study, greater effortful control was associated with a steeper decreasing slope across the mid-portion of the day for toddlers (Watamura et al., 2004). In their sample of 8-year olds, Davis, Donzella, Krueger, & Gunnar (1999) did not find shyness and fearfulness to be associated with larger increases in cortisol at the beginning of a school year, but instead that cortisol increases were more common in the extroverted and aggressive children. In addition, several studies (e.g., Ahnert et al., 2004; Watamura et al., 2002; Watamura, Kryzer et al., 2009) have failed to find any associations between temperament and cortisol reactivity in young children.

Recognizing the relationship between temperament and attachment, Nachmias et al. (1996) examined *both* attachment security and temperament in a sample of 18-month-olds in relation to cortisol reactivity. Using Ainsworth's Strange Situation Paradigm to assess attachment security, they found that behaviorally inhibited infants were more likely to show elevations in cortisol in response to a series of novel stimuli only if they were also insecurely attached to their primary caregiver. While replication of these results is still needed, they nevertheless demonstrate the potential moderating role of attachment, and point to the need to consider attachment security when examining the correlates of infant or child temperament on cortisol reactivity.

Temperament and Attachment

Although both attachment theory and theories of temperament make predictions about development and adjustment in a variety of psychosocial domains, it is believed by

most researchers that even though these constructs are related, they have distinct influences (Vaughn & Bost, 1999). Attachment relationships are explicitly social, with an emphasis on the construction, maintenance, and cognitive meaning of a given relationship. Most theories on temperament, in contrast, focus on personality formation and on differences in traits of the individual. Yet, we can expect that temperament will exert some influence on both attachment security and working models. An infant or preschooler who is by nature fussy, extremely negative, or who does not easily follow a routine is more likely to develop insecure relationships with their primary caregivers because responding sensitively and consistently to their needs will be much more difficult than for an infant who is easy-going and not particularly negative (Calkins & Fox, 1992). A difficult temperament may narrow the range of caregiver environments in which the relationship can develop securely. This issue is further complicated by the typical temperament assessment measures. Most measurement techniques rely on parental (or teacher) reports, which mean that the same person who is providing information about temperamental characteristics is also the person who serves as the primary attachment figure.

The Current Study

The current study had three principal aims: 1) to examine whether child attachment to their primary caregiver predicted cortisol reactivity across the day at child care; 2) to investigate whether child temperament predicted cortisol reactivity across the day at child care; and 3) to examine whether a secure attachment to the lead teacher buffered children against stress reactivity at child care. It was predicted that both insecure attachment security to primary caregiver and negative child temperament would serve as

risk factors for rising cortisol across the day at child care. It was also predicted that attachment security with lead teacher would serve as a buffer against stress reactivity at child care.

Previous work to date with children in child care has only assessed relations between cortisol levels and attachment to primary caregivers in infants transitioning to child care in the morning (Ahnert et al., 2004) or in a laboratory setting using the Strange Situation. The current study assessed attachment security to primary caregivers and cortisol reactivity across the day at child care in a sample of preschool aged children using Waters (1995) Attachment Q-Sort.

Although previous work suggests a relationship between cortisol reactivity at child care and child temperament (e.g., Bruce, Poggi Davis, Gunnar, 2000; Dettling et al., 1999; Dettling et al., 2000; Tout et al., 1998; Watamura et al., 2002; Watamura et al., 2004), the specific temperamental characteristics posing the greatest risk for HPA-axis reactivity at child care remain inconclusive. The current study sought to further explicate the relationship between temperament and cortisol reactivity at child care using both a parent and teacher version of Rothbart et al.'s (2001) Children's Behavior Questionnaire and the temperament items from the parent and teacher rated Attachment Q-Sort.

Finally, no work to date has assessed the potential buffering effects that attachment security with the primary care provider at child care might afford. Although several studies have been conducted demonstrating that the formation of secure attachment relationships to teachers are possible (e.g., DeMulder, Denham, Schmidt, & Mitchell, 2000), and that these relationships can have positive effects on both cognitive (O'Connor & McCartney, 2005) and psychosocial (Moss, St-Laurent, Dubois-Comtois,

& Cyr, 2005) development, it is unknown what type of relationship (if any) exists between attachment security at child care and HPA-axis responsivity. With the hope of better understanding any potential buffering effects, in addition to assessing attachment security to the primary caregiver at home, the current study also assessed child attachment security to the lead teacher at child care. Cortisol levels in saliva were assessed at mid-morning and mid-afternoon on three child care days.

Chapter Two

Method

Participants

Participants were toddlers and preschoolers attending one of six full-day child care centers. A total of 255 children were enrolled in the classrooms at the time of the study. Criteria for exclusion were: Children were members of their current child care classroom for less than one month ($n = 1$), were diagnosed with developmental disabilities ($n = 7$), or attended child care for the full day less than 3 times per week ($n = 25$).

Of the 222 potential participants, parents of 166 children (76 female) agreed to participate in the study. Eight children in the study were siblings. The sample children were enrolled in one of 14 classrooms. The children were 2.03 to 5.38 years (M age = 4.03, $SEM = .07$). Seventy-five percent of children were identified by parents as white and 25% as non-white (17% African American/ Black, 8 % Asian American/ Asian, 2% American Indian/ Alaskan). In addition, 45% of those identifying as white were also identified as non-Hispanic, with 55% identifying as Hispanic. For 14% of the families (24 children), Spanish was identified as their primary spoken language, and therefore all questionnaires and procedures were administered to them in Spanish. Average annual income for the families was \$61,328 (range = \$7500 to more than \$199,980, $SEM =$ \$4868).

Settings

The population of interest was two-and-a-half to six-year-old children attending average to high quality full-day center-based child care. Five child care centers serving children in this age range and offering full-day placements were selected as research sites. Child care settings were chosen using the following criteria: 1) to permit examination of the unique family stressors associated with poverty, several of our centers served Head Start eligible families; 2) to ensure adequate representation of understudied populations of children and families in the Denver Metro area, the study oversampled centers that serve racially and ethnically diverse families; 3) to avoid confounding family stressors and child care quality, the study also selected sites providing high quality programming, and a range of supports for children and families such as family liaisons and well-articulated in-service policies for children with developmental delays; and 4) as most previous work has utilized university-affiliated child care centers, the study included one university-affiliated site to allow inclusion of a sample similar to previous studies. These sites were evaluated using the ECERS-R (Harms & Clifford, 1998) and had a median score of 5.62 (out of 7) with a range of 4.93 to 6.27.

Measures

To assess attachment to the primary caregiver and the lead teacher, child temperament, and cortisol patterning across the day at child care, several measures were used. Attachment security and secure base behaviors with both primary caregivers and teachers were assessed using Waters' (1995) Attachment Q-Sort, temperament was assessed using parent and teacher reports on the appropriate rater forms of the Children's Behavioral Questionnaire (CBQ, Putnam & Rothbart, 2005; TBCQ, Gunnar, Tout, de

Haan, Pierce, & Stanbury 1997), cortisol was assessed via saliva samples, and classroom quality was evaluated using the Early Childhood Environment Rating Scale-Revised (Harms, Clifford, & Cryer, 1998).

Attachment Q-Sort

Security of attachment was assessed using the Attachment Q-Sort (AQS; Waters, 1995). The AQS contains 90 statements about a child's behavior in the context of interaction with a specific caregiver. The items were developed to provide a comprehensive characterization of the child's use of the caregiver as a secure base for exploration and as a haven of safety when distressed (Ainsworth & Marvin, 1995). Because the AQS is based on observations of the child in their natural environments, it is considered by some to have better ecological validity than lab-based measures (Howes & Ritchie, 1999). It also allows for an economical examination of attachment beyond infancy and can be used with a broader age range. The AQS has been used previously with both parents and teachers, with slightly modified wording for the child care context (van IJzendoorn, Vereijken, Bakermans-Kranenburg, & Riksen-Walvern, 2004).

Although ideally sorted by a trained observer during at least two 2-6 hr home visits or two 2-6 hr classroom observations for each child, a recent meta-analysis (van IJzendoorn et al., 2004) of 171 studies utilizing the AQS indicated that 93 of them successfully utilized mother, father, or teacher as the rater with adequate variance. The current study's own pilot testing of this measure indicated that even with the longest window of total observation time recommended (12 hrs) in the classroom, many relevant events did not occur in such a way as to allow a reliable rating across children. Furthermore, because observers have limited access to observing the dynamics of the

relationship pair, they may miss important attachment related events that primary caregivers or teachers may take into account when completing the AQS. Therefore, the AQS was completed by the child's primary caregiver (93% mother) at home and by their lead teacher (100% female) at child care.

Primary caregivers and teachers were asked to sort the 90-item cards into nine piles with roughly 10 cards in each pile. Items that are "more characteristic" or "like" the child are given high placements (i.e., categories 7 – 9), and items that are "less characteristic" or "unlike the child" are placed in the lower categories (i.e., 1-3). Items that are "neither characteristic nor uncharacteristic" are sorted in the center of the item distribution (i.e., categories 4-6). This fixed distribution of items has been shown to be easier to learn than a quasi-normal or uneven distribution (Waters, 1985). Another advantage of a Q-sort methodology is it does not allow the rater to rate all items positively or negatively but forces a categorization of the child.

Temperament

Parents were asked to complete the Children's Behavior Questionnaire (CBQ) (Rothbart et al., 2000), a parent-report temperament measure designed for 3 to 8 year olds. The parent version is well-validated and is available in a short form as a 15 scale 94-item questionnaire (Putnam & Rothbart, 2006). Items are scored on a 7-point Likert scale with lower scores indicating items less representative of the child. A possible choice of "not applicable" is also included. The 15 scales are: Activity Level, Anger/Frustration, Approach/Positive Anticipation, Attention Focusing, Discomfort, Falling Reactivity/Soothability, Fear, High Intensity Pleasure, Impulsivity, Inhibitory Control, Low Intensity Pleasure, Perceptual Sensitivity, Sadness, Shyness, and Smiling and

Laughing. This revised version was developed by the original authors for use when other research demands on the participant prevent them from completing the longer, standard 195-item questionnaire. Alphas's for these 15 scales have been found to be over .60 (Putnam & Rothbart, 2006). Reliability for this sample ranged from .31 to .78 with an average of .61. Scales falling within the good range (above .70) included Anger/Frustration (.72), Falling Reactivity/ Soothability (.78), and Shyness (.75). Scales falling within the adequate range (.50 to .69) included Activity Level (.66), Approach/ Positive Anticipation (.53), Attention Focusing (.64), Discomfort (.65), Fear (.61), High Intensity Pleasure (.68), Inhibitory Control (.64), Low Intensity Pleasure (.61), and Perceptual Sensitivity (.69). Scales falling within the poor range (below .50) included Impulsivity (.42), Sadness (.31), and Smiling and Laughter (.49). Scales falling within the poor range should thus be interpreted with caution.

Lead teachers were asked to complete the Teacher-Children's Behavior Questionnaire (TCBQ) (Gunnar et al., 1997). This 10 scale, 50-item version was modified from the original CBQ (Rothbart et al., 2000) with help from Mary Rothbart. Items are scored on a 5-point Likert scale with lower scores indicating items less representative of the child. A possible choice of "not applicable" is also included. The TCBQ retains the following scales: Activity Level, Anger/Frustration, Attention Focusing, Discomfort, High Intensity Pleasure, Impulsivity, Inhibitory Control, Sadness, Shyness, and Smiling and Laughter. Reliability information from a norming sample is not available. Reliability in the current sample ranged from .56 to .88 and averaged .75. Scales falling within the good range (above .70) included Activity Level (.76), Inhibitory Control (.82), Sadness (.71), Smiling and Laughing (.88), Shyness (.88), and Attention

Focusing (.87). Scales falling within the adequate range (.50 to .69) included Anger (.66), High Intensity Pleasure (.66), Discomfort (.67), and Impulsivity (.56).

Cortisol

Saliva samples were collected from children at child care with the goal of obtaining samples on at least three child care days at 10am and 4pm for a total of six samples per child. Although standard for this type of study, our ability to interpret the data would have improved if we had collected salivary cortisol at more than one morning and afternoon time point. Average sampling times at child care were 9:52 (range: 9:11 to 10:29; median 9:53), and 15:35 (range: 14:25 to 16:36; median 15:31). For the first two classrooms, these unstimulated saliva samples were obtained using a 1.5 inch cotton dental roll that was then expressed into a vial. It has since been established that cotton fibers retain cortisol, particularly with low volume samples. To allow inclusion of the samples collected with cotton, the values were corrected by a factor of 1.4 nmol/L after assay as determined by testing the retention of known cortisol concentrations using cotton rolls from the same lot used in this study. For the remaining classrooms, saliva samples were obtained via synthetic salivette collection devices (Sarstedt, Nuembrecht, Germany). Vials and salivettes were then labeled with the child's ID number, sample number, and time and date of collection, and frozen at -20° C until data collection was complete. After sampling was complete, the samples were defrosted and batched for assay in groups of 36. Samples were assigned to batches so that classroom and batch were not confounded, and so that all samples from the same child were analyzed in the same batch. Samples were sent to the Biochemical Laboratory, Psychobiology, University of Trier, Germany to be assayed. Cortisol levels were determined by

employing a competitive solid phase time-resolved fluorescence immunoassay with fluorometric end point detection (DELFLIA). For samples retained in the analyses described below, the mean intraassay coefficients of variation (CV) for blind controls of real saliva of high and low concentration were 14.6% and 15%. For duplicates of the samples used in this study, the interassay CV was 5%.

Classroom Quality

Because previous work has demonstrated the importance of quality when assessing physiologic stress reactivity at child care, the effects of quality were minimized by including only those classrooms that were of similar quality ratings. Classroom quality was assessed using the Early Childhood Environment Rating Scale-Revised (Harms, Clifford, & Cryer, 1998). The ECERS-R consists of 43 items, that assess seven aspects of center-based care and education for children aged 2 ½ to 5. These areas are measured by the following subscales: Space and Furnishing (e.g., indoor space), Personal Care Routines (e.g., greeting/ departing), Language-Reasoning (e.g., encouraging children to communicate), Activities (e.g. dramatic play), Interaction (e.g., supervision of children), Program Structure (e.g., free play), and Parents and Staff (e.g., provisions for parents). Detailed descriptions are provided for each item. Item scores are 1 (inadequate) through 7 (excellent). The ratings are designed to be based on a minimum of 2 hr observations. In the current study, observation times ranged from 6 to 30 hrs.

The Health and Demographic Questionnaire. Cortisol is a stress sensitive hormone that is affected by a wide range of both physical and social factors. For example, different types of medications such as steroid inhalants and allergy preventatives are known to decrease the HPA response (e.g., Buske-Kirschbaum, von

Auer, Krieger, Weis, Rauh, & Hellhammer, 2003). The Health & Demographic Questionnaire (see Appendix A) asked parents the child's age in months, whether the child was adopted and if so at what age; how many siblings the child had, the sibling(s) age, and whether they were living with the child; the child's race; the child's ethnicity; the child's first language; if the child used an inhaler for asthma or other reasons; whether the child had any allergies; if the child took any other medications on a regular basis (and what they were); if the child was currently ill; and whether the child had any other medical conditions that were not addressed in any of the other items. Data on medication and illnesses were used to exclude saliva samples from the analyses that contained medications thought to interfere with cortisol assays and to exclude samples that were taken while the child was ill as described above.

Additional Measures

Current Illnesses: Because we were interested in understanding normative stress reactivity across the day at child care, in addition to controlling for medication intake, it was also important to sample when children were healthy and not experiencing a febrile illness because fevers induce increases in cortisol (Nickels & Moore, 1989). After each morning sampling at child care, child temperature was obtained using a GeniusTM2 IR Tympanic Thermometer. Samples on days where the child's temperature was at or above 99.5 were not used in analyses. Children were also asked about illness symptoms, and obvious symptoms such as a runny nose or cough were recorded. If children were absent due to an illness, we waited at least two days after their return and until symptoms were cleared to collect samples.

Attendance: The study also wanted to control for length of time after arrival to the center since cortisol takes approximately 20 minutes after a stressor has occurred for the peak response to be measured in saliva and to ensure that samples were collected from days where the child attended full-day. Arrival and departure times were obtained from the classroom on sampling days with samples excluded on days when this information was not available or the child arrived or left early. Morning awakening time was not assessed in this study.

Napping Behaviors

Napping at childcare has also been found to lower cortisol across napping periods, with a significant rebound in levels following the nap (Watanabe et al., 2001). It is therefore important to consider napping effects when collecting salivary cortisol.

Because teachers do not typically record nap length for children in this age range, we recorded nap awakening time and did not collect saliva samples until the child had been awake for at least 30 minutes. Previous work (Watanabe et al., 2002) indicates that rising cortisol patterns are evident again 30 minutes after getting up from a resting period.

Procedures

Recruitment Procedures

Center recruitment was conducted via center director interviews (see Appendix B). Interviews assessed variables such as program philosophy, curriculum, funding sources, center size, similarity to other centers within the area, population served, and education level of teachers. Families were then recruited through letters placed in their parent mailboxes at the identified centers. For several days after letters were distributed

and until at least one parent for each child was approached, research assistants were available during pick-up to answer questions and sign consent forms.

Saliva Sampling

Collection occurred by center, one classroom at a time. During the first week in a classroom, researchers visited the classroom daily so that the children felt comfortable in their presence and so that researchers could become familiar with the teachers and the daily schedule of activities. At the end of the week, families were recruited and teachers signed consent forms. Researchers also demonstrated salivary collection methods to the children and teachers.

Salivettes were collected from 114 participating children on a small group basis and generally occurred over 4-6 days. For the first 9 participants, salivary cortisol was obtained with a 1.5 inch dental cotton roll as opposed to a salivette. If a child had been absent, ill, or had low volumes during the sampling period, the child was sampled individually after the first group sampling period was successfully completed. Samples were collected mid-morning and mid-afternoon, as close to 10:00 and 16:00 as possible with as little disruption to the classroom schedule as possible. Both morning and afternoon samples were taken before snack or at least 30 minutes after snack or breakfast, and afternoon samples were taken at least 30 minutes after nap time and lunch. Given schedule differences in the various centers, both morning and afternoon sampling times were somewhat variable (mid-morning samples: $M = 9:5$, $SEM = .03$; range = 9:11 to 10:40; mid-afternoon samples: $M = 15:34$, $SEM = .05$; range = 14:25 to 16:37) (see Table 1). Restricting the interval between the two samples could artificially result in flatter cortisol patterns across the day, if it were true that cortisol begins to rise across the

morning period and then again between nap and late afternoon. In these data, morning sampling time was negatively related to cortisol values, $r(110) = -.41, p < .001$, indicating that later sampling time likely did not contribute to a flatter pattern in the sample. However, a positive trend was evident for afternoon sampling time, $r(109) = .18, p = .056$, indicating that the earlier sampling that occurred in two of the centers (six classrooms), may have contributed slightly to the flatter cortisol values seen across the child care day. Saliva sampling took approximately 5 minutes to complete and was structured around a game where participants shared imagined flavors for their salivettes or were sang to or told a story. Participants chewed on a synthetic cotton-like collection swab for 1 minute or until fully saturated and then deposited the roll into a small plastic tube. Families were compensated \$25 for their child's classroom participation.

Attachment and Temperament

Classroom Procedures

Lead teachers completed the AQS with support from the lead researcher for each child in the sample in their class. Each of the 90 items was read to the teacher by the researcher and then sorted into one of three roughly equal piles according to whether the behavior described was "like", "unlike", or "neither like or unlike" that child. During this division, teachers were encouraged to provide example behaviors for each sort and prompted to re-sort when piles were of unequal size. Following this initial division, the teacher further subdivided each of these three categories into three more categories as described earlier. Teachers were kept unaware of the constructs (security & dependency) under investigation and were simply instructed to use the items to create best descriptors. Teachers were paid \$10 for each AQS which took approximately 30-40 minutes to

complete. In classrooms where there were two lead teachers ($n = 2$), the AQS was completed by the teacher who was in charge of providing assessments of that child's yearly progress and therefore the appropriate lead for that child. On average, teachers completed one AQS per day while their classrooms were actively participating.

Lead teachers in each classroom were also asked to complete the T-CBQ for each child in the study and were paid \$10 for each returned questionnaire. Again team teachers in charge of assessing a particular child within the classroom completed questionnaires for that child. Teachers were asked to complete the questionnaires for all children in the study in one or two sittings to increase the likelihood that different children within the same classroom were evaluated relative to the same frame of reference.

Home Procedures

When a family was compensated for their classroom participation, a home visit was scheduled and the family was given a packet of questionnaires to complete. Included in this packet were the CBQ and the health and demographics questionnaire used in this study. In addition a child care decisions questionnaire, a family stress questionnaire, a maternal depression questionnaire, an attitudes toward maternal employment questionnaire, a family finances questionnaire, and the Child Behavior Checklist (CBCL; Achenbach & Rescorla, 2000), were included for use in a different study. For 78% of the families, questionnaire packets were completed by the child's mother. In addition, for 14% of the families, these questionnaires were translated into Spanish. Completed questionnaires were collected at the scheduled home visit.

During the 1 hr and fifteen minute home visits, one parent was designated by the family as the primary caregiver to complete the AQS with support from the lead researcher or a trained research assistant. Procedures for sorting were exactly the same as described above with lead teachers. Overlap between parents completing the CBQ and sorting the AQS was 93%.

Preliminary Analyses

Restricting the dataset

Two children refused saliva sampling. These two children were distributed across centers and classrooms. Only one of the families of these children returned a completed questionnaire packet. Both refusers were male. The child with available data was four years old and was non-white/ Hispanic. This child was within one standard deviation of the sampling mean on all of the mother and teacher-rated temperament scales. Two refusers represents a very low refuser rate (2%; typical rates are 5-10%), which may be due in part to differences in this sample from previous work (fewer children with a history of participating in multiple research projects) and also to changes in our sampling procedure (cotton dental rolls were replaced with salivettes which are more pleasant to chew). Data from children who refused saliva sampling were excluded from all subsequent analyses.

Six children took medications expected to interfere with the cortisol assay (inhaler for asthma, $n = 4$; allergy medication, $n = 2$). Children with medications were distributed across centers and classrooms. Children with medications were compared to children with no known medications on age, sex, race/ethnicity, and the three T-CBQ factors of T-Surgency, T-Negative Affectivity, and T-Effortful Control. There were no differences

between children with medications and those with no known medications on any of these variables (p 's > .30).

For an additional seven children, individual samples were excluded. For two children, two and three samples respectively were excluded due to dairy contamination. For five children, a sample for each was excluded because the cortisol values were extremely high for the total sample ($> 3 SD$ of the sample mean for that time point) and unrepresentative of that child's other values.

Data Reduction

Cortisol

Cortisol assays for each sample were performed in duplicate. These two assay results were then averaged together, creating up to a total of eight cortisol values per child, reflecting two samples per day on up to four child care days. These cortisol samples were then averaged by time point, creating two average cortisol levels reflecting mid-morning ($M = .13 \mu\text{g/dL}$, $SEM = .01$, $\alpha = .41$) and mid-afternoon values ($M = .13 \mu\text{g/dL}$, $SEM = .01$, $\alpha = .74$) at child care. This was done to stabilize estimates of child care cortisol levels irrespective of day to day fluctuations. Cortisol values at both time points were examined for positive or negative skew. A clear negative skew was evident for the child care mid-morning values, therefore \log_e transformations of both time points (Morning Cortisol = $-.21 \mu\text{g/dL}$, $SEM = .05$; Afternoon Cortisol = $-.21 \mu\text{g/dL}$, $SEM = .05$) were used for analyses. Finally, four summary variables were created. Cortisol Patterning was the average \log_e transformed mid-afternoon child care value minus the \log_e transformed mid-morning child care value with scores ranging from -1.34 to $1.41 \mu\text{g/dL}$ ($M = .06 \mu\text{g/dL}$, $SEM = .01$). A positive number reflects an increase in cortisol across the

day, while a negative number indicates a decrease across the day. Three categorical variables representing whether children showed a rising, flat, or falling pattern of cortisol production across the day were also created. Changes equal to or greater than .05 $\mu\text{g/dL}$ were used as a conservative estimate of change, derived by selecting a value above the error rate between duplicate assays of the same sample from this and previous work. The Child Care Rise variable was three categories, 1 = falling, change \leq -.05; 2 = flat, -.049 to .049; and 3 = rising, \geq .05. Due to the high percentage of children in the flat group and the physiological importance of a falling versus a rising profile, two dichotomous variables were created to allow for comparisons of the risk group to all others (Rising versus Flat or Falling) and the protected group to all others (Falling versus Flat or Rising).

Attachment Q-Sort

To generate attachment security scores for each participant and their primary caregiver and teacher, the Q-sort description of the child was correlated with the description of the hypothetical “very securely attached” child provided by Waters, Vaughn, Posada, & Kondo-Ikemura (1995) as suggested by the instrument authors (Waters & Deane, 1985). Total scores for the Security to Primary Caregiver and Security to Teacher measures could thus range from -1 to 1, with a higher score reflecting attachment security. For this sample, the average attachment security scores with the primary caregiver and teacher respectively were .37 ($SEM = .02$, range -.19 to .76) and .32 ($SEM = .02$, range -.33 to .71) indicating a moderate degree of congruence between these children and the hypothetically secure child on average and a considerable variance across the sample. Child dependency to their primary caregiver and teacher were also

derived by computing a correlation between descriptions of the hypothetical “dependent child” criterion sorts (Waters et al., 1995) and the Q-sort descriptions for the participants in this study. Total scores for the Dependency to Primary Caregiver and Dependency to Teacher could range from -1 to 1, with lower scores reflecting less dependency. Average scores in this sample for primary caregiver and teacher dependency were respectively -.08 ($SEM = .02$, range -.42 to .41) and -.19 ($SEM = .02$, range -.53 to .32). Correlation coefficients were then transformed by using Fisher’s r-to-z procedure. Transformed security scores with primary caregivers (Security Primary) ranged from -.19 to 1.00 ($M = .41$, $SEM = .02$) with dependency scores (Dependency Primary) ranging from -.45 to .44 ($M = -.08$, $SEM = .02$). Transformed security scores with teacher (Security Teacher) ranged from -.34 to .89 ($M = .35$, $SEM = .02$) with dependency scores (Dependency Teacher) ranging from -.59 to .33 ($M = -.20$, $SEM = .02$). These scores are similar to those reported by a variety of researchers using the Q-sort with preschoolers (e.g., Teti, Nakagawa, Dass, & Wirth, 1991). Finally, Fisher transformed security and dependency scores with the primary attachment figure were summed to create a variable representing differing levels of these two constructs combined (e.g., high security and high dependency; Security/ Dependency).

One useful feature of the AQS is the authors’ inclusion of “filler” or non-attachment related items. These filler items help to prevent the occurrence of socially desirable responses and also help to keep potential sorters from identifying the constructs of interest. Many of these items assess temperament. Using these 34 non-attachment related items for both the primary caregiver and teacher sorts, the null hypothesis for Bartlett’s Test of Sphericity was rejected ($p < .001$) indicating that a factor analysis could

be conducted. A principal components factor analysis with varimax rotation was then performed for both primary caregiver and teacher sorters (see Tables 2 and 3). Four factors for both sorters were identified using the Scree test criterion (Cattell, 1966). For primary caregiver, these factors together accounted for 35% of the variance and for teachers they accounted for 45%. Using a cutoff of .4, the variables that loaded on factor 1 for the primary caregiver were indicative of a child with temperamentally low sociability. The variables that loaded on factor 2 were best described as a temperamentally positive child. Factor 3 was representative of a temperamentally surgent child. Finally, factor 4 loadings were descriptive of a temperamentally negative/ difficult child (see Table 2 for loadings of variables on factors, communalities, and percents of variance). Similar factors emerged from the teacher sorts except that factor 1 loaded on negative/ difficult, factor 2 for low sociability, factor 3 for surgency, and factor 4 as positivity (see Table 3).

CBQ Temperament Ratings

The CBQ 94-item and T-CBQ 50-item questionnaires were scored according to the original factors described by Rothbart and colleagues (Rothbart et al., 2000). For the CBQ, the three conventional summary dimensions were derived from 15 scales as follows: 1) Surgency, consisting of High Intensity Pleasure, Activity Level, Impulsivity, and Shyness (reverse scored) ($\alpha = .64$); 2) Negative Affectivity, consisting of Discomfort, Fear, Anger/Frustration, Sadness, and Falling Reactivity/ Soothability (reverse-scored) ($\alpha = .58$) and; 3) Effortful Control, consisting of Smiling and Laughter, Inhibitory Control, Low Intensity Pleasure, Attention Focusing, and Perceptual Sensitivity ($\alpha = .73$). For the T-CBQ, the three conventional summary dimensions were derived from 10 scales: 1)

Surgency, consisting of High Intensity Pleasure, Activity Level, Impulsivity, and Shyness (reverse-scored) ($\alpha = .83$); 2) Negative Affectivity, consisting of Discomfort, Anger, and Sadness ($\alpha = .71$); and 3) Effortful Control, consisting of Smiling and Laughter, Inhibitory Control, and Attention Focusing ($\alpha = .51$). For both the CBQ and T-CBQ, scale scores were standardized and averaged to compute the individual conventional summary dimensions.

Demographics

Age was calculated by subtracting the first saliva sampling date from the child's birth date reported by parents. For six children, no birth date was available and therefore age in years as provided by teachers was used. Child race and ethnicity were reported by parents using the National Institutes of Health categories. Children were coded as having either minority race (any race other than White/ Caucasian American) or minority ethnicity (Hispanic) and a summed dichotomous variable was created (0 = non-minority race and ethnicity; 1 = minority race or ethnicity).

Chapter Three

Results

The analytic approach for these data was to first assess bivariate relations for cortisol, attachment, and temperament variables with age, sex, and race/ethnicity. Next, bivariate relations among the main variables were examined. Finally, the three main research questions were addressed: 1) does child attachment to primary caregiver predict cortisol reactivity across the day at child care; 2) does child temperament predict cortisol reactivity across the day at child care; and 3) can a secure attachment to the teacher buffer children against stress reactivity at child care? Because these data are nested, multi-level models (Hierarchical Linear Modeling version 6.0, SSI, Raudenbush, Byrk, Cheong, & Congdon, 2004) were used with the lead teacher as the level-2 variable, and all of the predictors and outcomes as level-1 (within child) variables. Because lead teachers completed the attachment Q-sorts and temperament questionnaires on the children in their care (or the children they knew best in classrooms with two lead teachers), and as we expected the teacher level to include classroom quality differences as well as programmatic and population center-level differences, lead teacher rather than classroom or center was used for the level-2 variable.

Bivariate Relations with Age, Sex, and Minority Race/ Ethnicity

Bivariate relations between age, sex, and race/ ethnicity and each of the five cortisol variables (Morning Cortisol, Afternoon Cortisol, Cortisol Patterning Group,

Cortisol Risers, and Cortisol Fallers), each of the six CBQ temperament factors (Surgency, Effortful Control, Negative Affectivity, T-Surgency, T-Effortful Control, and T-Negative Affectivity), each of the five attachment variables (Security Primary, Dependency Primary, Security Teacher, Dependency Teacher, and Security/Dependency Primary) and each of the eight ASQ temperament factors (Sociability, Positivity, Surgency, Negativity/Difficulty, T-Sociability, T-Positivity, T-Surgency, T-Negativity/Difficulty) were assessed. Results of these bivariate analyses are presented in Table 4. Overall, children who were older were more likely to have lower morning and afternoon cortisol values at child care, to exhibit a falling or flat cortisol pattern across the day at child care, and to be rated by parents as higher in negative affectivity. There were no relations between age and the attachment variables. Girls were more likely to be rated as securely attached to and more highly dependent on teachers. They were also rated as higher on effortful control, less sociable and less surgent by both parents and teachers, and as less negative/difficult by teachers alone. There were no sex differences in any of the cortisol variables. Minority race/ethnicity children were rated as more dependent on teachers, lower in teacher-rated negative affectivity and higher in ASQ teacher-rated surgency. There were no associations between any of the cortisol or primary caregiver attachment variables and race/ethnicity.

Cortisol Patterning Across the Day at Child Care

Mid-morning and mid-afternoon cortisol levels at child care for the full sample are plotted in Figure 2. A paired samples t-test revealed that these two time points did not differ significantly, $p > .20$, suggesting an overall flat pattern across the day for this sample.

Children were classified as exhibiting a rising, falling or flat pattern across the day using changes of .05 $\mu\text{g/dL}$ or greater between mid-morning and mid-afternoon cortisol values. Using this .05 cutoff, 17% of the participants were classified as falling across the day, 58% as flat across the day, and 25% as rising across the day (see Table 5 for percentages across the different rise/fall/ and flat variable groupings). Mid-morning cortisol, $F(15, 94) = 3.19, p < .001$, Teacher Security, $F(15, 94) = 2.98, p < .001$, and T-Negative Affectivity, $F(15, 94) = 2.06, p < .05$, all differed across teachers. As a result, all analyses were run using multilevel models (HLM, 6.0), with teacher as the level-2 variable.

Aim 1: Does Child Attachment to Primary Caregiver Predict Cortisol Reactivity Across the Day at Child Care?

Neither Security Primary nor Dependency Primary was related to mid-morning, $r(101) = .06, p > .50$; $r(101) = -.04, p > .60$, or mid-afternoon, $r(100) = .06, p > .50$; $r(100) = .00, p > .90$, cortisol values at child care (see Table 6). However, there was a trend for children who were more securely attached to their primary caregiver to be classified as showing rising cortisol across the day at child care using the dichotomous Cortisol Risers variable, $t(98) = 3.01, p = .08$.

As this result was in the opposite direction as the original hypothesis, the logic of the original hypothesis was revisited. It was originally hypothesized that children who are more securely attached to primary caregivers would be protected from stress at child care by their positive expectations for caregiving relationships and by the skills and traits they are expected to have developed through their secure primary relationships. However, the children in this study are as young as 2 years of age, and they are handling the challenge

of child care across the long day without their primary attachment figures. If they do not yet have fully developed secure working models and related skills and traits, and they are therefore still dependent on their primary caregivers for support in the face of challenge, they may be more apt to react with physiologic stress than children who are already looking elsewhere for support due to their insecure primary attachments. To test this explanation and given that security and dependency to primary caregiver were negatively correlated, $r(101) = -.20, p < .05$, a composite variable was created by adding primary caregiver dependency to the security score.

Children scoring higher on the composite Security/ Dependency variable were more likely to rise across the day at child care using the dichotomous Cortisol Risers variable, $t(98) = .20, p < .05$, and there was a trend with the 3-category Cortisol Patterning variable, $F(2, 97) = 2.97, p = .056$. Security/ Dependency did not however predict those children who were more likely to fall using the Cortisol Fallers dichotomous variable, $t(98) = 1.30, p > .40$.

With all of the variables nested at the teacher level, models were tested with primary caregiver security/ dependency and cortisol patterning using hierarchical linear modeling software (HLM). HLM analyses were used so as to maintain analytic consistency and because teacher differences were prevalent on cortisol, attachment, and temperament variables. Accounting for nesting with HLM allows for an accurate assessment of the standard errors (Raudenbush & Bryk, 2002) even when there is variability at the teacher level (e.g., some teachers had only five children and others had seventeen) (Raudenbush, Bryk, Cheong & Congdon, 2000).

A two-level hierarchical model assessed the effects of primary caregiver Security/Dependency on the dichotomous Cortisol Risers variable. Cortisol Risers was estimated using a Bernoulli technique, with 0 representing a falling or flat pattern and 1 representing a rising pattern. Both security/dependency and Cortisol Risers were first level (child) variables. The second-level unit was simply the teacher identifier variable. This analysis resulted in a significant main effect for Security/ Dependency with primary caregiver. For a one unit increase in security/ dependency, the odds of being in the riser group increased by a factor of 7.28 ($Y = 1.98, p < .05$) (see Table 7).

Aim 2: Does Child Temperament Predict Cortisol Reactivity Across the Day at Child Care?

None of the parent or teacher-rated temperament factors from the CBQ (Negative Affectivity, Effortful Control, Surgency, T-Negative Affectivity, T-Effortful Control, and T-Surgency) were related to either mid-morning or mid-afternoon cortisol values at child care (see Table 6). Looking at individual scale scores, only parent-rated Perceptual Sensitivity was negatively correlated with mid-morning cortisol values, $r(98) = -.25, p < .01$. There were no correlations between mid-morning cortisol and any of the teacher-rated temperament scales (see Table 6).

Given the number of comparisons, these few correlations are difficult to interpret and may be simply occurring by chance. Therefore, creating theoretically driven composite variables from the scales post-hoc seemed ill-advised. Using the ASQ temperament factors, none of the four primary caregiver factors were correlated with either mid-morning or mid-afternoon cortisol at child care (see Table 6). However, Sociability for the teacher AQS was significantly related to mid-afternoon cortisol at

child care, $r(99) = .26, p < .01$. A two-level hierarchical model assessed the effects of AQS teacher-rated Sociability on the dichotomous Cortisol Risers variable. Cortisol Risers was estimated using a Bernoulli technique, with 0 representing a falling or flat pattern and 1 representing a rising pattern. Both Sociability and Cortisol Risers were first level (child) variables. The second-level unit was the teacher identifier variable. This analysis resulted in a significant main effect for low sociability. For a one unit increase in low sociability, the odds of being in the riser group increased by a factor of 1.74 ($Y = .55, p < .05$) (see Table 7).

In the second model, a two-level hierarchical model assessed the effects of primary caregiver Security/ Dependency and AQS Sociability on the dichotomous Cortisol Risers variable. Cortisol Risers was estimated using a Bernoulli technique, with 0 representing a falling or flat pattern and 1 representing a rising pattern. Security/Dependency, Sociability, and Cortisol Risers were level-1 (child) variables. The second-level unit was the teacher identifier variable. This analysis resulted in a significant main effect for both Security/ Dependency and low sociability. For a one unit increase in security/ dependency, the odds of being in the riser group increased by a factor of 20.51 ($Y = 3.02, p < .01$) and for low sociability, the odds of being in the riser group increased by a factor of 1.92 ($Y = .65, p < .05$) (see Table 7).

Aim 3: Does a Secure Attachment to Teacher Buffer Children Against Cortisol Reactivity at Child Care?

Child security with teacher was not related to either mid-morning or mid-afternoon cortisol at child care (see Table 6), nor to the 3-category Cortisol Patterning variable or the Cortisol Risers variable. However, children who were more secure with

their teacher were more likely to be classified as falling across the day at child care using the Cortisol Fallers variable, $t(107) = 1.31, p < .05$.

A two-level hierarchical model assessing the effects of teacher security on the dichotomous Cortisol Fallers variable was then computed. Cortisol Risers was estimated using a Bernoulli technique, with 0 representing a flat or rising pattern and 1 representing a falling pattern. Both Security Teacher and Cortisol Risers were first level (child) variables. The second-level unit was the teacher identifier variable. This analysis resulted in a significant main effect for Security Teacher. For a one unit increase in teacher security, the odds of being in the Cortisol Fallers group increased by a factor of 13.83 ($Y = 2.63, p < .05$) (see Table 7).

In order to test for moderation, in the second model, the first level units were the primary caregiver Security/ Dependency variable, the Security Teacher variable, and an interaction term predicting the dichotomous Cortisol Risers outcome variable coded as above. The second-level unit was the teacher identifier. Comparing the deviance statistics between this model and the model without Teacher Security and the interaction term indicated that this model did not improve the fit as compared to the model with only Security/ Dependency to primary caregiver, $\chi^2(2) = 2.91, ns$. This analysis resulted in non-significant main effects for Security/ Dependency, $Y = -.14, p > .60$, Teacher Security, $Y = .11, p > .70$, and for the interaction term, $Y = .65, p > .30$, indicating that secure attachment to teachers does not matter more for children with high Security/ Dependency (see Table 7).

Additional Findings

Although this study was not designed to assess global quality differences across child care classrooms and efforts were made to constrain classroom variability, differences in ECERS-R quality ratings were found to be related to cortisol reactivity at child care in this sample. Among the six subscales on the ECERS-R (Space and Furnishings, Personal Care Routines, Language and Reasoning, Activities, Interaction, and Program Structure), only Interaction was related to mid-morning or mid-afternoon cortisol with a positive association between this subscale and mid-morning cortisol, $r(110) = .22, p < .05$. Space and Furnishings was related to the three cortisol patterning variables, with higher scores related to children being classified as falling on the Cortisol Risers variable, $t(107) = 5.39, p < .05$, and a trend on the Cortisol Patterning 3 category variable, $F(2, 106) = 2.95, p = .056$. However, entering ECERS-R quality into the models above did not improve the fit.

Chapter Four

Discussion

This study proposed a model integrating characteristics of the caregiving environment and of the child to predict stress reactivity at child care. Three main associations in this model were tested. First the study assessed whether an insecure attachment to the primary caregiver was associated with increased risk for stress reactivity across the day at child care. While it seems evident that attachment security to primary caregiver matters, attachment insecurity is not necessarily a risk factor for this outcome. Instead, children with high security coupled with high dependency to their primary caregiver were most likely to show clear elevations across the child care day.

This finding was initially surprising given the previous laboratory (Gunnar et al., 1992; Nachmias et al., 1996) and naturalistic (Ahnert et al., 2004; Gunnar & Brodersen, 1992) findings indicating that children who are less securely attached to their primary caregivers are most at risk for experiencing stress reactivity as assessed by salivary cortisol. However, only one of these studies (Gunnar et al., 1992) assessed cortisol reactivity in the absence of the primary caregiver, and even in this study the separation period was very brief (i.e., 30 minutes), as compared to the full-day, repeated separations experienced with child care. To date, Ahnert et al.'s (2004) transition study with infants is the only published study addressing long-term, repeated separations typically experienced at child care. In this study, both securely and insecurely attached infants

showed higher morning cortisol in the first few months of out-of-home child care. However, differences between children with secure versus insecure attachment classifications were only related to physiologic stress reactivity during the first 9-days of adaptation to child care when the primary caregiver was present. Insecurely attached infants were most likely to show higher morning cortisol during this period.

From an attachment perspective, the lengthy separation that occurs at child care would assume to activate the child's relevant internal working model(s) of attachment (Main, Kaplan, & Cassidy, 1985). These conscious and unconscious representations of the self and others are an integral component of the attachment system and are thought to guide the appraisals of both experience and behavior. While Bowlby (1982) described four phases in the development of attachment, he did not specifically address the developmental trajectory of internal working models. Since then, developmental researchers from several perspectives (cognitive, behavioral, social) have attempted to deconstruct the normative development of working models and their component parts with inconsistent results. Most recently, Delius, Bovenschen, & Spangler (2008) investigated working model development in a sample of preschoolers using a picture book with attachment-related stories. The findings show an increase of attachment-related knowledge across the preschool period, with the most rapid changes from four to five years. Consistent with cognitive theories about the development of domain-specific knowledge (Delius, 2004), this study demonstrated that children at this age: 1) have more knowledge about their own child-caregiver dyad than about other dyads; 2) have more knowledge about children's behavioral options than about caregivers' options; and 3) have an increase in knowledge about behavioral strategies in attachment-related

situations across the preschool period. Because working models in this study were examined only through a cognitive lens, it did not address changes in children's socio-emotional reliance on their working models between two and six years of age. However, what is evident from this study is that the cognitive representations of their working models are continuing to solidify across the preschool period.

Without fully formed working models, secure preschoolers, in the absence of their primary caregivers, may not be afforded the protection typically afforded to them in their caregiver's presence or later in development when their representations are more coalesced. This could potentially explain the nature of the attachment findings in the current study, particularly in light of the fact that it was children who were high in both security and dependency who were most likely to exhibit rising cortisol across the child care day.

Although Bowlby (1969), in his original inception of attachment theory, clearly defines the concepts of attachment and dependency as separate constructs, he also recognizes the inherent links between them. This relationship is particularly salient in infancy. In their early study on attachment, dependency, and development, Sroufe, Fox, and Pancake (1983) found that infants in all three attachment classifications demonstrated dependence on their primary caregivers. However, the behavioral manifestation of this dependence varied by attachment category (i.e., clinging vs. seeking attention in positive ways). From this perspective, it is those infants who use their dependency behaviors effectively with their caregivers early in development that will eventually become independent, securely attached children (Weinfield, Sroufe, Egeland & Carlson, 1999). As with most developmental processes, there is variability in when this transition from

appropriate dependence to independence occurs among securely attached children. Factors delaying this transition might include temperament (like shyness, fearfulness, or low sociability) or early life experiences (like child care attendance). The children in this study who have not yet solidified their working models with their primary caregiver and are still highly dependent on them may utilize their physiologic stress systems to manage the challenge of full-day child care.

An alternative explanation for the findings in the current study is that perhaps children who find child care more stressful react physiologically and behaviorally to it, and these reactions lead their caregivers to perceive them as more dependent than other children. If this were true, however, we might expect teacher ratings of dependence, which were moderately correlated with primary caregiver ratings, to also predict stress reactivity and that was not the case.

There are several limitations to the findings of the current study that should be noted. First, working models with primary caregivers were not directly assessed in this study. This did not allow for the investigation of the post-hoc explanation that working models in the securely attached, yet stress reactive, children are not yet solidified. Second, although it has been shown that parents can be successfully trained to sort the Attachment Q-sort (De Wolff & van IJzendoorn, 1997) and that the AQS items are not easily distinguished in terms of the positive or negative dimensions therefore reducing social desirability (Waters & Deane, 1985), future research should include independent assessments of the child. To more accurately assess the directionality of these findings, this research would ideally be longitudinal in nature, assessing attachment security in

infancy using the Strange Situation and subsequently assessing stress reactivity to child care in the preschool period.

A final limitation involves the outcome cortisol variables. Only the dichotomous Cortisol Risers variable (rising by at least .05 $\mu\text{g/dL}$ mid-morning to mid-afternoon as compared to children classified as flat or falling across that time period) was significantly related to primary caregiver security/ dependency. Neither the Cortisol Fallers dichotomous variable nor the three category Cortisol Patterning variable was associated with security/ dependency at the .05 significance level. This may in part be due to low power resulting from the high proportion (58%) of children in this sample exhibiting a flat cortisol pattern across the day. This large proportion of children with a flat profile limited the variability in the sample and created small cell sizes in the falling and rising cortisol groups (19 and 27 respectively). The resulting low power could account for why security/ dependency was only significantly related to the Cortisol Risers variable, with a trend for the three category Cortisol Patterning group ($p = .056$).

This study is one of the first to assess stress reactivity across the day at child care with an inclusive sample of both low socio-economic (SES) and Mexican-origin families. Children from these families are likely to have experienced more stressful life events than those children previously studied that come from a higher SES background and who have not experienced the unique challenges associated with immigration. It is possible that preschoolers living under the strain of chronic poverty who must adapt to everyday stressful events have developed an attenuated stress response after repeated exposure to chronic and severe stressors. Alternatively, these children may have a well-developed stress response that is activated to more potent stressors and they may simply not find the

relatively mild stress and challenge of high quality child care sufficient to evoke a physiologic stress response. In this sample, there was an unusually high percentage of children demonstrating a flat cortisol pattern across the day, not a higher than usual proportion of children exhibiting a falling pattern, suggesting that attenuation may in fact be present in some of the children studied.

In an effort to understand which child vulnerabilities may contribute to rising cortisol, the study also examined whether child temperament was related to stress reactivity across the day at child care. Given the inconsistent associations between temperament dimensions and stress reactivity in prior work, predicting which specific factors might be associated with rising cortisol across the day at child care was difficult. From the previous work (e.g., Dettling et al., 1999; Watamura et al. 2003; Watamura et al., 2004), it was expected that shyness, impulsivity, fearfulness, or effortful control might be associated with cortisol reactivity. In this sample, neither parent-rated nor teacher-rated child temperament, using the CBQ or T-CBQ, predicted cortisol reactivity. Instead, low child sociability as assessed by the teacher-rated AQS was shown to be a risk factor for rising cortisol across the day at child care. This finding was particularly intriguing given that it explained unique variance when included in the model with the security/ dependency attachment measure. That is, children who were higher in security and dependency with their primary caregiver and those who were low in sociability were more likely to exhibit stress reactivity at child care. This profile, although not the one originally predicted, has high face validity and warrants further attention.

One question raised by this study is why the CBQ and T-CBQ yielded null results, while the ASQ yielded one finding. It could be that the way that the ASQ is

sorted reduces the tendency to provide socially desirable answers as the authors have contended, and is therefore more valid. However, one important limitation to this study design is the reliance on parent and teacher reports of both temperament and attachment. Because the constructs themselves are interrelated, and as the reporters are the same, this particular confound limits some of the conclusions that this study can make about the relationships between cortisol, attachment, and temperament as independent constructs.

Another interpretation of the inconsistent temperament findings in these and other data is that child temperament may not necessarily have direct effects on cortisol reactivity at child care. Instead, it may indirectly influence stress reactivity via its influence on the child's relationships with both their peers and teachers. For example, a child who has low effortful control may find herself or himself in more negative situations which in turn results in greater physiologic stress reactivity.

After considering the qualities the child brings to child care, the study then assessed whether attachment security to teacher would serve as a buffer against physiological stress reactivity. Evidence supported this hypothesis such that children with higher security scores with teachers were more likely to exhibit the falling cortisol profile across the child care day. Unlike the AQS data with the primary caregiver, high dependency with teacher was not related to physiologic stress reactivity at child care. It is important to note that, as compared with parents, the teacher is present throughout much of the child care day. Thus, it could be that a child who is highly dependent on their teacher is able to have their needs met by their teacher and is therefore no more at risk for physiologic stress reactivity across the day than is a child with low dependence. Future studies will need to address this hypothesis further. One possibility would be to examine

teacher sensitivity, intrusiveness and child dependency in a semi-structured, observer-coded, interaction that would mimic some of the challenges associated with the child care (e.g., novelty and frustration).

Of course, given the correlational design, the directionality of the teacher security finding is unclear. It could be that children with better coping mechanisms have lower baseline cortisol reactivity because they find child care less stressful and are also more likely to be rated as secure by teachers. This would imply that security ratings were simply more common among these well-adapted children and were not indicative of a buffering relationship. In addition, as with the AQS findings with primary caregiver, the teacher attachment findings suffer from the limitations associated with self-report methodologies. Although it was not possible in this study to observe the teacher–child relationship for the recommended six to eight hours, other studies have used independent observers at child care to assess attachment security to teachers (De Wolff & van IJzendoorn, 1997). The findings from this study need to be replicated using an observer-sorted AQS. However, the main effect of teacher security suggests that good relationships with teachers have the potential to serve as a buffer for stress reactivity at child care. There was no evidence in this data for moderation of the relationship between security/dependency to primary caregiver and stress reactivity by security to teacher. It may simply be that all children, regardless of their attachment histories and temperamental characteristics, benefit from a secure relationship with their teacher in this age range. Alternatively, because of the high proportion of children classified with a flat pattern, there may not have been enough children in each cell to detect moderation effects. Power analyses with the two smaller group sizes and the three predictors

indicated that we only had sensitivity to detect an effect size of .42 or greater, therefore it may be that moderation was present and undetected in this study.

Other findings of note from this study include the two results with the ECERS-R global classroom quality. Because global classroom quality differences have been previously established, we attempted to constrain the quality of the classrooms studied to the high quality range. While we were generally successful at this (total ECERS-R scores were 5.66 on average), and overall ECERS-R scores were not related to the cortisol variables, two ECERS-R subscales were related in interesting ways. In those classrooms scoring higher on the interaction items, children had higher morning cortisol values. As on average in this sample mid-morning to mid-afternoon values did not differ, suggesting possible attenuation of morning samples, it follows that children in classrooms with better interactions would have the higher morning values associated with a normal declining circadian rhythm, although the interaction score was not associated with lower afternoon values, so this interpretation was only partially supported.

Thirty-eight percent of children in classrooms scoring in the bottom half of the distribution for the space and furniture items (4.86 – 5.57) were classified as risers and only 19% of those in classrooms scoring in the top of half of the distribution (5.86 – 6.43) were risers. As crowding has been previously associated with elevated cortisol levels (Evans & Wener, 2007) this finding is sensible and suggests that it may be worth considering crowding and noise specifically in studies of stress reactivity at child care. While the quality data from this sample are interesting, they should be interpreted with caution given the limited variability among the 14 classrooms as compared, for example, to the work of Sims and colleagues (Sims et al., 2006).

Future Directions

The current study demonstrated that children classified as high in security and dependency to their primary caregivers, and classified with low sociability are more likely to show rising cortisol across the day at child care. In addition, this study showed that those children classified as securely attached to their lead teacher are more likely to show decreasing cortisol across the day at child care. This finding is particularly intriguing given the potential implications for intervention. If it is true that the behaviors representative of a secure attachment relationship can serve to buffer preschoolers from experiencing increases in cortisol across the day at child care, it may be possible to decrease the percentage of children rising across the day at child care by implementing an intervention to support these behaviors.

Emotional Availability as an Avenue for Intervention

One promising avenue for intervention is called Emotion Availability (EA). EA refers to “the degree to which each partner (in a relationship dyad) expresses their emotions and is responsive to the emotions of the other” (Emde, 1980, pp. 80). The concept of EA is influenced by the concepts of maternal sensitivity, emotional availability, and of the prototypical sensitive caregiver in Bowlby’s (1982; Bretherton, 1985; Cassidy, 1990) attachment theory. Biringen, Robinson, & Emde (1990, 1993, 1998) have developed an observational system for capturing EA during caregiver–child interactions. EA includes four adult dimensions (sensitivity, structuring, non-intrusiveness, and non-hostility). Within this framework, it is important how the caregiver attends to the emotional signals of the child, and how the caregiver emits her/ his own emotional signals.

Although EA has not yet been assessed in relation to physiologic stress reactivity, EA has been associated with increased infant-mother attachment security (Biringen, Damon, Grigg, Mone, Pipp-Seigel, et al., 2005), secure working models in children (Rethazi, 1998), and attachment security to teachers at child care (Biringen, Robinson, & Emde, 2008), and therefore may be useful as an intervention strategy for protecting children attending child care against cortisol reactivity across the day. EA provides us with an effective and concrete method for helping teachers to become more sensitive and emotionally attuned to the children in their care. This, in turn, might help to facilitate the development of secure attachment bonds. Efforts to implement this particular intervention in this population as a follow-up to this study are in the early planning stages.

Conclusions

The current study provides evidence for the existence of both individual and relationship risk factors for stress reactivity across the day for the child attending full-day, center-based child care. Furthermore, it extends previous work by including children from diverse socioeconomic backgrounds. Partial support for the proposed model was demonstrated, and ways to further test the proposed associations emerged. These results also propose one avenue for supportive intervention. While this study did not address outcomes associated with stress reactivity at child care, previous work suggesting possible negative outcomes further recommends piloting an intervention.

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Appendix A

Child Health & Demographic Questionnaire

What is your child's age in years and months (ex. 3 years 4 months) _____

Was your child adopted?

Yes _____ No _____ If yes, at what age _____
and what is her/his country of origin? _____

How many brothers/sisters does your child have (please include all children you are raising, whether or not they are biologically related to this child)? _____

For each child, please indicate:

Sister/Brother	Age: ____	Living with this child? Yes/No	Sister/Brother	Age: ____	Living with this child? Yes/No
Sister/Brother	Age: ____	Living with this child? Yes/No	Sister/Brother	Age: ____	Living with this child? Yes/No
Sister/Brother	Age: ____	Living with this child? Yes/No	Sister/Brother	Age: ____	Living with this child? Yes/No
Sister/Brother	Age: ____	Living with this child? Yes/No	Sister/Brother	Age: ____	Living with this child? Yes/No

What is your child's race? (Please check all that apply)

____ American Indian or Alaskan Native ____ Asian or Asian-American
____ Black or African-American ____ White
____ Native Hawaiian or other Pacific Islander

What is your child's ethnicity? (Please check one)

____ Hispanic or Latino
____ Not Hispanic or Latino

What is your child's first language? _____

Please list any other languages your child speaks: _____

Does your child use an inhaler for asthma or other reasons?

Yes _____ If yes, please name the brand or medication _____
No _____

Does your child have any allergies?

Yes _____ If yes do you take any medication for allergies?
No _____ Yes ____ No ____

Does your child take any other medications regularly? If so, please list:

Is your child currently feeling sick or has your child been sick in the last week? If yes, please list symptoms and number of days they have felt this way:

Does your child have any medical conditions that were not addressed above? If so, please describe:

Appendix B

Center Director Interview Questions

Thank you for your interest in this research project. I have several questions I'd like to ask about your center. We plan to use the information from these interviews to select centers that are as similar as possible. We are not looking for particular characteristics; instead we are hoping to find a group of centers that are reasonably similar.

1. First, are you part of a larger umbrella organization?

2. Do you have any partnerships or sister centers or formal relationships with any other centers?

3. Are there any other centers you are aware of in the Denver Metro area that are similar to your center?

4. How would you describe your program's philosophy?

Appendix B

5. Do you use a particular curriculum

6. What sources of funding do you use to run your center

- a. tuition _____
- b. child care subsidies _____
- c. support from a parent organization like a corporation or church _____
- d. Other _____

7. What is the size of your center?

- a. Capacity _____
- b. Current enrollment _____
- b. How many classrooms do you have? _____
- c. How many children are served in each classroom? _____

8. What age ranges do you serve?

- a. Youngest: _____
- b. Oldest _____

9. What is your adult:child ratio for preschool age children?

10. What level of education do your preschool teachers have?

- a. How many teachers total _____
- b. how many with no college education _____

Appendix B

c. with CDA or AA _____

d. with BA _____

e. with MA _____

11. How many years of experience do your teachers have? (How many teachers total, how many years each?) _____

12. What are your aggregate family demographics?

a. Race percentages

b. Ethnicity percentages

c. percent receiving subsidies

13. What percentage of your families are Mexican-origin immigrants? _____

a. What strengths do you see in these families? _____

b. What unique challenges do these families face? _____

c. What do you feel you do well to meet the needs of these families? _____

d. In what areas do you think there is room for improvement in meeting the needs of these families?

14.

a. How many of your preschool classrooms are half day? _____

b. How many full-day? _____

Appendix B

Great. Thank you so much for your time. At this point we are interviewing several directors for our research project. Once interviews are complete we would like to begin conducting classroom observations in approximately 32 classrooms. We will contact you by late January to let you know whether or not we would like to invite teachers at your center to participate in classroom observations for the purpose of finding 16 classrooms to conduct our full study. Both you and individual teachers will have an opportunity to decide at that point if you would like to move forward. I just want to emphasize that we are selecting classrooms for observation based only on their similarity to a sizable group of other classrooms.

Do you have any questions?

At this point do you think your center might be interested? (Question for first tier only)

Thank you!

Table 1. Average Sampling Times by Center

	Center A	Center B	Center C	Center D	Center E
Mid-Morning Sampling Time	9:33 (9:31 to 9:36)	10:16 (9:52 to 10:40)	9:15 (9:11 to 9:32)	9:48 (9:37 to 10:01)	10:06 (9:51 to 10:29)
Mid- Afternoon Sampling Time	15:32 (15:29 to 15:34)	15:17 (14:58 to 15:45)	15:33 (15:11 to 15:55)	16:13 (15:52 to 16:37)	15:04 (14:25 to 15:40)

Table 2. Loadings of Primary Caregiver Sorted AQS Variables on Factors, Communalities, and Percents of Variance

Item	F ₁	F ₂	F ₃	F ₄	h ²
Child follows mother's suggestions readily even when they are clearly suggestions rather than orders	.10	.61	-.03	.02	.39
When mother says to follow her, child does so	.07	.65	-.17	.33	.56
When mother asks child to do something, she/he readily understands what she wants (may or may not obey)	-.26	.12	.14	.17	.13
When mother tells child to bring or give mother something, she/he obeys	.18	.39	.27	-.06	.30
Child is strongly attracted to new activities and toys	-.20	.38	.44	-.12	.40
Child is light hearted and playful most of the time	-.35	.59	.05	-.19	.51
Child examines new objects or toys in great detail. Tries to use them in different ways or take them apart	.22	.45	.43	-.02	.44
Child's facial expressions are strong and clear when she/he is playing with something	-.01	.46	.15	.22	.28
Child is more interested in people than in things	-.53	-.02	-.10	.16	.32
Child is careful and gentle with toys and pets	-.33	.27	-.56	-.00	.50
Child quickly gets used to people or things that initially made him/her shy or frightened	-.40	.48	.12	-.17	.43
Child walks around without bumping, dropping or stumbling	-.01	.12	-.09	-.36	.15
When child is in a happy mood, she/he is likely to stay that way all day	.01	.55	-.01	-.37	.43
Child prefers toys that are modeled after living things (e.g. dolls, stuffed animals)	-.35	-.08	-.27	.37	.32
On the average, child is a more active type person than mother	-.04	-.03	.62	.13	.41
Child makes at least some effort to be clean and tidy around the house	.33	.27	-.01	.37	.32
Child is very active. Always moving around. Prefers active games to quiet ones	-.06	-.13	.72	.04	.53
Child is often business-like when playing away from mother or alone with her/his toys	-.03	-.01	-.06	.40	.17

Child enjoys climbing all over visitors when she/he plays with them	-.26	.08	.43	.00	.26
Child laughs and smiles easily with a lot of different people	-.65	.33	.17	-.02	.57
Child ignores most bumps, falls or startles	.10	.10	.37	-.33	.27
Child is fearless	.15	.16	.43	-.48	.47
Child spends most of her/his playtime with just a few favorite toys or activities	.17	.02	.11	-.11	.05
Child quickly loses interest in new adults if they do anything that annoys them	.42	-.09	.20	.23	.28
Child's initial reaction when people visit the home is to ignore or avoid them, even if she/he eventually warms up to them	.61	.04	-.21	.01	.41
When child cries, she/he cries hard	-.05	.00	.15	.61	.39
Child largely ignores adults who visit the home. Finds her/his own activities more interesting	.70	-.01	-.04	-.10	.50
When given a choice, child would rather play with toys than with adults	.57	.16	.08	-.10	.37
Child becomes shy or loses interest when an activity looks like it might be difficult	.35	-.25	-.08	.21	.24
Child easily becomes angry with toys	.36	-.02	.32	.40	.32
Even before trying things her/himself, child tries to get someone to help her/him	.30	.31	-.24	.45	.44
Child is easily upset when mother make her/him change from one activity to another	.05	-.42	.18	.15	.23
Child often cries or resists when mother takes her/him to bed for naps or at night	.05	.27	-.20	-.14	.13
At times, child attends so deeply to something that she/he doesn't seem to hear when people speak to her/him	.03	-.15	.42	.34	.31
Percent of variance	9.39	9.25	8.40	7.54	

Table 3. Loadings of Teacher Sorted AQS Variables on Factors, Communalities, and Percents of Variance

Item	F ₁	F ₂	F ₃	F ₄	h ²
Child follows teachers suggestions readily even when they are clearly suggestions rather than orders	-.58	.14	.15	.31	.48
When teacher says to follow her, child does so	-.71	.14	.01	.16	.55
When teacher asks child to do something, she/he readily understands what she wants (may or may not obey)	-.42	-.03	.25	.13	.26
When teacher tells child to bring or give teacher something, she/he obeys	.06	.07	-.06	.84	.71
Child is strongly attracted to new activities and toys	-.10	-.15	.58	-.30	.46
Child is light hearted and playful most of the time	-.17	.03	.15	.83	.74
Child examines new objects or toys in great detail. Tries to use them in different ways or take them apart	.07	.11	.62	-.00	.41
Child's facial expressions are strong and clear when she/he is playing with something	.25	-.03	.54	.26	.42
Child is more interested in people than in things	-.03	-.76	-.16	-.19	.64
Child is careful and gentle with toys and pets	-.73	.09	-.02	.05	.54
Child quickly gets used to people or things that initially made him/her shy or frightened	.03	-.18	.32	.39	.29
Child walks around without bumping, dropping or stumbling	.57	-.04	-.10	.19	.37
When child is in a happy mood, she/he is likely to stay that way all day	-.44	.18	-.01	.59	.57
Child prefers toys that are modeled after living things (e.g. dolls, stuffed animals)	-.40	-.19	-.26	.02	.26
On the average, child is a more active type person than the teacher	.66	-.06	.41	.17	.63
Child makes at least some effort to be clean and tidy around the house	-.62	-.01	.09	-.03	.40
Child is very active. Always moving around. Prefers active games to quiet ones	.70	-.02	.33	.21	.64
Child is often business-like when playing away from teacher or alone with her/his toys	-.11	.21	-.05	-.23	.22

Child enjoys climbing all over visitors when she/he plays with them	.55	-.35	.06	.38	.57
Child laughs and smiles easily with a lot of different people	.24	-.42	.28	.50	.57
Child ignores most bumps, falls or startles	-.01	.24	.42	.04	.24
Child is fearless	.39	-.22	.55	.15	.52
Child spends most of her/his playtime with just a few favorite toys or activities	.16	.56	-.26	.04	.41
Child quickly loses interest in new adults if they do anything that annoys them	.12	-.10	.20	-.62	.45
Child's initial reaction when people visit the class is to ignore or avoid them, even if she/he eventually warms up to them	-.27	.66	-.30	-.12	.59
When child cries, she/he cries hard	.55	-.17	-.33	-.12	.46
Child largely ignores adults who visit the class. Finds her/his own activities more interesting	-.19	.78	-.07	-.19	.68
When given a choice, child would rather play with toys than with adults	.06	.72	.15	.15	.58
Child becomes shy or loses interest when an activity looks like it might be difficult	.08	.32	-.46	-.26	.39
Child easily becomes angry with toys	.52	-.09	-.06	-.32	.39
Even before trying things her/himself, child tries to get someone to help her/him	.05	-.01	-.47	-.11	.24
Child is easily upset when mother make her/him change from one activity to another	.61	-.06	-.02	-.26	.44
Child often cries or resists when caregiver takes her/him to bed for naps	.25	-.29	-.06	.03	.15
At times, child attends so deeply to something that she/he doesn't seem to hear when people speak to her/him	.33	.18	.12	.07	.16
Percent of variance	15.70	13.82	8.20	7.94	

Table 4. Bivariate Relations Between Variables and Participant Demographics

Variables	Age	Sex	Race/Ethnicity
Cortisol			
Morning Cortisol	$r(106) = -.35^*$	$t(108) = .01$	$t(91) = .08^+$
Afternoon Cortisol	$r(105) = -.30^{**}$	$t(108) = 2.79$	$t(90) = 1.19$
Cortisol Patterning Group	$F(104) = 2.70^+$	$\chi^2(2,110) = .77$	$\chi^2(2,92) = 1.37$
Cortisol Risers	$t(105) = .29^*$	$\chi^2(1,110) = .70$	$\chi^2(1,92) = .66$
Cortisol Fallers	$t(105) = .03$	$\chi^2(1,110) = .05$	$\chi^2(1,92) = 1.19$
Attachment			
Security Primary	$r(101) = -.16$	$t(99) = 3.04$	$t(91) = .71^+$
Dependency Primary	$r(101) = -.01$	$t(99) = .80$	$t(91) = .07$
Security/ Dependency	$r(99) = -.15$	$t(99) = 1.35$	$t(91) = 1.01$
Security Teacher	$r(106) = -.08$	$t(108) = 3.25^{**}$	$t(91) = .33$
Dependency Teacher	$r(106) = .04$	$t(108) = 1.02^*$	$t(91) = 3.42^*$
Temperament			
Parent-rated			
Negative Affectivity	$r(96) = .24^*$	$t(96) = 3.51$	$t(90) = .01$
Effortful Control	$r(96) = -.07$	$t(96) = .37^*$	$t(90) = 3.92$
Surgency	$r(96) = .14$	$t(96) = 1.07$	$t(90) = 2.23$
Teacher-rated			
T-Negative Affectivity	$r(106) = .08$	$t(108) = .64$	$t(91) = .08^{**}$
T-Effortful Control	$r(106) = .15$	$t(108) = 2.42^*$	$t(90) = 2.77$
T-Surgency	$r(106) = .08$	$t(108) = 2.42^{**}$	$t(90) = 6.57$
AQS Factors - Primary			
Negative/ Difficult	$r(93) = -.05$	$t(91) = 1.20$	$t(85) = .01$
Sociability	$r(93) = .60$	$t(91) = .17^{**}$	$t(85) = 10.71$
Surgency	$r(93) = .18$	$t(91) = 1.14^{***}$	$t(85) = .00$
Positivity	$r(93) = -.14$	$t(91) = .14$	$t(85) = 3.63$
AQS Factors - Teacher			
Negative/ Difficult	$r(98) = .02$	$t(98) = 11.23^{***}$	$t(81) = .80$
Sociability	$r(98) = -.09$	$t(98) = .01^{**}$	$t(81) = 3.52$
Surgency	$r(98) = .18^+$	$t(98) = 1.08^{**}$	$t(81) = 3.16^{***}$
Positivity	$r(98) = -.14$	$t(98) = 31.15$	$t(81) = .48$

Table 5. Mean (SEM) Cortisol Values and Cortisol Patterning Percentages

Mid-Morning Cortisol		Mid-Afternoon Cortisol	
-2.18 (.05)		-2.12 (.05)	
Percent Falling Across the Child Care Day	Percent Flat Across the Child Care Day	Percent Rising Across the Child Care Day	
17.4%	57.8%	24.8%	
<i>N</i> = 19	<i>N</i> = 63	<i>N</i> = 27	

Table 6. Intercorrelations Among the Variables

	1	2	3	4	5	6	7	8	9	10	11	12	
1. Morning Cortisol	-												
2. Afternoon Cortisol	$r = .43^{***}$ $n = 110$	-											
3. Negative Affectivity	$pr = .03$ $n = 98$	$pr = -.04$ $n = 98$	-										
4. Effortful Control	$r = -.15$ $n = 98$	$r = -.00$ $n = 98$	$r = -.13$ $n = 98$	-									
5. Surgency	$r = -.07$ $n = 98$	$r = -.08$ $n = 98$	$r = -.05$ $n = 98$	$r = -.05$ $n = 98$	-								
6. Teacher Negative Affectivity	$r = .07$ $n = 98$	$r = -.13$ $n = 98$	$r = .27^{***}$ $n = 98$	$r = .16$ $n = 98$	$r = .02$ $n = 98$	-							
7. Teacher Effortful Control	$r = -.03$ $n = 110$	$r = -.05$ $n = 110$	$r = -.11$ $n = 98$	$pr = .07$ $n = 98$	$r = .05$ $n = 98$	$r = -.44^{***}$ $n = 110$	-						
8. Teacher Surgency	$r = -.06$ $n = 110$	$r = -.11$ $n = 110$	$r = -.10$ $n = 98$	$pr = .07$ $n = 98$	$r = -.05$ $n = 98$	$r = .00$ $n = 110$	$r = .21^*$ $n = 110$	-					
9. Security Primary	$r = .06$ $n = 101$	$r = .06$ $n = 100$	$r = -.26^{**}$ $n = 98$	$r = .37^{***}$ $n = 98$	$r = .00$ $n = 98$	$r = -.18^*$ $n = 101$	$r = .14$ $n = 101$	$r = .05$ $n = 101$	-				
10. Dependency Primary	$r = -.04$ $n = 101$	$r = .00$ $n = 100$	$r = .30^{**}$ $n = 98$	$r = -.06$ $n = 98$	$r = -.27^{**}$ $n = 98$	$r = .10$ $n = 101$	$r = -.09$ $n = 101$	$r = -.22^*$ $n = 101$	$r = -.20^*$ $n = 101$	-			
11. Security Teacher	$r = .14$ $n = 110$	$r = .04$ $n = 110$	$r = -.18^*$ $n = 98$	$pr = .01$ $n = 98$	$r = .00$ $n = 98$	$r = -.35^{***}$ $n = 110$	$pr = .41^{***}$ $n = 110$	$pr = .06$ $n = 110$	$r = .29^{**}$ $n = 101$	$r = .02$ $n = 101$	-		
12. Dependency Teacher	$r = .09$ $n = 110$	$r = .02$ $n = 110$	$r = .08$ $n = 98$	$r = .21^*$ $n = 98$	$r = -.27^{**}$ $n = 98$	$pr = .35^{***}$ $n = 110$	$r = -.27^{**}$ $n = 110$	$r = -.26^{**}$ $n = 110$	$r = .04$ $n = 110$	$r = .39^{***}$ $n = 101$	$r = .07$ $n = 110$	-	
13. T-Sociability	$r = .06$ $n = 100$	$r = .24^*$ $n = 99$	$r = .01$ $n = 88$	$pr = -.15$ $n = 88$	$r = -.19^+$ $n = 88$	$pr = -.26^{**}$ $n = 100$	$pr = .02$ $n = 100$	$pr = -.49^{***}$ $n = 100$	$r = -.16$ $n = 91$	$r = -.02$ $n = 91$	$pr = -.08$ $n = 100$	$pr = -.27^{**}$ $n = 100$	-

+ = .10; * $p < .05$; ** $p < .01$; *** $p < .001$

Table 7. Summary of Hierarchical Linear Modeling Analyses

	Notation	Coefficient	Standard Error	T-ratio	Approx. DF	P-value	Odds Ratio
Model 1 (Outcome Fall/ Flat vs. Rise)							
Intercept	B0	-1.80	.48	-3.72	15	.00	
Security/ Dependency Primary Caregiver	B1	1.98	.96	2.06	98	.04	7.28
Model 2 (Outcome Fall/ Flat vs. Rise)							
Intercept	B0	-1.35	.29	-4.70	15	.00	
Teacher Sociability	B1	.55	.26	2.11	97	.04	1.74
Model 3 (Outcome Fall/ Flat vs. Rise)							
Intercept	B0	-2.45	.60	-4.09	15	.00	
Security/ Dependency Primary Caregiver	B1	3.02	1.13	2.64	87	.01	20.51
Teacher Sociability	B2	.65	.29	2.21	87	.03	1.92
Model 4 (Outcome: Rise/ Flat vs. Fall)							
Intercept	B0	-2.64	.62	-4.27	15	.00	
Teacher Security	B1	2.63	1.30	2.02	107	.05	13.83
Model 5 (Outcome: Fall/ Flat vs. Rise)							
Intercept	B0	.18	.12	1.59	15	.03	
Security/ Dependency Primary Caregiver	B1	.14	.29	-.48	96	.63	-.77
Teacher Security	B2	.11	.30	.37	96	.71	.54
Interaction Term	B3	.65	.67	.97	96	.34	1.51

Figure 1. Conceptual Model

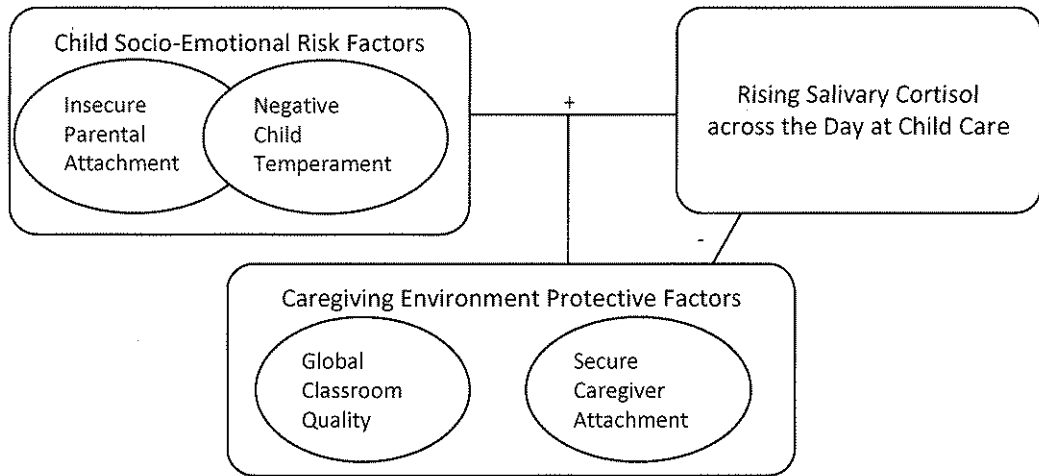


Figure 2. Salivary Cortisol Values Across the Day at Child Care

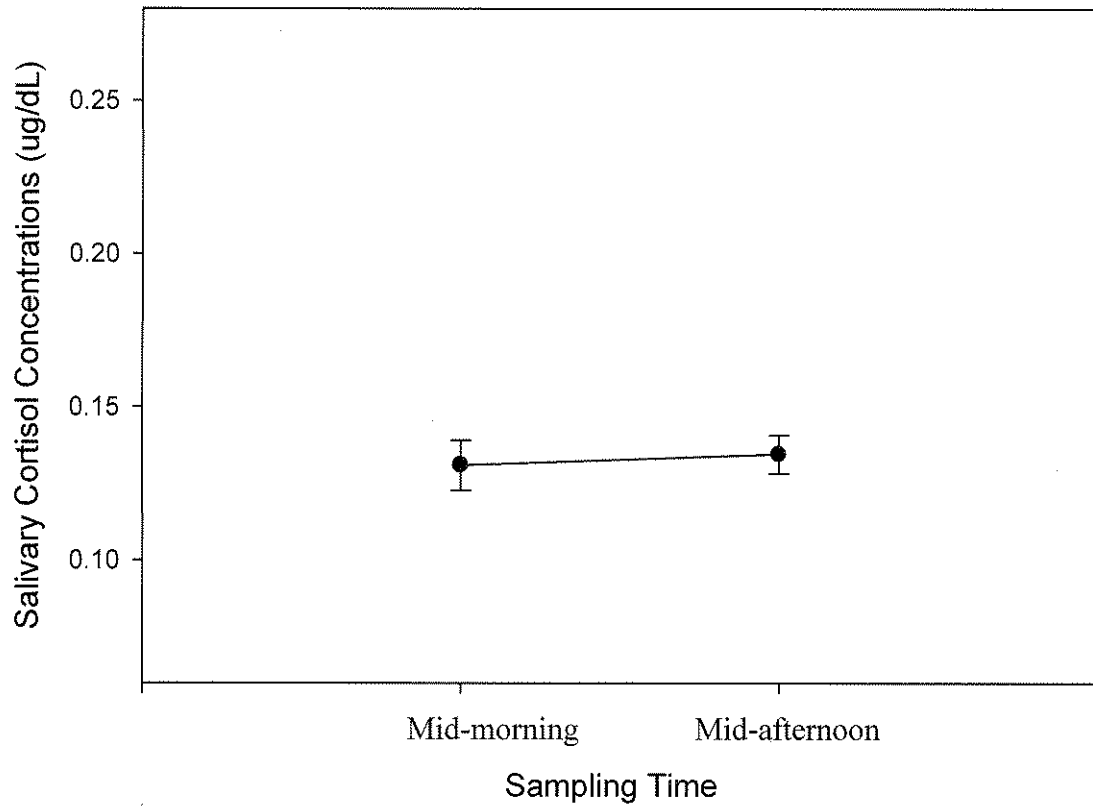


Figure 3. Cortisol Patterning by Security/ Dependency, Teacher Security and Teacher Sociability

