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INTERPARENTAL VIOLENCE IN EARLY CHILDHOOD: IMPLICATIONS FOR EMOTIONAL, PHYSIOLOGICAL AND BEHAVIORAL REGULATION

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Abstract

Estimates indicate that millions of infants and young children are exposed to interparental violence each year, yet much is still unknown about the potential effects of such violence on early emotional competencies and regulatory skills. Guided by emotional security theory, the current investigation sought to advance research on interparental violence and young children's emotional, physiological, and behavioral regulation. Using a large, diverse sample of couples with young children living low-income, non-urban communities, the following two studies utilized mixture modeling techniques to provide a more comprehensive and nuanced view of interparental violence and young children's emotional responses and regulatory skills.

Study 1 examined the linkages between interparental violence, self-regulatory behaviors, and the development of stress response patterns across early childhood. Latent profile analysis revealed distinct patterns of adrenocortical and behavioral stress responses at 7-, 15-, and 24-months of age (7m n = 735; 15m n = 634; 24m n = 567). Interparental violence was linked with unique patterns of responding to emotion-eliciting stressors in infancy and toddlerhood, although stress responses at 15-months appeared unrelated to family functioning. Further, infant and toddler stress responses were linked with the use of specific self-regulatory strategies, suggesting possible patterns of adaptation to violent homes. Latent transition analysis revealed substantial reorganization in stress responses across early childhood, and a trajectory of risk if children did not transition to well-regulated stress-response profiles.

Study 2 examined whether the presence of severe interparental violence in the home was associated with differences in emotion regulation processes at 24-months of age (n = 427). Using hidden Markov modeling, differences in the organization and unfolding of emotional expressions and regulatory actions were found for children from violent homes. Specifically, toddlers from

violent homes appeared to have difficulties redirecting attention away from the source of their frustration or communicating their desires to caregivers at low levels of negative reactivity, and engaged in more disruptive forms of anger release as they became more upset, relative to children from non-violent homes. The presence of severe interparental violence was also linked with higher levels of negative reactivity when children became distressed, as well as fewer states characterized by neutral affect. Further, the degree of violence appeared to make a difference, as children from more violent homes spent a greater amount of time in highly distressed states. Collectively, these findings suggest specific deficits in foundational emotional and regulatory skills linked with interparental violence, highlighting the need for further research examining the processes and pathways through which these linkages occur, and the need for interventions directly addressing these deficits.

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Chapter 1

General Introduction

Concern over the effects of interparental violence on child adjustment is well-founded. Estimates indicate that 30% of American children live in families in which interparental violence occurs, and approximately 7 million of these children are in households characterized by severe violence (McDonald, Jouriles, Ramisetty-Mikler, Caetano, & Green, 2006). Exposure to violence is not only widespread, but is considered to be one of the most damaging stressors occurring in childhood (Margolin & Gordis, 2000). Indeed, interparental aggression has been linked with a wide array of maladaptive child outcomes, including behavior problems (e.g., Sternberg, Lamb, Guterman, & Abbot, 2006), anxiety and depression (e.g., Graham-Bermann, 1996; Sternberg et al., 1993), academic and peer problems (e.g., Paley, Conger, & Harold, 2000; Davies, Woitach, Winter, & Cummings, 2008), and trauma symptoms (e.g., Bogat, DeJonghe, Levendosky, Davidson, & von Eye, 2006). Young children may be particularly at risk, as evidence suggests interparental discord may intensify in early childhood (e.g., Shapiro, Gottman, & Carrère, 2000), and younger children are disproportionately exposed to violence occurring in the home (Fantuzzo & Fusco, 2007). However, the processes and pathways through which interparental violence influences early childhood adjustment are still poorly understood (Cummings & Davies, 2002; Cummings, El-Sheikh, Kouros, & Buckhalt, 2009).

Examining children's emotional, physiological, and behavioral regulation may be critical in understanding how interparental violence influences child outcomes (Cummings et al., 2009), particularly in early development. The early childhood family context is thought to play a key role in shaping children's abilities to monitor, evaluate, and modify emotional reactions

(Thompson, 1994), as well as adaptive modulation of the physiological stress response (Gunnar & Quevedo, 2007; Lueken & Lemery, 2004). Although most work has focused on the role of parenting processes in shaping early regulatory skills, evidence with older children suggests the interparental relationship also plays an important role (e.g., Davies & Cummings, 1998; Davies, Sturge-Apple, Cicchetti, & Cummings, 2007). Further, alterations in early regulatory skills may be an important link between exposure to interparental aggression and child maladjustment. Impaired emotional, physiological, and behavioral regulation is associated with mental health risk in a number areas, including greater depression (Cicchetti & Toth, 1998; Luby et al., 2003), anxiety (Campbell-Sills & Barlow, 2007; Essex, Klien, Eunsuk, & Kalin, 2002), externalizing behavior (Gilliom, Shaw, Beck, Schonberg, & Lukon, 2002; Kuczynski & Kochanska, 1990; Granger et al., 1996), and early-onset child psychopathology, in general (Keenan, 2000; Gunnar & Vazquez, 2006). However, work to date has primarily focused on contemporaneous reactions and regulation to interparental conflict; less is known about whether and how interparental aggression may alter the general development of early regulatory skills, which may be an important link in understanding the factors contributing to adjustment problems. Further, more comprehensive examinations of interparental violence and children's functioning are needed, particularly those that recognize the complexity and diversity of children's responses, and the multitude of pathways that may lead to maladjustment. The current investigation sought to address these gaps.

Guided by family systems perspective and grounded in Davies and Cummings' (1994) emotional security theory, the following two empirical papers examined relations between interparental violence and children's developing emotional, physiological, and behavioral regulation. Data for these studies were drawn from the Family Life Project, an ongoing

longitudinal investigation of family functioning and child development in a large, diverse sample of families, involving detailed observational, physiological, and survey data. After discussing the theoretical perspectives framing these studies, this chapter will give a brief overview of extant work on relations between interparental aggression and children's regulation. The limitations of this existing research will be discussed, leading to the specific aims of the current two studies.

Theoretical Perspectives

Studies of interparental aggression and child development can be understood within a family systems perspective (e.g., Cox & Paley, 1997), which suggests that insight into individual development can be gained through understanding the functioning of the family context, and that relationships across levels of the family system are necessarily interrelated and interdependent. Further, the family system is considered to follow principles of adaptive self-stabilization and self-organization, such that disruptions within one aspect of the family result in coordinated changes to the functioning of individuals and family subsystems. While these changes may be important in maintaining and regulating functioning within and across the family system, they may be maladaptive for the individual and set the stage for future dysfunction. Thus, aggressive conflict between parents is likely to have cascading effects across the family, triggering changes which may be adaptive for the family system, but may be dysfunctional for children's long term development.

Building from a family systems framework and attachment theory, Davies and Cummings (1994) put forth a specific theoretical rationale to account for how and why high levels of discord were associated with a wide range of maladaptive outcomes: emotional security theory. In this theory, frequent exposure to aggressive, violent, or unresolved interparental conflict is hypothesized to undermine children's feelings of safety, security, and protection

within the family; it is this sense of emotional insecurity that is thought to play a critical role in placing children's adjustment at risk. Drawing from a functionalist perspective on emotions (e.g., Campos, Mumme, Kermoian, & Campos, 1994), responses to aggressive conflict are best understood in relation to the individual's goals, and the dynamic relation between the person and the environment. Maintaining a sense of emotional security is a central goal that organizes children's emotional experiences, action tendencies, and internal representations (Davies, Winter, & Cicchetti, 2006); the threats to emotional security provoked by interparental violence are thought to trigger heightened emotional reactivity (e.g., fear, distress), attempts to regulate conflict exposure (e.g., avoidance, disruptive behavior), and engender negative internal representations of family relations (e.g., the consequences of aggressive conflict for personal well-being and the functioning of the family). In turn, these responses are theorized to broaden and integrate into general patterns of responding, contributing to maladaptive functioning outside of the family context. Thus, heightened emotional arousal and reactivity may prime the child to react quickly to signs of threat in a violent home, but may tax important psychological resources and prompt maladaptive responses to other challenges within the environment. Similarly, avoidance of interparental conflict may be adaptive in violent or aggressive homes, but if avoidance becomes a behavioral style for dealing with emotions or challenging situations, it may negatively impact the child's adjustment.

Interparental Conflict and Children's Emotional, Physiological, and Behavioral Regulation

Guided by emotional security theory and a family systems perspective, a growing body of research suggests that interparental violence undermines children's feelings of emotional security, which may place children's adjustment at risk (e.g., Davies & Cummings, 1998; Harold, Shelton, Goeke-Morey, & Cummings, 2004). The following sections briefly review the

linkages between interparental aggression and children's regulatory processes, focusing on emotion regulation and stress responses. Due to the limited research on associations between interparental violence and disrupted regulatory processes in early childhood, research with older children and adolescents, as well as interparental conflict in general, is included where relevant.

Interparental Violence and Emotion Regulation. As maintaining emotional security is theorized to be a primary emotion regulation goal (Cummings & Davies, 1996), the conceptual linkages between interparental aggression, emotional security concerns, and emotion regulation are clear. It should be noted that these linkages to emotion regulation refer to "emotion as regulating and emotion as regulated" (Cole, Martin, & Dennis, 2004; p. 320) -- both the changes taking place as a result of the emotion that has been activated, and changes in the emotion itself (the intensity, temporal features, or valence of the emotion; Thompson, 1994). For example, high levels of fear engendered by violence may alter attention processes, as the child attempts to maintain vigilance against threats to their emotional security (emotion as regulating). Alternatively, avoidant self-regulatory strategies engendered in aggressive homes (e.g., withdrawal or physically avoiding the negatively arousing stimulus) may alter the child's ability to successfully reduce their distress in other situations (emotion as regulated).

Research on interparental aggression and children's emotion regulation has largely focused on the emotional and behavioral responses to conflict. For example, research on kindergarten, school-aged, and adolescent children suggests that children from high conflict homes attempt to regulate their distress in the face of interadult anger by avoiding or intervening in the argument (Davies & Cummings, 1998; Davies & Forman, 2002). Cummings, Pellegrini, Notarious, and Cummings (1989) found preschool-aged children from high conflict homes engage in similar behavior in response to interadult anger, attempting to defend their parent or requesting to leave.

Further, interparental aggression in the home is linked with indices of emotion dysregulation in response to conflict, as evidenced by preschool and school-aged children's heightened agitation, fear, anger and aggression, or blends of positive and negative emotionality (e.g., Davies, Myers, Cummings, & Heindel, 1999; El-Sheikh, Cummings, & Goetsch, 1989; Martin & Clements, 2002). It has been suggested that, with repeated exposure, these regulatory patterns in response to conflict may generalize to broader patterns of responding to challenging situations, contributing to children's adjustment problems (Davies & Cummings, 1994; Shelton & Harold, 2007).

Interparental Violence and Stress Responses. Consistent with emotional security theory, evidence suggests that exposure to interparental violence is stressful for children. As previously noted, several studies have shown that interparental conflict is associated with increased fear, anger, and arousal in school-aged children, particularly when the conflict is aggressive or involves the use of physical force (e.g., Davies, Sturge-Apple, Winter, Cummings, & Farrell, 2006; Harold, Shelton, Goeke-Morey, & Cummings, 2004). Discord appears to be a salient stressor even within the infancy and toddler period, with young children showing clear signs of behavioral distress in response to interparental conflict or interadult anger (Cummings, et al., 1981; Dejonghe, Bogat, Levendosky. von Eye, & Davidson, 2005). Although links between increased distress to conflict and alterations in young children's behavioral responses to other stressors have yet to be established, research with elementary school-aged children suggests heightened emotional reactivity to discord may mediate relations between interparental conflict and children's adjustment problems (Davies & Cummings, 1998).

Emerging evidence suggests that interparental discord may also alter physiological stress responses, particularly those related to adrenocortical functioning. In the face of challenge, two

major stress responsive systems coordinate a host of physiological changes to meet external and internal demands – the autonomic nervous system (ANS) and the hypothalamic-pituitary-adrenal (HPA) axis. While evidence indicates the coordination of the ANS may moderate associations between conflict exposure and adjustment problems (El-Sheikh et al., 2009), there is also research to suggest that alterations to the functioning of the HPA axis may be one pathway through which interparental aggression shapes child functioning (Davies, Sturge-Apple, Cicchetti, & Cummings, 2007). Controlling slower, long-term responses to challenge, the HPA axis is considered to be an "environmentally sensitive physiological system", involving interactions among the hypothalamus, pituitary, and adrenal glands (Granger et al., 1998; p.709). In response to stress, corticotrophin-releasing hormone (CRH) is released by cells in the paraventricular nuclei of the hypothalamus, where it travels through blood vesicles to the anterior pituitary, stimulating the release of adrenocorticotrophic hormone (ACTC) from the anterior pituitary into general circulation (Gunnar & Quevedo, 2007). Cortisol is released from the adrenal cortex in response to ACTH, and is considered to be the major end product of the HPA axis (Chrousos & Gold, 1992). The cortisol response allows the body to respond to stress by mobilizing energy, modulating the biology of growth and repair, and altering the processing of emotionally-salient events (Gunnar & Davis, 2003; Lupien et al., 2006). Within normative HPA functioning, negative feedback loops maintain cortisol levels within a certain range; high levels of cortisol stimulate down-regulation of the HPA-axis, ultimately resulting in a return to basal levels of cortisol (Thompson, 2000).

However, chronic stress may alter the operation of the HPA system, with serious repercussions for children's health and development. The concept of allostatic load suggests that repeated exposure to environmental adversity may result in damage to multiple domains of

functioning, due to the harm incurred by repeated attempts to maintain homeostasis, or insufficient activation or deactivation of these physiological responses (McEwen, 1998; McEwen & Seeman, 1999). Consistent with this concept, research indicates that chronic stress in the family environment may disrupt normative patterns of adrenocortical activity, placing children's development at risk (Gunnar, 1998; Gunnar & Donzella, 2002; Repetti, Taylor, & Seeman, 2002). Indeed, there is emerging evidence linking chronic conflict in the home with altered adrenocortical functioning. In a study of 63 children, Pendry and Adam (2007) found greater wake-up and average cortisol levels in kindergarteners and adolescents from high conflict homes, even after controlling for maternal emotional functioning and parenting quality. Similarly, in a sample of 48 school-aged children, Saltzman, Holden, and Holahan (2005) found elevated baseline levels of cortisol in children exposed to violence. In one of the larger studies conducted to date (n = 178), Davies and colleagues (2007) found that intense interparental conflict was associated with kindergartener's diminished cortisol reactivity to a simulated phone argument, which in turn predicted children's externalizing symptoms over a 2-year period. However, alterations in diurnal rhythm, average cortisol levels, or reactivity to conflict may not map onto adrenocortical functioning in response to general stressors, making investigation of cortisol reactivity in the face of challenges particularly important (Fisher, Gunnar, Dozier, Bruce, & Pears, 2006).

Overall Limitations of Extant Research on Interparental Violence and Child Outcomes

The past few decades of research have offered a great deal of theoretical and empirical insight on the ways in which intense interparental conflict may alter child outcomes. Research suggests that hostile, aggressive, or violent interparental relations may undermine children's social and emotional well-being, altering the ways in which children regulate emotions,

physiology, and behavior. However, a number of gaps remain in our knowledge of the pathways and processes through which interparental violence may shape child adjustment. The current study sought to address gaps in three main areas: 1) the influence of interparental violence on regulation in early childhood, 2) the integration of children's physiological and behavioral responses to family stress, and 3), the specific ways in which emotion regulation processes may differ for children exposed to violence.

Interparental Violence in Early Childhood. Although young children may be particularly at risk for witnessing interparental aggression (Fantuzzo, Boruch, Beriama, Atkins, & Marcus, 1997; Shapiro, Gottman, & Carrere, 2000), little is known about how exposure to interparental violence may alter stress responses and regulatory skills in early childhood. This is an important limitation, as the family context provides foundational experiences for the development of emotion self-regulation (Morris et al., 2007), and early caregiving environments play a critical role shaping behavioral and biological stress responses (e.g., Gunnar & Davis, 2003). Interparental violence may be especially threatening in early development, as "young children are emotionally sensitive but lack the skill, experience, and self-sufficiency to deal with strong emotions" (Cole, Luby, & Sullivan, 2008; p. 143), and young children may have limited strategies for minimizing exposure to dysregulating conflict (Crockenberg, Leerkes, & Lekka, 2007). Further, experiences in the first two years of life are thought to be critical for the development of normative neuroendocrine regulation (Ashman et al., 2002), and early emerging dysregulated patterns of adrenocortical functioning are likely to persist without intervention (Dozier et al., 2006).

Additionally, although evidence suggests exposure to chronic or intense interparental aggression may alter children's subsequent responses to interadult anger, whether and how

violence within the home alters general responses to emotional challenges is less understood. The extension and generalization of these emotional and regulatory responses is a critical link in understanding the processes leading to maladaptation over time, and warrants further investigation. This may be particularly the case in early childhood, when foundational development is occurring in general regulatory skills.

Integration of children's physiological and behavioral responses to family stress. As noted by Katz (2001), "It is only through integrating our understanding of both biological and behavioral processes that we can get a complete picture of the effects of marital conflict on the whole child" (p. 207). Despite repeated calls for a more holistic approach to children's responses to family stress and widespread recognition of how important the interplay of biological and behavioral responses are for child adjustment (Cummings, El-Sheikh, Kouros, & Buckhalt, 2009; Fox, Hane, & Perez-Edgar, 2006; Granger & Kivlighan, 2003), little is known about how exposure to interparental violence may shape the integration of children's stress responses across physiological and behavioral domains. This is a notable gap, as there is reason to believe that the coordination of behavioral and physiological responses may reveal important information about stress and self-regulation, as well as patterns of adaptation in violent homes.

At an analytic level, such an approach is consistent with person-oriented analyses. A central tenet of person-oriented research is that individuals should be viewed as an organized totality in order to understand their functioning and development (von Eye & Bergman, 2003). Common subgroups or types of individuals are thought to exist within a population, such that individuals with similar patterns of functioning and development can be grouped together and distinguished from individuals who belong to other groups (Bergman & Magnusson, 1997; Curran & Wirth, 2004). Thus, it is assumed that various factors may not function in similar ways

in different individuals, and that analyses that aggregate population characteristics without taking into account these group-based differences may obscure meaningful associations and misrepresent relationships (Bergman, Magnusson, & El-Khouri, 2003). With this in mind, examining constellations of behavioral and adrenocortical reactivity and regulation may provide important insight into the development of dysfunctional patterns of stress responses.

Interparental Violence and Emotion Regulation Processes. Dysfunctional emotion regulation has often been inferred by observing high levels of distress in children from high conflict homes, or through the use of specific strategies by these children (e.g., avoidance, involvement). However, as noted by Cicchetti, (2002), examining the coordination of emotional expression and regulatory actions may help capture the adaptability of regulatory skills in ways that an overall mean score on an emotion variable or a regulatory behavior cannot. Unfortunately, accurately assessing and analyzing the temporal dynamics between the multiple co-occurring behaviors involved in emotion regulation has been a consistent challenge for the field (as noted by Dennis, Cole, Wiggins, Cohen, & Zalewski, 2009). As a result, there is a dearth of knowledge regarding interparental violence and emotion regulation processes.

Specifically, it is unknown how interparental violence may alter the coordination of emotional expression and regulatory actions, or the ways in which these regulatory dynamics unfold over time. Emotional security theory underscores the importance of the overall organization of emotion and behavior in understanding children's responses to interparental aggression, and scientists increasingly recognize that critical information on emotion regulation skills may be gained by examining the integration of emotional expressions and regulatory actions over time, and how these facilitate or impede functioning given situational demands (e.g., Dennis et al., 2009; Cole et al., 2004; Sroufe, 1996). Examination of emotion regulation as a

process, including the expression, sequence, and duration of emotions and self-regulatory behaviors, could offer insight into the specific deficits engendered by interparental violence, as well as possible avenues for intervention.

Research Aims

Guided by emotional security theory and a family systems perspective on family functioning and individual development (e.g., Cox & Paley, 1997; Davies & Cummings, 1994), as well as the need for more comprehensive and nuanced information on interparental violence and children's emotional, physiological, and behavioral regulation, the current investigation used a large, diverse sample of families with young children to examine the following two aims:

Aim 1: To examine associations between interparental violence, self-regulatory behaviors, and the development of unique stress response profiles across early childhood. Adaptation to stress is thought to involve the coordination of emotions, physiology, and behavior in order to meet environmental demands (Eisenberg et al., 1997; Stansbury & Gunnar, 1994), yet much work remains in understanding how conflict may influence integrated patterns of stress responses across these domains in early childhood. Thus, Study 1 used latent profile analysis (LPA) to examine whether profiles of adrenocortical and behavioral stress responses could be identified at 7-, 15-, and 24-months of age. Children's adrenocortical response and negative reactivity and to an emotion-eliciting challenge were used, along with global ratings of negative emotions and basal cortisol levels. Multinomial logistic regression models were then used to examine whether and how interparental violence within the past year, as well as concurrent self-regulatory behaviors, were associated with the probability of membership in the latent stress response classes at each time point. Finally, latent transition analysis (LTA) was used to examine

transitions in class membership over time, as well as the ways in which earlier violence was associated with later class membership.

Aim 2: To examine whether the presence of severe interparental violence in the home is associated with alterations in toddler emotion regulation processes. Severe interparental violence is theorized to impair children's regulatory skills, yet surprisingly little is known about whether and how interparental discord may alter the process of emotion regulation, particularly in early childhood. Study 2 employed hidden Markov modeling (HMM) to identify latent states of emotional expression and regulatory actions, using toddler's expressions of negative reactivity, orienting, soothing/communication, and avoidance/active regulation behaviors at 24-months during a toy-removal procedure. Differences in state characteristics, state sequence, and state duration were explored in a sample of children from violent and non-violent homes. Hierarchical regression models were then used to examine if greater interparental violence was associated with state duration for children from violent homes.

Recruitment and Sample Summary

Although a detailed description of sample recruitment for the Family Life Project (FLP) is too cumbersome for inclusion in each of the proposed papers (and has been described in detail elsewhere, e.g., Vernon-Feagans et al, 2008; Willoughby, Blair, Greenberg, & Stifter, 2007), the information below provides comprehensive background information on the data from which the current investigation is drawn.

One of the overarching goals of the Family Life Project is to examine the ways in which poverty and rurality shape family life and child development; areas were chosen for recruitment that were representative of two geographical regions with chronic rural poverty: the Black South and Appalachia (Dill, 2001). Specifically, three contiguous counties in Pennsylvania (a part of

Appalachia) and North Carolina (a part of the Black South) were selected; counties were selected in which the largest town had a population of no more than 50,000 people. Further, these counties contained adequate poverty rates and racial distributions (in NC) to address questions of interest within the project. Using a developmental epidemiological design, complex sampling procedures were used to recruit a representative sample of families, over-sampling for low-income (< 200% of the poverty threshold for a given household size, use of social services with a similar income requirement (e.g., food stamps, WIC), head of the household had less than a high school education) and African American families.

Families were recruited directly from three hospitals in PA (one per county), which represented a weighted probability sample of the seven hospitals providing coverage to 89% of all births to residents in the three target counties; a sub-sample of hospitals were selected in PA because the targeted recruitment rate for this site was much smaller than the number of projected births in these counties. Families were recruited from the three hospitals in the target counties in NC, as well as by phone for residents of the counties who gave birth in hospitals outside of the county. Families were excluded from participation if they did not speak English as a primary language in the home, did not reside in the target county, had plans to move outside of the state within the following three years, or had parental rights terminated by the state (except in cases where the child would be cared for by family members in the target county).

Over the course of the year, recruiters identified 5,471 women who gave birth to a child. Of these families, 72% met the inclusion criteria for the study. Out of these families, 68% were willing to be considered for the study, and 58% of these families were invited to participate in the project, based on screening information related to income and race collected in the hospital. Of the families who were sent an invitation letter to participate, 1,292 families (82%) enrolled in

the project, participating in a first home visit when the target child was approximately 2-months old. Of these families, 1,204 (93%) families participated when the child was approximately 7-months of age, 1,169 (90%) at 15-months of age, 1,144 (89%) at 2-years of age. Although data collection is ongoing, the current studies focused on child development during the first two years of life in order to address questions related to early childhood development. Due to the current focus on interparental violence, only families in which the child's biological mother resided with a romantic partner were selected for the following two studies; other specifics on sample selection are described within each study.

Chapter 2

Interparental Violence and Early Childhood Stress Responses: Patterns of Adrenocortical and Behavioral Reactivity

A long history of research suggests interparental violence poses a significant threat to children's development, yet the specific processes linking violence in the home and child adjustment remain unclear (Cummings, El-Sheikh, Kouros, & Buckhalt, 2009). Central to understanding the processes that place some children at risk is the notion of maladaptive or adaptive stress responses, or the ways in which children manage internal or external demands that strain their resources (Eisenberg, Fabes, & Guthrie, 1997). Emotional security theory suggests that interparental aggression threatens children's feelings of safety and security in the family, and how children respond to the stress of this emotional insecurity may be an important link between exposure to violence and early mental health risk (Davies & Cummings, 1994). Over time, patterns of responding to repeated emotional security threats are theorized to broaden and coalesce, contributing to the formation of general patterns of responding to challenging situations (Shelton & Harold, 2007). However, longitudinal work examining these processes is scarce (Cummings et al., 2009), and much is unknown about the links between interparental violence and the development of stress response patterns, particularly in infancy and early childhood. Specifically, adapting to stress is thought to involve the coordination of physiological, emotional, and behavioral responses (Eisenberg et al., 1997; Stansbury & Gunnar, 1994), yet much work remains in understanding how conflict may influence integrated patterns of responding across these domains. It is a central goal of the current study to examine the development of holistic patterns of physiological, emotional, and behavioral stress responses in

early childhood, and to examine how interparental violence may influence these integrated patterns of functioning.

As noted by Davies and Forman (2002), a "person oriented" approach that identifies patterns of stress responses may significantly advance our understanding of children's holistic functioning, and the diversity of strategies developed for preserving emotional security in discordant homes. A central premise of person-oriented research is that individuals should be considered as an integrated whole in order to understand their functioning and development (von Eye & Bergman, 2003). In contrast to variable-oriented approaches, in which the focus is on understanding relations between levels of variables (e.g., regression, structural equation modeling), the focus of person-oriented approaches is on understanding the holistic functioning of individuals, and identifying subgroups with similar patterns of functioning and development (e.g., cluster analysis, latent profile analysis) (Laursen & Hoff, 2006). From this perspective, insight can be gained by examining the overall organization of behavior and physiology, as each aspect takes on meaning through the role it plays in the general functioning of the individual (Magnusson, 1998). For example, the meaning of one behavior or characteristic (e.g., behavioral distress) may be misinterpreted if separated from the broader context of child functioning at other levels (e.g., physiological arousal). Further, if there are distinct patterns of responding to the stress of interparental aggression, the use of methodologies that take into account group-based differences could expand and clarify our understanding of the processes that place some children at risk. Consistent with an organizational perspective, the use of an approach that examines the ways in which children attempt to maintain their emotional security in violent homes is warranted (Davies & Forman, 2002).

There is a strong theoretical rationale for using a person-oriented approach in the study of stress responses. Although heightened negative emotions have been consistently used as indices of stress (e.g., Levine, 1983; Shelton & Harold, 2007), a separate line of research has examined the functioning of the hypothalamic-pituitary-adrenal (HPA) axis and its primary product, cortisol (e.g., Gunnar 1992). As one of the two main components of the psychobiology of the stress response, HPA axis activity and relative elevations in cortisol have been used as physiological indicators of stress, and alterations in adrenocortical functioning may indicate chronic stress exposure (Gunnar, Connors, Isensee, & Wall, 1988; Gunnar & Donzella, 2002). The cortisol response allows the body to respond to internal or external threats by mobilizing energy, modulating the biology of growth and repair, and altering the processing of emotionally salient events (Gunnar & Davis, 2003; Lupien et al., 2006). However, prolonged elevations in cortisol or blunting of this physiological response suggest maladaptive patterns of functioning, as elevated or blunted adrenocortical activity is associated with impairments in physical and mental health (McEwen & Seeman, 1999; Gunnar & Vasquez, 2006). For example, persistent HPA axis activity may promote atrophy in the hippocampus and prefrontal cortex, the neural systems responsible for memory, selective attention, learning, and inhibitory control (Bremner & Vermetten, 2001; McEwen, 2006), while abnormally low cortisol levels may also impair brain development, disrupt self-regulatory abilities, and heighten the risk for behavior problems (e.g., Blair, Granger, & Razza, 2005; Gunnar & Vazquez, 2001; Shirtcliff, Granger, Booth, & Johnson, 2005).

Because behavioral distress and elevated cortisol levels are frequently used to indicate stress in young children (e.g., Gunnar, 1992; Levine, 1983), it is often assumed that behavioral and adrenocortical stress reactions operate in a parallel fashion. However, evidence suggests that

the linkages between behavioral and adrenocortical reactivity are not straightforward (Stansbury & Gunnar, 1994); some studies report modest positive associations between cortisol reactivity and behavioral distress (e.g., Lewis & Thomas, 1990), while others report negative associations (e.g., Gunnar & Vazquez, 2001). Indeed, Gunnar and Donzella (1999) suggest that adrenocortical and behavioral reactions serve distinct functions, and each may have a unique developmental course. Loose coupling across these coordinated but autonomous components of the stress response may permit different patterns of adaptation (Gunnar & Davis, 2003; Quas, Hong, Alkon, & Boyce, 2000). For example, high cortisol levels despite minimal behavioral signs of distress may suggest active attempts to regulate or mask overt signs of negative emotions, while high behavioral signs of distress with minimal cortisol elevations may reflect suppression of the adrenocortical response due to chronic adversity in the environment. Thus, examining constellations of functioning across adrenocortical and behavioral domains may provide a more complete understanding of adaptation in the face of stress.

Although yet to be examined in a holistic fashion, emerging evidence from variable-oriented research suggests that interparental violence may alter both behavioral and adrenocortical responses to stressors. With respect to behavioral responses, research suggests interparental aggression may heighten negative reactions, although children may attempt to suppress overt signs of distress. For example, Schermerhorn, Cummings, DeCarlo, and Davies (2007) found that greater interparental discord was related to increases in kindergarteners' negative emotional reactivity to conflict, and interparental aggression has been linked with increased distress, fear, and anger in school-aged and adolescent children (e.g., Davies, Myers, Cummings, & Heindel, 1999; El-Sheikh, Cummings, Goetsch, 1989; Martin & Clements, 2002). Emotional security theory suggests that exposure to violence may heighten vigilance and

intensify negative reactivity, providing physical and psychological resources so that the child can react quickly to signs of threat in the home (Davies & Cummings, 1994). However, Davies and colleagues (2006) have suggested that children may attempt to "mask" distress expressions in violent households, in order to not draw the attention of hostile, angry caregivers (Davies, Winter, & Cicchetti, 2006). Indeed, restricted, flat affect and blunted emotional expressions have been linked with exposure to violence (for a review, see Margolin & Vickerman, 2007). Although this restriction of emotional expression may be adaptive in violent homes, inhibiting emotional expression may impair long-term functioning and tax the child's resources (Cole, Michel, & Teti, 1994; Davies & Forman, 2002).

With respect to adrenocortical functioning, a large body of variable-oriented research indicates that chronic stress in the family environment may disrupt normative adrenocortical activity (Hart, Gunnar & Cicchetti, 1995; Heim et al., 2000). Although work specifically on interparental violence and children's adrenocortical functioning is scarce, a growing body of research suggests aggression within the home may be linked with dysregulated adrenocortical activity. In a sample of kindergarteners and adolescents, low marital satisfaction and concurrent exposure to interparental aggression was associated with higher wakeup and average cortisol levels, even after controlling for maternal emotional functioning and parenting quality (Pendry & Adam, 2007). Similarly, in a sample of 5-13 year olds, Saltzman, Holden, and Holahan found elevated levels of cortisol in children exposed to violence, in comparison to a clinical group without domestic violence exposure. Examining concurrent cortisol responses to conflict, Davies and colleagues (2007) found that kindergarteners' diminished cortisol reactivity to conflict mediated associations between interparental discord and child externalizing problems two years later. Taken together, one could conjecture that these findings may reflect distinct consequences

of allostatic adjustments made to offset prior elevations in cortisol resulting from chronic conflict exposure (Gunnar & Vasquez, 2001; McEwen, 1998), but studies have yet to show how these processes unfold over time. Additionally, it is unknown how interparental violence may alter adrenocortical reactivity to general stressors.

Although holistic patterns of behavioral and adrenocortical responses to stress have yet to be investigated in infancy and early childhood, there is some evidence that a person-oriented approach may offer insight into adaptive and maladaptive stress responses in the face of interparental violence. Using cluster analysis, Davies and Forman (2002) found three profiles of behavioral responses to parental conflict in school-aged children and adolescents: *secure* children, who displayed well-regulated concern, *preoccupied* children, who displayed high distress and avoidant or involved (e.g., interfering in the conflict) regulation to interadult anger, and *dismissing* children, who showed avoidant patterns of regulation and negative emotional reactions, despite indicating low subjective distress. Although this study failed to find evidence for a fourth hypothesized profile, the *masking* pattern in which the child attempts to suppress overt signs of distress despite high subjective arousal, it has been theorized that this pattern may be particularly prevalent in violent homes (Davies, Winter, & Cicchetti, 2006). By taking a holistic view of overt and internal experiences of distress, these findings offer important insight into the divergent coping styles employed by children in the face of conflict. However, it is unknown how patterns of responding to inter-adult anger may map onto general patterns of responding to stress, and the incorporation of adrenocortical activity may provide more complete information on the ways in which children adapt to the chronic stress of interparental violence.

Further, it is unknown how interparental violence may influence behavioral and adrenocortical stress response patterns across infancy and early childhood. This is a notable gap,

as young children are at increased risk for interparental violence exposure (Fantuzzo, Boruch, Beriama, Atkins, & Marcus, 1997), and early experiences in the family are thought to play a central role in shaping both behavioral and biological stress responses (e.g., Gunnar & Davis, 2003; Morris, Silk, Steinberg, Myers, & Robinson, 2007). The first two years of life may be particularly important for the development of normative adrenocortical functioning, with a large body of research suggesting chronic stress in early childhood may have lasting effects (e.g., Ashman, Dawson, Panagiotides, Yamada, & Willkinson, 2002; Gunnar & Davis, 2003). Research suggests infants and toddlers are clearly attuned to, and distressed by, interadult anger (Cummings, Zahn-Waxler, & Radke-Yarrow, 1981), and work with older children indicates conflict involving physical aggression is particularly upsetting (e.g., Cummings et al., 1989; El-Sheikh & Cheskes, 1995). Indeed, infants and toddlers who witness interparental violence may show symptoms of hyperarousal, appearing more anxious or irritable on average (Bogat, Dejonghe, Levendowsky, Davidson, & von Eye, 2006; Scheeringa & Zeanah, 1995).

Research Aims

In sum, guided by emotional security theory (Davies & Cummings, 1994), the current study examined whether interparental violence was associated with unique patterns of responding to stress in early childhood. First, we explored whether meaningful patterns of behavioral and adrenocortical stress responses could be indentified in 7-, 15-, and 24-month old children using a person-oriented, latent-variable approach: latent profile analysis (LPA). Although largely exploratory, it was hypothesized that the majority of children would display well-regulated stress responses (as indicated by average levels of adrenocortical activity and low to average levels of behavioral activity), but that subgroups in which at least one aspect of the child's functioning (behavioral or adrenocortical) demonstrated a less optimal response would

also be present, consistent with Davies and Forman's (2002) findings. Further, given previous research suggesting substantial changes in the organization of adrenocortical and behavioral relations in early childhood (for a review, see Gunnar & Poggi-Davis, 2003), it was hypothesized that there would be shifts in the patterns present across development. Second, the current study examined if recent interparental violence and concurrent regulatory behavior were associated with membership in these latent, stress response classes. It was hypothesized that recent violence within the home would be associated with less optimal stress responses, and that these children would also demonstrate distinct regulatory behaviors in the face of challenge (Davies &Forman, 2002). Third, the longitudinal associations between stress response profiles were examined across early childhood, as well as the linkages with prior violence exposure. It was hypothesized that children who demonstrated less optimal stress response patterns would follow distinct trajectories across early childhood, and that earlier violence would predict later membership in less optimal stress response profiles.

Method

Participants

Participants for the current study were drawn from the Family Life Project, an ongoing longitudinal investigation of child development and family functioning in 1,292 families residing in predominately low-income, nonmetropolitan communities in Pennsylvania and North Carolina. Families were recruited from local hospitals shortly after the birth of a child over the course of a year, over-sampling for low-income and African American families. For detailed information regarding the sampling plan and recruitment procedures in the Family Life Project, see Vernon-Feagans, Pancsofar, Willoughby, Odom, Quade, & Cox, 2008.

The current study focuses on home visits that took place when the target child was approximately, 7-, 15, and 24-months of age. Because interparental violence was a central construct of interest, the sample was restricted to children who resided with their biological mother and her romantic partner. Of the 1,204 (93%) families who participated at the 7-month visit, 1,169 (97%) resided with their biological mother across early childhood, and 781 (67%) of these resided with a romantic partner at the 7-month visit. Of these families, 743 (95%) participated in the 15-month visit, 688 (93%) of which resided with the same romantic partner. At the 24-month visit, 668 (97%) of these families participated in the home visit, 622 (93%) of which resided with the same romantic partner. To minimize potential developmental differences in children's stress responses (and to be consistent with previously established developmental cut-points for this sample (e.g., Blair et al., 2008)), the decision was made to restrict the sample to restrict the analyses to children that were seen between 5- and 9- months of age at the 7-month visit, between 13- and 19- months at the 15-month visit, and between 22- and 29-months at the 24-month visit. This resulted in the exclusion of 46 children at the 7-month visit, an additional 15 children at the 15-month visit, and an additional 6 children at the 24-month assessment. Thus, the final sample consisted of 735 children at the 7-month visit, 634 children at the 15-month visit, and 567 children at the 24-month visit.

At the 7-month visit, approximately half of the children were female (48%), and 25% were identified as Black (75% identified as White). The majority of the couples were married (74%), and 51% of the families had an income to needs ratio less than 200% of the poverty line.

Procedures

Families were visited in their home by trained research assistants when the target child was approximately 7-, 15-, and 24-months of age in order to conduct in-home interviews, and to

collect observational and physiological assessments of the target child. Mothers completed questionnaires via laptop computer and reported demographic information on all household members. Home visitors independently completed post-visit ratings of the child's behavior over the course of the entire visit. At each visit, children participated in a series of developmentally appropriate challenging tasks designed to elicit emotional reactivity and self-regulatory behavior, which were videotaped for later coding (e.g., Buss & Goldsmith, 1998; Kochanska, Tjebkes, & Forman, 1998; Stifter & Braungart, 1995). For all of the tasks at each time point, mothers were informed that they could stop the procedure at any time, and the research assistant terminated the tasks if the child engaged in 20-seconds of hard crying.

7-month Challenge Tasks. At the 7-month visit, infants were presented with series of three tasks while seated in a walker: a mask presentation, followed by a barrier challenge, and finally an arm restraint procedure. For the *mask presentation*, mothers were seated beside their child while the child was presented with a succession of four unusual masks for 10-second intervals. While wearing each of the masks, the research assistant leaned towards the seated child, turned their head from side to side, and repeated the child's name. Mothers were asked not to interfere or distract their child, but to respond as they normally would if their child looked to them. For the *barrier challenge*, mothers were asked to step outside of the infant's line of sight, but to remain within hearing distance of their child. Infants were given an attractive toy to play with for 30 seconds, which was then removed by the research assistant and placed behind a clear, plastic barrier just beyond the child's reach for 30 seconds. The toy was then returned to the child, and the procedure was repeated twice for a total of three cycles. For the *arm restraint* procedure, the mother remained outside of the child's line of sight, and a research assistant crouched behind the infant and gently restrained the child's arms for two minutes. The infants'

arms were then released, and the child was allowed to self-soothe for one minute. Mothers were then told they could comfort their child as they would normally.

15-month Challenge Tasks. At the 15-month visit, children were presented with two tasks while seated in a booster seat: a toy-removal procedure (replacing the barrier task), followed by the mask presentation. For the *toy removal* task, the mother was given an attractive toy, and asked to play with the child and the toy for one minute. The mother was then instructed to remove the toy and place it outside of the child's reach, at which point the home visitor and the mother engaged in conversation while the child remained in the booster seat. After two minutes, the mother returned the toy to the child, but did not play or engage the child with the toy in any way. The *mask presentation* followed this task, and involved the same protocol as in the infancy assessment.

24-month Challenge Tasks. At the 24-month visit, a similar *toy-removal* task to the procedure at 15-months was conducted. The mother and child played together with an attractive toy for one minute, and then the mother was asked to remove the toy and place it inside a clear container with the lid screwed on tightly. The container was then given to child while the mother and research assistant conversed for two minutes. The mother was then returned the toy to the child and soothed or engaged the child in play for one minute. The *mask presentation* was conducted after this task, following the identical protocol to the 7- and 15-month assessment.

Adrenocortical Assessment. To assess overall levels of adrenocortical activity, as well as cortisol reactivity and recovery in response to the emotionally arousing challenge tasks, three saliva samples were collected from children: 1) a baseline sample collected prior to the challenge tasks, 2) a sample collected 20-minutes after the child's peak arousal to the tasks, and 3) a sample collected 40-minutes after the child's peak arousal. Peak arousal was clearly outlined for

home visitors in the protocol, with a substantial portion of the children reaching peak arousal during the final task in the series at each time point. Saliva samples were collected using cotton or hydrocellulose absorbent material and expressed into cryogenic storage vials (cotton) or by centrifugation upon arrival at the laboratory (hydrocellulose) (Granger et al., 2007). Prior studies have found no differences in cortisol levels depending on the use of cotton or hydrocellulose collection techniques (Granger, et al.; Harmon, Granger, Hibel, & Rumyantseva, 2007). After collection, samples were placed on ice, temporarily stored in a -20°C freezer, shipped overnight in batches to the Behavioral Endocrinology Laboratory at the Pennsylvania State University, and then stored in -80°C freezers until they were assayed.

All samples were assayed in duplicate for cortisol using a highly sensitive enzyme immunoassay (510k) designed to measure adrenal function from saliva samples (Salimetrics, University Park, PA). The tests utilized 25 µL of saliva, had average intra- and inter-assay coefficients of variation less than 10 and 15%, and had a lower limit of sensitivity of .007 µg/dL (range of sensitivity from .007 to 3.0 µg/dL).

Measures

Covariates. Mothers reported on demographic information on all household members, including age, race, marital status, and income from all sources. In order to calculate the income-to-needs ratio of the family, the total household income from all sources was divided by the federal poverty threshold for that year, adjusted for the number and types of individuals in the household. An income-to-need ratio of 1.00 indicates the family income is at the poverty line.

Interparental aggression. Mothers reported on their own and their partners' use of verbal aggression and violence during the past 12-months when the child was 7-, 15-, and 24- months of age (Conflict Tactics Scale - Couple Form R (CTS-R); Straus, 1979; Straus & Gelles, 1990). The

9-item violence scale assesses the frequency with which she or the partner used physical force as a means of resolving the conflict (α = .81-.86; e.g., "How often has he kicked, bit, or hit you with a fist?"), ranging from 0 = "never" to 6 = "more than 20 times in the past year". Additionally because child outcomes may vary depending on the severity of violence in the interparental relationship, the subscales of minor and severe violence were also used. Minor violence consisted of 3 items (e.g., "How often has he slapped you?"). Severe violence consisted of 6 items (e.g., "How often has he beat you up?").

Adrenocortical functioning. In order to assess children's adrenocortical response to the challenge tasks relative to their baseline levels, "Area under the curve with respect to increase" (AUC_I, Pruessner, Kirschbaum, Meinlschmid, & Hellhammer, 2003) was used as an indicator of the change in cortisol levels after this stressor; this measure incorporates changes in cortisol (from baseline levels) in samples taken both 20- and 40 -minutes after the child's peak emotional reactivity to the challenge tasks into a single value (indicative of the sensitivity of the adrenocortical system). In order to account for diurnal variation in cortisol levels, the standardized residuals were used after controlling for time of day for both baseline and AUC_I measures.

Child global negative affect. After each home visit, both research assistants independently rated the child's behavior using an adaptation of the Infant Behavior Record (IBR; Bayley, 1969). Originally developed to assess individual differences in behavior observed during the administration of the Bayley Scales of Development, previous research has applied the IBR globally to rate child behavior observed across an entire visit (Stifter & Corey, 2001; Stifter, Willoughby, & Towe-Goodman, 2008). In the current study, the IBR was applied globally to behavior observed across the entire home visit. The IBR items included in the present study were

unhappiness (α = .71), and *irritability* (α = .75). Unhappiness was rated from 1 to 9, with 9 indicating the child seemed unhappy throughout the entire visit, and 1 indicating that nothing was upsetting to the child, and that the child radiated happiness (reverse score of the degree of happiness item). Irritability was also rated from 1 to 9, with 9 indicating the child was irritable to all degrees of stimulation encountered throughout the home visit, and 1 indicating no irritability. The mean of the home visitors' ratings were used; cross-rater correlations ranged from .56 to .59.

Child negative reactivity & regulation to a stressor. Teams of coders rated the child's behavior during each of the challenge tasks at 7-, 15-, and 24-months of age. Coders were trained to achieve a minimum reliability of .75 (Cohen's kappa) in order to rate the child's negative reactivity and emotion self-regulation strategies on a second by second basis (Stifter & Braungart, 1995).

The intensity of the child's negative reactivity was rated on a 4-point scale, where 0 represented observing no negative affect or vocalizations, 1 represented mild negative reactivity (e.g., child is frowning, fussy, or whiny), 2 represented moderate negative reactivity (e.g., crying) and 3 represented high negative reactivity (e.g., screaming, intense crying, wailing, or breath-holding). Drift reliability was assessed on 15% of the families by task (κ = .86 for arm restraint, κ = .89 for the barrier task, κ = .89-.95 for the mask presentation, κ = .87-.90 for toy removal). The proportion of time the child spent in mild, moderate, and highly negative reactive states during the task were calculated by dividing the number of seconds for each code by the total duration for each task. In order to calculate the mean intensity of negative reactivity, the proportion of time the child spent in mild, moderate, and highly reactive states was multiplied by 1, 2, and 3, respectively, and a mean of these intensity scores was created for each task (e.g., mask, barrier, arm restraint, and toy removal). For the current study, the mean intensity of

negative reactivity during the task in which the child evidenced the most overall distress was used.

A separate team of coders rated the presence of specific self-regulatory behaviors for each task. At 7-months, coders rated *re-orienting to adults*, which involved the infant looking to the face of the mother or research assistant, *self-soothing*, which included small, repetitive fine-motor movements (such as sucking on hands, fingers, or the tray, rubbing eyes, hands or face, or twisting hair), and *avoidance*, which involved the child averting eye contact, turning away from the stimulus, or struggling against the restraint of the seat. At 15- and 24-months, coders similarly rated *self-soothing* and *avoidance*, as well as *re-orienting to mother*, which involved the infant specifically looking at the mother's face. Additionally, coders rated *tension reduction*, which included the child banging hands, feet, or torso repetitively against the seat, and *neutral vocalizations*, which indicated the child verbalized or blew bubbles, raspberries, or other mouth noises with neutral affect. Drift reliability was assessed on 15% of the families by task (κ = .82-.93 for arm restraint, κ = .83-.95 for the barrier task, κ = .89-.98 for the mask presentation, κ = .86-.91 for toy removal).

Analytic Strategy

Latent profile analysis (LPA) was used to identify subgroups of children with similar patterns of behavioral and adrenocortical stress responses at 7-, 15-, and 24-months of age, respectively, using the child's basal cortisol levels, adrenocortical response to the challenge tasks (area under the curve with respect to the increase; AUC_I), peak negative behavioral reactivity observed in the challenge tasks, as well as global observational ratings of the child's overall unhappiness and irritability. LPA is used to divide a population into mutually exclusive and exhaustive latent subgroups, identifying underlying groups of individuals, or latent classes, who

share qualitatively distinct patterns of characteristics (Muthén, 2001). Within LPA, observed continuous variables are used as indicators of categorical latent classes. Variables were standardized prior to entry in the models to account for scale differences across the measures. In order to account for missing data and to improve missing data estimates (Collins, Schafer, & Kam, 2001), all analyses were conducted using multiple imputation. LPA models were fit using Mplus version 5.2 (Muthén & Muthén, 2008), and the optimal number of classes were selected based on a balance of model fit, interpretability, and parsimony (e.g., Bayesian information criterion (BIC), Akaike information criterion (AIC), Lo Mendell Rubin (LMR; Lo, Mendell, & Rubin, 2001), entropy statistic (Celeux & Soromenho, 1996)).

Next, multinomial logistic regressions were estimated within the LPA model to examine whether and how interparental violence during the past year (maternal reports of total, minor, and severe violence in the interparental relationship at 7-, 15-, and 24-months of age) and concurrent child regulatory behaviors (from the challenge tasks) were associated with the probability of membership in the latent stress response classes at each time point, respectively, accounting for various child (i.e., child sex, age, ethnicity), and family characteristics (i.e., income status, marital status, stability of partner relationship) that could alter the magnitude of associations.

Latent transition analysis (LTA) was then used to examine transitions in class membership over time, as well as the ways in which earlier violence was associated with later class membership. A two-step process was used in estimating these models. First, an LTA model was fit using 7-month class membership to predict 15-month class membership, as well as 15-month class membership to predict 24-month class membership. Next, interparental violence was added to this model. Specifically, interparental violence reported at 7-months was used to predict

15-month class membership and 24-month class membership, and interparental violence reported at 15-months was used to predict 24-month class membership (see Figure 2-1 for the conceptual model).

Results

Based on a combination of model fit, interpretability, and parsimony, a 4-class model was determined to provide the best fit to the data at 7- months, and a 3-class model provided the best fit at 15- and 24-months, respectively (see Table 2-1). Tables 2-2 – 2-4 show the standardized mean scores for the stress response indicators used in the model at each age. Classes were assigned labels based on distinguishing characteristics. At 7-months, over half the sample (55%) were characterized by relatively average to low levels of reactivity across adrenocortical and behavioral measures of stress responses; thus, this class was labeled 'Low/Average Reactors' (see Table 2-2). Approximately one-third of the sample (34%) were labeled 'High Cortisol, Moderate Negative Behavioral Reactors', as they showed the highest levels of adrenocortical reactivity, but moderate levels of behavioral reactivity. Two smaller subgroups compromised the remainder of the sample. 'High Negative Behavioral Reactors' (6%) showed high negative reactivity to the challenge tasks and were rated as highly irritable and unhappy over the course of the visit, yet showed average adrenocortical responses. Finally, 'High Baseline, Blunted Cortisol Reactors' (6%) were distinguished by high basal cortisol levels, but a markedly low cortisol response to the emotional eliciting challenge.

At 15-months, 81% of the infants were classified as 'Low/Average Reactors', due to average to low levels of reactivity across adrenocortical and behavioral stress responses (see Table 2-3). 'High Negative Overall Behavior Reactors' (14%) were distinguished by relatively high ratings of unhappiness and irritability. Finally, a 'High Baseline, Blunted Cortisol Reactors'

class (5%) also emerged at 15-months, which was predominately distinguished by high basal levels of cortisol and a blunted adrenocortical response to challenge. Notably, levels of negative reactivity to the emotional eliciting challenge did not distinguish between the groups – all groups were characterized by average negative reactivity to the emotion eliciting challenge.

At 24-months, 80% of the sample was classified as 'Low/Average Reactors', demonstrating average to low levels of stress responses across measures (see Table 2-4). 'High Cortisol, High Negative Behavioral Reactors' (14%) were distinguished by the highest levels of adrenocortical reactivity, as well the highest behavioral responses to challenge, overall irritability, and unhappiness. Finally, a 'High Baseline, Blunted Cortisol, Moderate Negative Overall Behavior' class emerged at 24-months, which was distinguished by high basal levels of cortisol, blunted adrenocortical response to challenge, and moderate levels of overall irritability and unhappiness.

Concurrent Interparental Violence, Child Regulatory Behaviors, and Stress Response Profiles. Tables 2-5 – 2-7 present results of the multinomial logistic regression models examining associations between concurrent interparental violence, regulatory behaviors, and child membership in the latent stress response classes. At each age, the 'Low/Average Reactors' class was selected as the reference group. Total violence, minor violence, and severe violence were examined in separate models: Model 1 contained total violence, Model 2 contained minor violence, and Model 3 contained severe violence. At 7-months, infant regulatory behaviors and each form of interparental violence predicted probability of latent class membership (see Table 2-5). Relative to the Low/Average Reactors' class, infants with more interparental violence in the home were 33% more likely to be in the 'High Cortisol, Moderate Negative Behavioral Reactors' class; similar findings emerged for both minor and severe violence. Further, infants in

the ‘High Cortisol, Moderate Negative Behavioral Reactors’ class were 37-39% less likely to reorient to adults to regulate their distress than ‘Low/Average Reactors’. Relative to ‘Low/Average Reactors’, ‘High Baseline, Blunted Cortisol’ reactors were more likely to reside in Pennsylvania, more likely to be older, and more likely to use avoidant regulatory behaviors, although the latter two findings only approached significance.

At 15-months, concurrent interparental violence was not associated with class membership (total, minor, or severe violence; see Table 2-6). Children in the ‘High Negative Overall Behavior’ class were more likely to reside in Pennsylvania relative to the ‘Low/Average” class; no other significant associations emerged.

At 24-months, neither total nor minor interparental violence predicted probability of class membership (see Table 2-7). However, toddlers in homes with more severe interparental violence were 47% more likely to be the ‘High Baseline, Blunted Cortisol, Moderate Overall Negative Behavior’ class relative to the ‘Low/Average Reactor’ class. Further, toddlers in the ‘High Baseline, Blunted Cortisol, Moderate Overall Negative Behavior’ class were more 65% likely to use avoidant regulatory behaviors than ‘Low/Average Reactors’. ‘High Cortisol, High Negative Behavioral’ Reactors were 46% more likely to use avoidance, 56% more likely to use tension reduction, and almost 3.5 times less likely to use neutral vocalizations as a regulatory strategy, compared to the ‘Low/Average’ reactors. Further, children in the ‘High Cortisol, High Negative Behavioral’ class had a greater likelihood of being male than children in the ‘Low/Average’ class.

Transitions between Stress Response Profiles across Early Childhood. At both 7- and 15-months, children had the highest probability of transitioning to the Low/Average class at the subsequent time point, regardless of initial class status (see Table 2-8 for transition probabilities).

Examining transition probabilities to classes other than the 'Low/Average class" at 15- and 24-months, children in both the 'High Cortisol, Moderate Negative Behavioral Reactors' class and the 'High Negative Behavioral Reactors' class at 7-months had a greater probability of transitioning to the 'High Negative Overall Behavior' class at 15-months than to the 'High Baseline, Blunted Cortisol Response' class at 15-months. Children in the 'High Baseline, Blunted Cortisol Reactors' class at 7-months were slightly more likely to transition to the 'High Baseline, Blunted Cortisol Reactors' class at 15-months than to the 'High Negative Overall Behavior' class at 15-months.

At 15-months, children in the 'High Negative Overall Behavior' class were more likely to transition to the 'High Cortisol, High Negative Behavioral Reactors' class at 24-months than to the 'High Baseline, Blunted Cortisol, Moderate Negative Overall Behavior' class at 24-months. Children in the 'Low/Average' class at 15-months were more likely to transition to the 'High Cortisol, High Negative Behavioral Reactors' class at 24-months than to the 'High Baseline, Blunted Cortisol Reactors' class at 24 months. Children in the 'High Baseline, Blunted Cortisol Response' class at 24 months were most likely to have transitioned from the 'High Baseline, Blunted Cortisol Response' class at 15-months.

Next, LTA models were run examining early interparental violence as predictor of later latent class membership, accounting for the longitudinal links between stress response patterns. As shown in Table 2-9, relative to children who stayed in the 'Low/Average' reactors class, there were no significant differences in violence exposure across the 7-15-month transitions, above and beyond the longitudinal associations between these stress responses. Across the 15-24-month transitions, only one difference emerged: relative to children who stayed in the 'Low/Average' reactors class, children with greater minor violence in the home prior to 7-months of age were

65% more likely to transition to the 'High Baseline, Blunted Cortisol, Moderate Negative Overall Behavior Class', although this association only approached significance.

Because 15-month latent stress response classes were generally unrelated to family functioning or self-regulatory behaviors, post-hoc analyses were conducted to explore direct associations between 7-month and 24-month latent classes of stress responses. As can be seen in Table 2-10, children in all classes at 7-months were most likely to transition to the 'Low/Average' class at 24-months. Children in both the 'High Cortisol, Moderate Negative Behavioral Reactors' class and the 'High Negative Behavioral Reactors' class at 7-months had a greater probability of transitioning to the 'High Cortisol, High Negative Behavioral Reactors' class at 24-months than to the 'High Baseline, Blunted Cortisol Response' class at 24-months. No children transitioned from the 'High Negative Behavioral' reactors class at 7-months to the 'High Baseline, Blunted Cortisol Response, Moderate Negative Overall Behavior' class at 24-months. Children in the 'High Baseline, Blunted Cortisol Response' class at 24 months were most likely to have transitioned from the 'High Baseline, Blunted Cortisol Response' class at 7-months.

Finally, LTA models were run examining if interparental violence at 7- and 15- months was a predictor of 24-month latent class membership, accounting for the longitudinal links between 7- and 24-month stress response patterns. As can be seen in Table 2-11, findings were similar to the previous LTA model examining linkages across 7-, 15-, and 24-months. Specifically, across the 7-24-month transitions, only one difference emerged: relative to children who stayed in the 'Low/Average' reactors class, children with greater minor violence in the home prior to 7-months of age were 67% more likely to transition to the 'High Baseline, Blunted

Cortisol, Moderate Negative Overall Behavior' class, although this association only approached significance (total and severe violence were unrelated).

Discussion

The current study sought to explore whether interparental violence was associated with specific patterns of behavioral and adrenocortical responses stress responses across early childhood, as well as the self-regulatory strategies associated with these stress responses. Consistent with emotional security theory, findings from the current study suggest that interparental violence was linked with unique patterns of responding to emotion eliciting stressors in infancy and toddlerhood, although stress responses at 15-months appeared disconnected from family functioning. Further, infant and toddler stress responses were linked with the use of specific self-regulatory strategies, suggesting possible patterns of adaptation to violent homes. In general, stress response patterns appeared specific to each period of development, with infant and toddler responses linked with experiences of violence in the home within the past year, and substantial reorganization of stress response profiles occurring across early childhood.

Broadly, the findings from the current study highlight the strengths of using a person-oriented approach in the study of interparental violence and child outcomes, and of considering relevant developmental changes occurring across early childhood. Because security concerns engendered by violence are theorized to organize children's responses across multiple domains, there have been repeated calls to integrate children's physiological and behavioral functioning in the study of interparental aggression and child outcomes (e.g., Davies et al., 2008; Katz, 2001). Indeed, the current study found noteworthy associations between violence in the home and patterns of stress responses that would have been obscured if only one domain of child

functioning had been examined. For example, previous research with this sample found no direct linkages between interparental violence and mean levels of infant cortisol reactivity (Hibel, et al., 2009), yet important distinctions were found in the coordination of adrenocortical functioning and child behavior in relation to interparental violence. Further, our findings suggest notable differences the stress response patterns emerging across early childhood, and the ways in which interparental violence was linked with these patterns across development.

In the first year of the child's life, interparental violence was linked with stress responses characterized by the greatest adrenocortical activity, with moderate elevations in negative behavioral reactivity. Emotional security theory suggests that exposure to violence in the home may sensitize children to possible threats in their environment, and the current findings offer a unique perspective on this elevated arousal in infancy. Children in this profile did not demonstrate the highest levels of distress, yet they had the most adrenocortical activity in response to challenge; although aroused by the emotion eliciting challenge, these children did not communicate their distress at the highest levels. Further, children in this 'High Cortisol, Moderate Negative Behavioral Reactor' class were less likely to look to their mother or the home visitor as a means of regulating their distress. In homes characterized by violence, demonstrating high levels of negative affect may be pose a threat to children's safety, and infants may be forced to be less reliant on caregivers to support them in times of stress. Given the importance of ongoing interactions with caregivers for the development of adaptive self-regulatory skills (e.g., Fox & Calkins, 2003), this pattern of behavior may set the stage for future maladjustment.

There were intriguing differences in the toddler stress response class linked with recent interparental aggression. Severe interparental violence within the past year was associated with a stress response class consisting of high baseline levels of cortisol, blunted adrenocortical activity

to the emotion eliciting stressor, and moderate negative behavior. Notably, toddlers in this class demonstrated more distress than the majority of children, but they did not show the highest levels of negative reactivity. With respect to adrenocortical functioning, these findings are in line with research on older children linking interparental conflict and elevated average or baseline cortisol levels (e.g., Pendry & Adam, 2007; Salzman, Holden, & Holahan, 2005), and diminished adrenocortical reactivity (Davies et al., 2007). There are several possible explanations for this pattern of response. Gunnar & Vazquez (2001) note a growing body of research suggesting possible suppression of the HPA axis (hypocortisolism) to acute stressors for children experiencing chronic stress; it is possible that toddlers exposed to severe violence in the home are more likely to show a pattern of higher levels of cortisol at home, with suppressed adrenocortical reactivity to acute emotional stressors. Alternatively, toddlers from severely violent households may be more reactive to the presence of unfamiliar adults within the home, and a stress response may have been mounted to the research assistants' arrival (effectively making the "baseline" measure of cortisol indicative of this initial stress response). It has also been theorized that hypocortisolism is linked with passive, avoidant coping styles and repression of emotional experiences (Henry, 1993). In line with this notion, toddlers in this 'High baseline, blunted cortisol, moderate negative behavior' profile were more likely to engage in avoidant regulatory behavior during the challenge tasks. As noted by Davies and Forman (2002), suppression of subjective distress and avoidant coping may be one pattern of adaptation to chronic interparental aggression in the home; the current findings suggests that this pattern may already be present in toddlerhood.

Unexpectedly, stress responses at 15-months appeared relatively unrelated to self-regulatory strategies, or to experiences of violence within the home. Further, unlike the other

assessment points, there were no notable differences in the profiles that emerged with respect to levels of negative reactivity to the challenge tasks. As noted by Gunnar and Davis (2003), late infancy is a period of "emotional reorganization", with developmental changes in fear reactivity, normative decreases in cortisol responsivity, as well as rapid growth in motor skills (crawling, walking) and the emergence of language. Given these dramatic biobehavioral changes and corresponding shifts in the coordination of these systems, it is not entirely surprising that attempting to examine patterns of coordination during this developmental period did not yield fruitful results. Although clearly preliminary, the current findings suggest that investigating holistic profiles of adrenocortical and behavioral stress responses at 15-months may be challenging. In order to adequately capture stress response patterns during late infancy, more intensive and frequent assessments may be necessary, incorporating information on children's verbal, motor, and emotional development.

With respect to the longitudinal trajectories of stress responses, it is notable that children were more likely to transition to more well-regulated stress responses across development than they were to follow more risky trajectories. Although interparental aggression clearly places children's development at risk, these findings are in line with research suggesting that the majority of children from violent homes do not develop serious adjustment problems (e.g., Hughes, 1997; Hughes, Graham-Bermann, & Gruber, 2001).Further, the current study employed maternal report of interparental violence, and it is unknown whether this violence was directly observed by the child. Despite of this limitation, the current findings suggest that if infants did not develop more adaptive stress responses over time, they were likely to following a trajectory involving higher levels of negative affect and cortisol responses. Specifically, early stress response classes linked with violence exposure (e.g., the 7-month 'High Cortisol, Moderate

Negative Behavioral' class) were likely to wind up in the 'High Cortisol, High Negative Behavior' class at 24-months (if they did not transition to the "Low/Average" response pattern). Given that high negative affect and chronic cortisol elevations may tax important resources necessary for physical and mental health, these children may be at particular risk for developing adjustment problems. Additionally, it is notable that children in this 24-month 'High Cortisol, Moderate Negative Behavioral' class were also more likely to engage in more avoidance and tension reduction, as well as less neutral vocalizations in the emotion-eliciting challenge. Given that infants in the 'High Cortisol, Moderate Negative Behavioral' class at 7-months were less likely to look to adults as a way of reducing their distress, these longitudinal links could reflect difficulties developing adaptive regulatory skills in violent households.

Interestingly, although violence across the second year of the child's life was linked with the 24-month stress response class characterized by high baseline levels of cortisol, blunted adrenocortical activity to the emotion eliciting stressor, and moderate negative behavior, this response pattern appeared to emerge most frequently from the 'High Baseline, Blunted Cortisol' response pattern in infancy -- a class which was unrelated to violence reported at 7- or 15-months. However, it should be noted that this 24-month class *was* linked with reports of minor violence, but not severe violence, at 7-months (at trend level). As noted by others, it may be difficult to obtain accurate reports of sensitive material (such as reports of domestic violence) from participants until a measure of trust has been obtained by researchers (e.g., Burton et al., 2008; Dodson & Schmalzbauer, 2005). It is possible that at 24-months, some mothers felt more comfortable with reporting about all forms of violence within the home given their participation in the project over the course of two years. If reports of severe violence have increased in accuracy over the course of the project, it is possible to conjecture that had severe violence been

accurately reported earlier, it may also have been linked with the "High Baseline, Blunted Cortisol" class in infancy. Alternatively, exposure to violence in the second year of the child's life may have a different impact on children's developing stress responses, particularly if these children were already exhibiting some form of dysregulation in the way they respond to stressors. Given the preliminary nature of these findings, conclusions regarding the longitudinal course of the 'High Baseline, Blunted Cortisol Response, Moderate Negative Overall Behavior' class remain largely speculative.

A number of limitations to the current study should be noted. First, contrary to our hypotheses, there were no clear longitudinal links between the stress response classes associated with interparental violence in infancy and those observed across early childhood; linkages were limited to violence occurring within the past year of the child's life. However, it would be premature at this point to conclude that early violence exposure has no lasting effects on children's stress responses. Rather, given that substantial emotional reorganization continues to occur across early childhood, proximal exposure to interparental violence may be more directly relevant to current child functioning. Second, there were individual differences in which portion of the challenge tasks evoked peak negative reactivity, and the emotional response that was elicited. Although incorporation of global levels of reactivity and peak arousal from multiple stress eliciting contexts provides greater confidence that general stress response patterns were captured, the specific emotions or combinations of emotions elicited during these tasks may have important implications for behavior, physiology, and children's later adjustment (Crockenberg & Langrock, 2001). Further exploration of the role of specific emotions and patterns of arousal to distinct types of challenges is warranted. Third, given the economically strained nature of the sample and known linkages between poverty and stress responses (e.g, Lupien, King, Meaney, &

McEwen, 2001; Evans & English, 2002), it is unclear if these specific stress response profiles might emerge in lower-risk samples. Fourth, there is an implicit assumption within the logistic regression models that the relationship between each covariate and the probability of class membership does not vary according to other sample characteristics. However, it is possible that the association between one or more covariates (e.g., income) and the probability of class membership varies according to a third family characteristic (e.g., site). Future research is needed to examine such potential interactions that may influence the probability of membership in latent stress response classes. Finally, although the current findings describe linkages between interparental violence and children's stress responses, the specific mechanisms responsible for these linkages remain unclear. For example, domestic violence may be likely to occur during pregnancy, particularly in low-income families (e.g., Jasinski, 2004), and research suggests that prenatal maternal stress is linked with increased negative reactivity and dysregulated adrenocortical functioning in infancy (e.g., Mulder, et al., 2002; Weinstock, 1997). Alternatively, children in violent homes may be at particular risk for aggressive and harsh parenting (e.g., Erl & Burman, 1995; Hughes, 1988), and emerging evidence suggests linkages between paternal negative and intrusive behavior and early childhood adrenocortical functioning (Mills-Koonce et al., *under review*). Further research is needed to clarify the processes linking interparental violence and children's stress responses.

Although a number of unanswered questions remain, the current study has a number of strengths. This is the first study, to our knowledge, to investigate the longitudinal relations between interparental violence and person-oriented stress responses in early childhood, integrating both behavioral and adrenocortical measures. Further, multiple levels of information were incorporated on children's stress responses in these domains, including pre-task cortisol

levels and total adrenocortical output to an emotion eliciting stressor, micro-analytic assessments of children's reactivity and regulation, and global ratings of children's behavior. Using a large, diverse sample of families and young children, the current study advances understanding of the interparental violence and early childhood development.

Interparental violence is considered to be one of the most widespread and damaging stressors children can be exposed to (Margolin & Gordis, 2000). Rather than impacting one domain of development in isolation, exposure to violence is likely to have cascading effects on multiple aspects of child functioning, and scientists are only beginning to understand the effects of violence on the whole child. The findings from the current study suggest that violence is linked with alterations in children's stress response patterns across behavioral and physiological domains, which may have serious implications for their health and development. Understanding the pathways through which adaptive or maladaptive stress response patterns develop could shed insight into how to best target interventions to address the specific needs of children exposed to violence, making this an important area for future research.

Table 2-1

Comparison of Models for Latent Stress Response Profiles at 7-months, 15-months, and 24-months of age.

Number of Latent Classes	***Log Likelihood***	***AIC***	***BIC***	***Adj. BIC***	***Lo-Mendel-Rubin***	***Entropy***
7-m (*n* = 735)						
1	-5212.10	10444.20	10490.19	10458.44	---	---
2	-5005.64	10043.29	10116.88	10066.08	<.01	.77
3	-4841.14	9726.28	9827.48	9757.62	<.01	.84
4	-4777.45	9610.90	9739.70	9650.79	.02	.82
5	-4731.95	9531.91	9688.30	9580.34	.10	.84
15-m (*n* = 634)						
1	-4495.53	9011.07	9055.59	9023.84	---	---
2	-4259.71	8551.41	8622.64	8571.84	<.01	.91
3	**-4178.24**	**8400.47**	**8498.42**	**8428.57**	**.03**	**.92**
4	-4102.32	8260.65	8385.31	8296.41	.28	.93
24-m (*n* = 567)						
1	-4020.19	8060.38	8103.78	8072.04	---	---
2	-3791.16	7614.32	7683.77	7632.97	<.01	.90
3	**-3692.99**	**7429.99**	**7525.47**	**7455.63**	**.04**	**.92**
4	-3642.15	7340.31	7461.84	7372.95	.05	.94

Note: Bold font indicates the model that best fit the data

Table 2-2

Standardized Mean Scores for a 4-Class Model of 7-Month Stress Responses (n = 735).

	Low/Average Reactors (55%)	High Cortisol, Moderate Negative Behavioral Reactors (34%)	High Negative Behavioral Reactors (6%)	High Baseline, Blunted Cortisol Response (6%)
Adrenocortical functioning				
Basal Cortisol	-.17	-.21	.18	2.56
AUC_I	.07	.25	-.01	-2.02
Behavioral reactivity				
Negative reactivity to challenge	-.31	.37	.97	-.19
Overall Unhappiness	-.59	.62	1.96	-.12
Overall Irritability	-.60	.58	2.26	-.12

Table 2-3

Standardized Mean Scores for a 3-Class Model of 15-Month Stress Responses (n = 634).

	Low/Average Reactors (81%)	High Negative Overall Behavior (14%)	High Baseline, Blunted Cortisol Response (5%)
Adrenocortical functioning			
Basal Cortisol	-.15	-.07	2.48
AUC_I	.14	-.07	-1.86
Behavioral reactivity			
Negative reactivity to challenge	.01	-.02	-.06
Overall Unhappiness	-.33	1.79	.14
Overall Irritability	-.30	1.64	.19

Table 2-4

Standardized Mean Scores for a 3-Class Model of 24-Month Stress Responses (n = 567).

	Low/Average Reactors (80%)	High Cortisol, High Negative Behavioral Reactors (14%)	High Baseline, Blunted Cortisol, Moderate Negative Overall Behavior (5%)
Adrenocortical functioning			
Basal Cortisol	-.15	-.13	2.49
AUC_I	.08	.38	-2.11
Behavioral reactivity			
Negative reactivity to challenge	-.12	.61	.12
Overall Unhappiness	-.33	1.61	.43
Overall Irritability	-.34	1.68	.39

Table 2-5

Odds Ratios for Multinomial Logistic Regression Models of Interparental Violence and Child Regulatory Behaviors Predicting the Probability of Child Membership in 7-month Latent Stress Response Classes (*n* = 735).

	Model 1: Total Violence			Model 2: Minor Violence			Model 3: Severe Violence		
Variable	High Cortisol, Moderate Negative Behavioral	High Negative Behavioral	High Baseline, Blunted Cortisol	High Cortisol, Moderate Negative Behavioral	High Negative Behavioral	High Baseline, Blunted Cortisol	High Cortisol, Moderate Negative Behavioral	High Negative Behavioral Reactors	High Baseline, Blunted Cortisol
Covariates									
Site[a]	1.70	1.10	4.31*	1.69	1.09	4.19*	1.73	1.10	4.33*
Child gender [b]	.68	.65	.68	.68	.66	.67	.68	.65	.69
Child age	1.15	1.04	1.63†	1.15	1.03	1.61†	1.17	1.04	1.63†
Child ethnicity (black vs. not)	.72	.33	1.76	.74	.34	1.71	.72	.33	1.80
Marital Status (married vs. not)	1.09	1.31	.73	1.09	1.32	.76	1.04	1.29	.73
Household Poverty									
Income to needs ratio	1.12	.90	.85	1.11	.89	.85	1.12	.90	.84
Interparental Violence									
Total Violence	**1.33***	1.14	.92	--	--	--	--	--	
Minor Violence	--	--	--	**1.31***	1.11	1.00	--	--	
Severe Violence	--	--	--	--	--	--	**1.31***	1.16	.83
Child Regulatory Behaviors									
Re-orienting to adult	**.72 (1.39)***	.51	.93	**.73 (1.37)***	.51	.93	**.72 (1.39)***	.51	.93
Self-soothing	1.26	1.15	1.23	1.26	1.16	1.23	1.25	1.15	1.23
Avoidance	1.28	1.04	**1.35**†	1.26	1.03	**1.34**†	1.30	1.05	**1.35**†

Note: Low/Average is the reference class. All continuous predictors were standardized prior to estimating logistic regression models; Odds ratios in parentheses are the reciprocals and refer to the odds of membership in the reference class; Superscript denotes covariates that significantly predict differences between a single class and the reference class, † $p < .10$, * $p < .05$; [a] Site: 0=NC;1=PA,; [b] Child Sex: 0 = female, 1 = male.

Table 2-6

Odds Ratios for Multinomial Logistic Regression Models of 15-month Interparental Violence and 15-month Child Regulatory Behaviors Predicting the Probability of Child Membership in 15-month Latent Stress Response Classes (*n* = 634).

	Model 1: Total Violence		Model 2: Minor Violence		Model 3: Severe Violence	
Variable	High Negative Overall Behavior	High Baseline, Blunted Cortisol	High Negative Overall Behavior	High Baseline, Blunted Cortisol	High Negative Overall Behavior	High Baseline, Blunted Cortisol
Covariates						
Site[a]	2.34*	1.74	2.37 *	1.73	2.32*	1.74
Child gender [b]	.87	1.66	.86	1.65	.88	1.68
Child age	1.03	.84	1.04	.84	1.04	.84
Child ethnicity (black vs. not)	.94	1.51	.92	1.47	.96	1.51
7m Marital Status (married vs. not)	1.16	1.01	1.19	1.02	1.11	1.02
7m Household Poverty						
Income to needs ratio	1.02	.85	1.04	.85	1.02	.85
7m Interparental Violence						
Total Violence	1.07	.92	--	--	--	--
Minor Violence	--	--	1.17	.97	--	--
Severe Violence	--	--	--	--	.95	.89
15m Child Regulatory Behaviors						
Re-orienting to mother	1.38	.62	1.37	.62	1.38	.63
Self-soothing	1.17	.72	1.19	.72	1.15	.72
Avoidance	.79	1.23	.79	1.22	.79	1.23
Tension Reduction	.99	1.30	1.00	1.30	1.00	1.31
Neutral Vocalization	.89	.82	.88	.82	.89	.81

Note: Low/Average is the reference class. All continuous predictors were standardized prior to estimating logistic regression models; Odds ratios in parentheses are the reciprocals and refer to the odds of membership in the reference class; Superscript denotes covariates that significantly predict differences between a single class and the reference class, † $p < .10$, * $p < .05$; [a] Site: 0=NC, 1=PA; [b] Child Sex: 0 = female, 1 = male.

Table 2-7

Odds Ratios for Multinomial Logistic Regression Models of 24-month Interparental Violence and 24-month Child Regulatory Behaviors Predicting the Probability of Child Membership in 24-month Latent Stress Response Classes (*n* = 567).

	Model 1: Total Violence		Model 2: Minor Violence		Model 3: Severe Violence	
Variable	High Cortisol, High Negative Behavioral	High Baseline, Blunted Cortisol, Moderate Negative Overall Behavior	High Cortisol, High Negative Behavioral	High Baseline, Blunted Cortisol, Moderate Negative Overall Behavior	High Cortisol, High Negative Behavioral	High Baseline, Blunted Cortisol, Moderate Negative Overall Behavior
Covariates						
Site[a]	.63	2.03	.65	1.98	.63	1.99
Child gender [b]	**1.75***	.63	**1.79***	.65	**1.74***	.58
Child age	.75	1.11	.76	1.11	.74	1.11
Child ethnicity (black vs. not)	.49	2.62	.49	3.00	.53	2.38
7m Marital Status (married vs. not)	1.51	.45	1.46	.42	1.5	.46
7m Household Poverty						
Income to needs ratio	.79	1.23	.79	1.19	.79	1.23
7m Interparental Violence						
Total Violence	1.28	1.28	--	--	--	--
Minor Violence	--	--	1.34	1.13	--	--
Severe Violence	--	--	--	--	1.19	**1.47***
15m Child Regulatory Behaviors						
Re-orienting to mother	.94	.84	.93	.85	.93	.83
Self-soothing	1.13	1.14	1.12	1.14	1.14	1.14
Avoidance	**1.46***	**1.64***	**1.45***	**1.68***	**1.48***	**1.65***
Tension Reduction	**1.56***	.77	**1.54***	.78	**1.58***	.75
Neutral Vocalization	**.29 (3.45)***	.89	**.29 (3.45)***	.87	**.29 (3.45)***	.89

Note: Low/Average is the reference class. All continuous predictors were standardized prior to estimating logistic regression models; Odds ratios in parentheses are the reciprocals and refer to the odds of membership in the reference class; Superscript denotes covariates that significantly predict differences between a single class and the reference class, † $p<$ .10, * $p < .05$; [a] Site: 0=NC, 1=PA; [b] Child Sex: 0 = female, 1 = male.

Table 2-8

Estimates of Transition Probabilities for Child Stress Responses across Early Childhood (*n* = 567).

	Latent Status		
	15-month		
7-month	High Negative Overall Behavior	High Baseline, Blunted Cortisol	Low/Average
High Cortisol, Moderate Negative Behavioral	.18	.06	.77
High Negative Behavioral	.31	.05	.64
High Baseline, Blunted Cortisol Response	.04	.06	.90
Low/Average	.11	.05	.84

	24-month		
15-month	High Cortisol, High Negative Behavioral	High Baseline, Blunted Cortisol, Moderate Negative Overall Behavior	Low/Average
High Negative Overall Behavior	.36	.05	.59
High Baseline, Blunted Cortisol Response	.08	.09	.83
Low/Average	.12	.05	.83

Table 2-9

Odds Ratios for Latent Transition Models of Stress Response Profiles across Early Childhood (*n* = 567).

	Model 1: Total Violence		Model 2: Minor Violence		Model 3: Severe Violence	
	15m High Negative Overall Behavior	15m High Baseline, Blunted Cortisol	15m High Negative Overall Behavior	15m High Baseline, Blunted Cortisol	15m High Negative Overall Behavior	15m High Baseline, Blunted Cortisol
Interparental Violence						
7m Total Violence	1.03	1.19	--	--	--	--
7m Minor Violence	--	--	1.12	1.15	--	--
7m Severe Violence	--	--	--	--	.92	1.20
	24m High Cortisol, High Negative Behavioral	24m High Baseline, Blunted Cortisol, Moderate Negative Overall Behavior	24m High Cortisol, High Negative Behavioral	24m High Baseline, Blunted Cortisol, Moderate Negative Overall Behavior	24m High Cortisol, High Negative Behavioral	24m High Baseline, Blunted Cortisol, Moderate Negative Overall Behavior
Interparental Violence						
7m Total Violence	1.13	1.53	--	--	--	--
7m Minor Violence	--	--	.90	**1.65**[†]	--	--
7m Severe Violence	--	--	--	--	1.30	1.13
15m Total Violence	1.13	.72	--	--	--	--
15m Minor Violence	--	--	1.32	.72	--	--
15m Severe Violence	--	--	--	--	1.02	.87

Note: Low/Average is the reference class at each time point; Odds ratios in parentheses are the reciprocals and refer to the odds of membership in the reference class.

Table 2-10

Estimates of Transition Probabilities for 7-month to 24-month Stress Responses (*n* = 567).

	Latent Status		
	24-month		
7-month	High Cortisol, High Negative Behavioral	High Baseline, Blunted Cortisol, Moderate Negative Overall Behavior	Low/Average
High Cortisol, Moderate Negative Behavioral	.19	.06	.75
High Negative Behavioral	.22	.00	.78
High Baseline, Blunted Cortisol Response	.13	.12	.75
Low/Average	.11	.06	.83

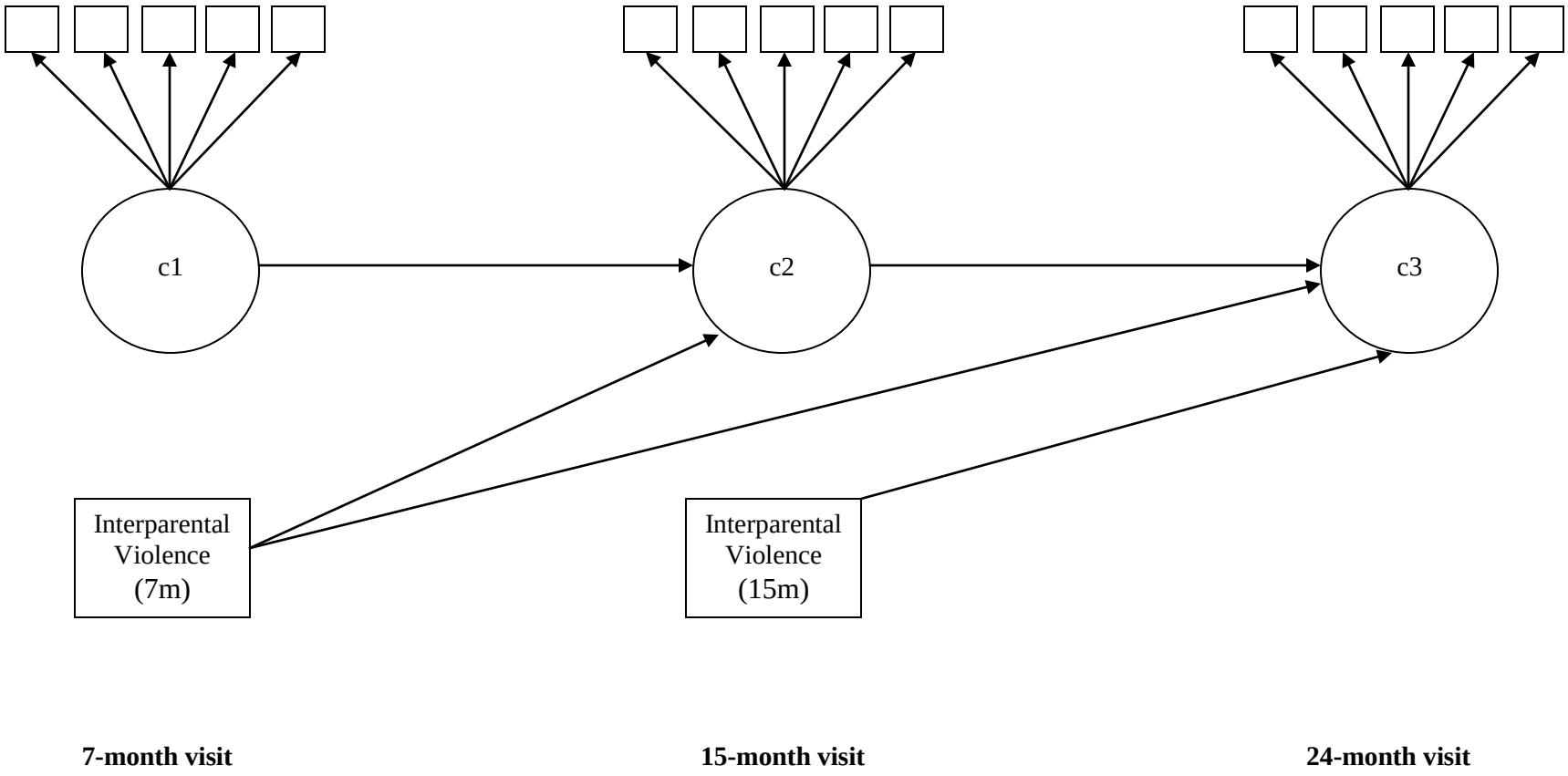
Table 2-11

Odds Ratios for Latent Transition Models of for 7-month to 24-month Stress Response Profiles (*n* = 567).

	Model 1: Total Violence		Model 2: Minor Violence		Model 3: Severe Violence	
	24m High Cortisol, High Negative Behavioral	24m High Baseline, Blunted Cortisol, Moderate Negative Overall Behavior	24m High Cortisol, High Negative Behavioral	24m High Baseline, Blunted Cortisol, Moderate Negative Overall Behavior	24m High Cortisol, High Negative Behavioral	24m High Baseline, Blunted Cortisol, Moderate Negative Overall Behavior
Interparental Violence						
7m Total Violence	1.14	1.63	--	--	--	--
7m Minor Violence	--	--	.94	**1.67**[†]	--	--
7m Severe Violence	--	--	--	--	1.28	1.20
15m Total Violence	1.10	.69	--	--	--	--
15m Minor Violence	--	--	1.27	.76	--	--
15m Severe Violence	--	--	--	--	1.00	.83

Note: Low/Average is the reference class at each time point; Odds ratios in parentheses are the reciprocals and refer to the odds of membership in the reference class.

Figure 2-1. Conceptual latent transition model for prior interparental violence predicting latent stress response profiles across early childhood.



Note: c1, c2, and c3 represent the categorical latent variable of class status (at 7m, 15m, and 24m, respectively)

Chapter 3

Interparental Violence and Emotion Regulation Dynamics in Early Childhood: A Hidden Markov Modeling Approach

Decades of empirical research suggest that interparental violence places children's development at risk, with a growing body of theoretical and empirical work pointing to the critical role of emotion in understanding children's responses to aggression in the home (Cummings & Davies, 2002). Davies and Cummings' (1994) emotional security theory suggests interparental violence undermines children's sense of safety and security in the family, and that the heightened arousal and vigilance engendered by chronic security threats may undermine adaptive emotion regulation. Although many different definitions of emotion regulation exist, most focus on the ability to monitor, evaluate, and modify emotional reactions (Thompson, 1994), and the family context is considered to play a critical role in shaping these regulatory skills (Morris, Silk, Steinberg, Myers, & Robinson, 2007). Indeed, there is some evidence to suggest that deficits in emotion regulation skills may be a critical link between interparental aggression and children's adjustment problems (e.g., Cummings, El-Sheikh, Kouros, & Buckhalt, 2009). However, surprisingly little is known about how interparental violence may alter the *process* of emotion regulation, particularly in early childhood. As the early family environment provides foundational experiences necessary for regulatory skill development (e.g., Fox & Calkins, 2003), and young children may be at the greatest risk for exposure to interparental violence (Fantuzzo, Boruch, Beriama, Atkins, & Markus, 1997), this is a notable gap. Thus, the current study sought to examine whether and how interparental violence alters emotion regulation dynamics in toddlerhood, when more autonomous forms of self-regulation are emerging.

In the majority of studies conducted to date, heightened emotional and behavioral reactivity to conflict is theorized to reflect reduced child regulatory capacities due to chronic exposure to aggressive conflict in the home (Cummings & Davies, 1996). Interparental aggression is linked with increased signs of distress, fear, and anger in school-aged children and adolescents (e.g., Davies, Myers, Cummings, & Heindel, 1999; El-Sheikh, Cummings, Goetsch, 1989; Martin & Clements, 2002). This heightened negative reactivity is found across domains, with elementary school-aged children reporting more subjective distress to conflict, as well as displaying greater behavioral and physiological reactivity (Davies, Sturge-Apple, Winter, Cummings, & Farrell, 2006; El-Sheikh, 2005; Saltzman, Holden, & Holahan, 2005). In addition to heightened reactivity to conflict, infants and young children who have been exposed to violence in the home may also appear more anxious and irritable on average, perhaps due to their constant state of hyperarousal (Bogat, Dejonghe, Levendowsky, Davidson, & von Eye, 2006; Scheeringa, Zeanah, Drell, & Larrieu, 1995).

Alternatively, other studies have examined the use or nonuse of specific regulatory strategies as indicating differences in emotion regulation due to interparental aggression. For example, research indicates interparental discord may engender avoidant or withdrawn regulatory behaviors in infant and school-aged children (e.g., Crockenberg, Leerkes, & Lekka, 2007; Nicolotti, El-Sheikh, & Whitson, 2003). Reducing exposure to threatening interparental behavior may be adaptive in violent homes, but the generalization of avoidant regulatory behavior to cope with negative emotions across a broad range of contexts may contribute to adjustment problems over time (Davies & Cummings, 1994). Further, there is some evidence to suggest that interparental aggression may limit children's use of the regulatory strategies of attention shifting and self-soothing. The ability to focus and shift attention is often impaired in young children exposed to family trauma, such as interparental violence (DeBellis, 2001;

Margolin & Vickerman, 2007), and insecure representations of the interparental relationship have been linked with attention problems for children in elementary school (Davies, Woitach, Winter, & Cummings, 2008). Crockenberg and colleagues (2007) have suggested that intense distress engendered by interparental aggression may limit the efficacy of distraction or self-soothing, which may only be successful at lower levels of arousal. However, less is known about how interparental violence in the first two years of life may alter regulatory strategies during the toddler years, when marked growth in children's abilities to shift attention and inhibit behavior typically occurs (Rothbart, Ellis, Rueda, & Posner, 2003).

Although research on heightened reactivity and specific regulatory strategies has advanced knowledge regarding relations between interparental aggression and child outcomes, there are several concerns that limit the use of these findings to infer impaired emotion regulation. Reliance on static, mean-level indicators does not disentangle associations between activated emotion and regulation, or account for emotion regulation as a process inherently involving change. As noted by Cole and colleagues (2004), inference of emotion regulation is greatly improved by independently assessing emotional expressions and putative regulatory strategies, and then analyzing the temporal relations between them. Although such research is more limited, work in the area of early childhood self-regulation suggests that the use of such approaches may help uncover meaningful associations between activated emotions and regulatory behavior, as well as provide insight into the efficacy of specific regulatory practices. For example, Buss and Goldsmith (1998) revealed through contingency analyses that distraction and approach reduced angry distress, but that regulation behaviors were unrelated to anger when temporal factors were not taken into account. Stifter and Braungart (1995) found that self-soothing regulatory behaviors were more likely to occur in intervals of decreasing infant

frustration, whereas avoidance and communication were found in intervals of increasing reactivity.

Sequential approaches, however, may not adequately capture the dynamics involved in regulatory processes. As noted by Rovine, Sinclair, and Stifter (2010), the numeric relation between a given behavior and an outcome does not adequately capture a dynamic process, such as emotion regulation. The use of contingency analyses obscures the effect of continuously maintaining a regulatory behavior, as the relations between a regulatory behavior and a change in emotional expression are only captured when the change directly follows the behavior. Further, the efficacy of regulatory behaviors used in combination is missed, because such sequential analyses reflect univariate associations between regulatory behavior and emotional reactivity. Because a number of changes in observed behavior during the sequence are necessary to adequately capture relations, the effects of rare events in an episode (such as the use of a highly effective regulatory strategy) are also lost. Due to these limitations, the use of a methodological approach uniquely suited to capturing the dynamics of regulatory processed is warranted. However, despite intense interest in emotion regulation and the breadth of literature surrounding its importance, examinations of emotion regulation as a dynamic process are rare (Cole et al., 2004).

There is reason to believe that examining individual differences in regulatory processes could offer insight on the patterns of emotional expression and regulatory action that may place children at risk for maladjustment. It is likely that maladaptive regulation is not solely characterized by mean differences in emotional expression, the use of specific strategies, or the length of time a strategy takes to reduce an emotional expression. Rather, there are likely to be distinct differences in the coordination of emotional expression and regulatory actions, as well as the ways in which these processes unfold over time. Consistent with a functionalist view of

emotions, "it is not the valence of an emotional response but the constituent expression-action patterns, and their appropriateness given contextual demands, that make them adaptive or maladaptive" (Dennis, Cole, Wiggins, Cohen, & Zalewski, 2009, p. 521). In order to adequately assess the processes that place some children at particular risk, an approach that captures the dynamics of emotional expression and regulatory actions, as well as individual differences in these dynamics, is needed.

Hidden Markov Modeling: An Alternative Approach

In order to address these limitations, and to improve understanding of the role of interparental violence in altering emotion regulation processes, the current study used a methodological approach suited to capturing the temporal dynamics involved in regulatory processes: latent or hidden Markov modeling (HMM; Rabiner, 1989; Visser, 2005). From the family of mixture models, HMM can be used to model latent state changes over a time series of categorical variables, and are well suited to study dynamic processes (Rovine et al., 2010). In the case of modeling emotional expressions and regulatory behaviors, the results of hidden Markov modeling reveal *latent states*, which are commonly occurring behaviors or combinations of behaviors (e.g., being highly distressed and self-soothing). In each state, the child has a probability of expressing a certain level of distress, and of employing a specific regulatory behavior (or combinations of behaviors); thus, co-occurring emotional expressions and self-regulatory actions are captured. Further, the results of the hidden Markov model reveal *transition probabilities*, which are the probabilities of moving to other states given the current state (e.g. given that the child is currently in the highly distressed and self-soothing state, he/she has a higher probability of moving to moderate distress and self-soothing state at the next time point, relative to moving to a completely non-distressed state; Rabiner & Juang, 1986; Rovine et al.). In this manner, the temporal dynamics of co-occurring emotional expressions and self-regulatory

actions are assessed. Additionally, once the optimal number of states that describe the regulatory processes of the group are identified, it is possible to examine individual differences by predicting the posterior probability of state membership for each child at each observation. These posterior probabilities provide the sequence of states for each child, and the total duration each child spends in each state can be calculated. Separate variables can then be used to predict individual differences in the duration of particular emotional expression and self-regulatory action states (e.g., does greater levels of exposure to interparental violence predict more time spent in highly distressed states?)

Research Aims

The current study expands on previous research by examining whether interparental violence was associated with alterations in emotion regulation processes. Specifically, this investigation sought to examine whether patterns of emotional expression and regulatory actions could be identified when toddlers were faced with a blocked goal, and whether children from homes in which severe violence had occurred in the first two years of life demonstrated differences in these patterns, compared to children from homes without severe interparental violence. Interparental violence was assessed by maternal report at three time points (when the child was 7-, 15-, and 24-months of age), and independent observations of toddler's reactivity and regulation were assessed from a toy-removal task conducted when the child was approximately 24-months of age. Although largely exploratory, it was hypothesized that children from violent homes may display unique patterns of emotion regulation, with more states characterized by higher levels of reactivity (e.g., Davies et al., 2006), and less attention shifting- or communicative-low distress states (e.g., Davies et al, 2008; Crockenberg et al., 2007). Further, this study examined whether individual differences in the duration of specific emotional expression and self-regulatory action states were predicted by the amount of severe violence

present during early childhood. It was hypothesized that children from high conflict homes may spend a greater amount of time in highly distressed states, given previous research on linkages between interparental aggression and heightened negative reactivity (e.g., Bogat et al., 2006; Davies et al., 2006; .

Method

Participants

Participants for the current study were drawn from the Family Life Project, an ongoing, longitudinal investigation of 1,292 families residing in predominately low-income, non-metropolitan communities. Families were recruited from local hospitals after the birth of a child, over-sampling for low-income and African American families to address overall project goals. For more information on the sampling plan and recruitment procedures for the Family Life Project, see Vernon-Feagans et al. (2008).

The current study focused on visits that took place when the target child was approximately 7-months, 15-months, and 24-months of age. Due to the interest in interparental violence, the sample was restricted to families in which the child resided with their biological mother and her same romantic partner across the first two years of life. Of the 1,204 families that participated when the child was 7-months, 791 (66%) included families in which child's biological mother resided with a romantic partner. Of these families, 752 (95%) participated when the child was 15-months, and 743 (94%) participated when the child was 24-months of age. One hundred and twenty-one of these families were excluded from the analyses because the mother was no longer living with or had changed partners by the 24-month assessment, or was no longer the child's primary caregiver. In order to minimize potential developmental differences in toddler's regulatory skills, the decision was made to restrict the analyses to children that were seen between 22 and 30 months of age (M = 24.45, SD =1.29) at the 24-month visit, resulting in

the additional exclusion of 3 children. Of these children, 427 toddlers had 90-150 seconds of coded data for the toy removal task, a time range which was selected to ensure the task was administered appropriately and that there was adequate data for modeling.

Of the 427 families selected, approximately 48% had household incomes below 200% of the poverty line, and 82% of the mother's were married to their romantic partner. Approximately 50% of the toddlers were boys, with 23% identified by the mother as black (77% identified as white).

Procedures

Trained research assistants visited families in the home when the child was approximately 7-, 15- and 24-months of age, and written consent was obtained prior to conducting each visit. At each visit, mothers completed questionnaire data via laptop computer.

During the 24-month visit, children participated in a toy removal task designed to elicit frustration to a blocked goal (Buss & Kiel, 2004; Goldsmith & Rothbart, 1996; Stifter & Braungart, 1995). For this task, toddlers were seated in a booster seat beside their mothers. Mothers were given an attractive toy to show their child, and the two played together with the toy for one minute. The mother was then asked to remove the toy, place it in a clear plastic container with a tightly fitting lid, and then to give the container to the child for two minutes. During this time, the research assistant and the mother engaged in conversation, while the child was left alone with the container. After two minutes, the mother removed the toy from the container and returned the toy to the child. The mother and child then played together with the toy for one minute. This procedure was videotaped and later coded on a second by second basis for a range of child reactivity and regulation behaviors, described in detail below. The current investigation focused on the portion of the task in which the toy (and the mother) was unavailable to the child, as this section elicited self-regulatory behavior.

Measures

Covariates. At 24-months, mothers reported demographic information on all household members, including age, ethnicity, gender, marital status, and all sources of income (e.g., jobs, regular help from friends or family members, cash income from welfare, alimony, unemployment insurance, etc.). The family's income-to-needs ratio was calculated by dividing the annual household income from all sources by the U.S. federal poverty threshold for the year based on the household size and composition. An income to needs ratio below one indicates the family's income was below the poverty line.

Interparental violence. At 7-, 15-, and 24-months, mothers completed the Conflict-Tactics Scale – Couple Form Revised (CTS-R; Straus, 1979; Straus & Gelles, 1990), a 19-item measure in which the mother reported on her own and her partner's behavior when they had a disagreement within the past 12-months. The severe violence scale consists of 6-items assessing the frequency with which partners used severe physical force as a means of resolving the conflict (α = .76-.87; e.g., "How often has he kicked, bit, or hit you with a fist?"). A home was classified as violent if the mother reported any acts of severe interparental violence at one or more time point; using this criteria, 82 homes were classified as violent, and 345 were non-violent. Of the homes classified as violent, total mean severe violence across early childhood ranged from 0.17-8.67 (M = 1.33, SD =1.69).

Child reactivity and regulatory behaviors. Separate teams of coders (trained to achieve a minimum reliability of κ = .75) rated children's emotional expressions and regulatory actions during the Toy Removal task on a second by second basis (Stifter & Braungart, 1995).

The intensity of the child's negative reactivity was rated on a 4-point scale, and drift reliability was calculated on over 15% of the families (κ = .87). A score of 0 indicated no negative affect was observed. A score of 1 indicated mild negative reactivity, such as the child

being fussy or whining, displaying behaviors such as a furrowed brow, crinkled nose, frowning, with their mouth slightly open, or pressed lips. A score of 2 indicated moderate negative reactivity, with the child crying, displaying behaviors such as a wide squared mouth and open or partially closed eyes. A score of 3 indicated high negative reactivity, with the child screaming or wailing, displaying behaviors such as partially or completely closed eyes, a wide or open mouth, tears, and the possibility of breath holding or their face changing colors.

The regulatory actions used by the child were also coded on a second by second basis, with behaviors falling under three broad domains: Orienting ($\kappa = .87$), Avoidance or Active Regulation ($\kappa = .90$), and Soothing or Communication ($\kappa = .88$). The Orienting domain included four possible codes: *orienting to the environment*, in which the child's eyes were focused on the environment or the home visitor for at least 1 second; *orienting to mother*, in which the child looked at the mother's face; *orienting to the toy*, in which the infant looked at the toy within the container; and *no orienting regulation*, in which the child did not show focused orienting that spanned the second of coding. The Avoidance or Active Regulation domain included four possible codes: *avoidance*, in which the child displayed behaviors such as an arched back, struggling against the restraint of the booster seat, straining forward, or pushing back against the seat or tray; *tension reduction*, in which the child banged their hands, feet, or entire torso against the seat or floor repetitively; *rejection*, in which the child actively pushed the container away, refusing the activity; or *no avoidance/active regulation*, in which the child did not display any of the above behaviors. The Soothing or Communication domain included four possible codes, *self-comforting*, in which the child engaged in small, repetitive, fine motor movements, such as rubbing their hands, twisting hair, or clasping hands or clothes; *neutral vocalizations*, in which the child verbalizes with neutral affect; *gesture*, in which the child uses body language to communicate non-verbally, such as pointing or offering the container to the mother; and *no*

soothing/communication, in which the child displayed none of the above behaviors. Within each domain, codes were mutually exclusive.

Analytic Strategy

Hidden Markov models were fit to the negative reactivity and regulation data using *depmix* (Visser, 2005; Visser, Raijmakers, & Molenaar, 2002; for more information on *depmix* see the R website at http://cran.r-project.org/web/packages/depmix/index.html). As there was a substantial amount of stability in codes on a second by second basis, the decision was made to draw samples in 3-second intervals; missing data was imputed using forward recursion (equivalent to full-information maximum likelihood (FIML) estimates based on the raw data likelihood; Stifter et al., *under review*). The optimal number of states was selected based on a balance of model fit and parsimony (i.e., lowest AIC and BIC index), as well as interpretability. First, the best fitting model for children from non-violent homes was estimated. Next, the best fitting model for children *with* severe interparental violence in the home was estimated; the fit indices for this model were then compared to the fit indices for a model in which the parameters for the model were constrained to be equal to the best fitting model for children from non-violent homes. Next, the posterior probability of state membership for at each observation for each child was predicted, and summary statistics on the state sequence, and state duration were calculated. Finally, separate hierarchical regression models were used to assess whether the amount of interparental violence in early childhood was associated with state duration.

Results

Comparisons for mean levels of interparental violence and observed toddler reactivity and regulation are present in Table 3-1, and intercorrelations between the primary study variables can be found in Table 3-2. Notably, the presence of interparental violence in the home only was

associated with a lower proportion of time spent in mild reactivity states, and a lower proportion of time spent orienting to the mother during the task.

As can be seen in Table 3-3, results of hidden Markov analyses suggested a 6-state model provided the best fit for the data from children with no severe interparental violence during infancy or early childhood. However, for children from violent homes, a 5-state was selected based on model fit and interpretability (although a 6-state model provided slightly better fit, this model resulted in a completely transitory, degenerate state in which no reactivity or regulation was observed). Next, a 6-state model with parameters identical to those estimated for children from non-violent homes was fit to the data from children *with* severe interparental violence in the home. The fit indices for this model were compared to the fit indices for the model in which these parameters were freely estimated. Results suggested that the 6-state model for children from non-violent homes did not fit the data well for children from homes in which severe violence was present.

The 6-state hidden Markov model for children from non-violent homes. The loading and transition matrices for the 6-state model for toddlers from non-violent homes can be found in Table 3-4 and Table 3-5 (respectively). State 1 was the state children were most likely to begin in, and the following states were ordered by increasing negative reactivity (such that State 6 had the highest levels of negative reactivity). Based on the pattern of behavior probabilities, the meaning of the latent states was interpreted.

For children whose mothers did not report severe interparental violence in early childhood, State 1 was characterized by a high probability of the child showing no negative reactivity (.96) and no regulation behaviors (.89, .94, .88 for no orienting, soothing/communication, and avoidance/active regulation, respectively; see Table 3-4). However, in comparison to the regulatory behaviors observed in other states, toddlers in State 1

had the lowest probability of looking at the toy (.05) and a greater probability of engaging in avoidance (.11). Although the transition matrix suggests that toddlers were most likely to remain in their current state, when they did transition they were most likely to move from State 1 into State 2 (.24) or to State 5 (.05).

State 2 was characterized by a high probability of the child showing no negative reactivity (.97), soothing/communication (.94), or avoidance (.96), and a high probability of looking at the toy (.89). When moving out of this state, children were most likely to transition back to State 1 (.11), or to State 5 (.04).

Compared to the prior states, State 3 showed a slightly lower probability of observing no negative reactivity (.91), with a high probability of orienting to the environment (.61), and a relatively high probability of self-comforting (.24) and avoidance (.11). Children were most likely to transition to State 2 (.06) when they moved from this state, or to State 1 (.03) or State 4 (.03).

State 4 was characterized by no negative reactivity or mild negative reactivity (.58 and .35), with a high probability of looking at the toy (.59). State 4 was also characterized by the greatest probability of neutral vocalizations (.32) or gesturing (.21), as well as tension reduction (.08), relative to the other states. When moving out of this state, children were most likely to transition to State 3 (.06), or to State 2 (.03).

State 5 was characterized by a high probability of the child showing mild negative reactivity (.71) and looking at the toy (.48), as well as the greatest probability of the child looking at their mother (.16), compared to the other states. Further, there was a high probability of no soothing/communication or avoidance/active regulation in State 5. Children were most likely to transition to State 2 (.06) when they moved from this state, or to State 1 (.04) or State 6 (.04).

State 6 was characterized by a high probability of moderate to high negative reactivity (.48 and .37, respectively), with either no orienting (.43) or looking at the toy (.39). Although there was a high probability of no soothing/communication behaviors (.82) or avoidance/active regulation behaviors (.83) being observed, there was a relatively higher probability of rejection (.04) compared to the other states. Children were most likely to transition to State 2 (.03) when they moved from this state, or to State 5 (.02).

The 5-state hidden Markov model for children from homes with severe interparental violence. For children whose mothers reported severe interparental violence in the first two years of life, the initial state was labeled State 2, both because of similarities in the pattern of behavior probabilities in this state to the pattern of behavior probabilities in State 2 for children not exposed to violence, and to aid in comparisons across the groups (see Table 3-6). State 2 for children from violent homes was characterized by a high probability of the child showing no negative reactivity (.98), and a high probability of looking at the toy (.77). Children were the most likely to transition to State 3 (.05) from State 2, although there was high probability of children remaining in their current state across the 5 states in this model.

State 3 was characterized by a slightly lower probability of the child showing no negative reactivity (.92), and a high probability of no orienting (.81), soothing/communication (.83), or avoidance/active regulation (.90) being observed. Children in State 3 also demonstrated the lowest probability of looking at the toy (.06), and the greatest probability of self-comforting (.10), in comparison to the other states. Children were most likely to transition back to State 2 (.09) when they moved from this state.

State 4 was characterized by a high probability of the child demonstrating no negative reactivity (.81) or mild negative reactivity (.19), and a high probability of the child looking at the toy or the environment (.47 and .45, respectively). Further, children in State 4 were the most

likely to engage in neutral vocalizations (.11), avoidance (.10), and rejection (.11) relative to the other states. Children were most likely to transition to State 3 (.03) when they moved from this state, or back to State 2 (.01) or to State 5 (.01).

State 5 was characterized by a high probability of the child demonstrating mild to moderate negative reactivity (.42 and .38, respectively), with a high probability of looking at the toy (.50), and the greatest probability of looking to their mother (.16), relative to the other states. Children in State 5 were also more likely to be engaging in some form avoidance/active regulation (a probability of .09 for avoidance, .08 for tension reduction, and .09 for rejection) relative to most other states, and the greatest probability of gesturing (.18). Children were most likely to transition back to State 2 (.06) when they moved from this state, or to State 6 (.04). Notably, all children who eventually transitioned to State 6 did so from State 5.

State 6 was characterized by a high probability of the child demonstrating high negative reactivity (.96), as well as a high probability of either engaging in no orienting behaviors (.57) or looking at the toy (.27). Similar to the other states, there was a high probability that the child did not engage in any soothing/communication (.85) or avoidance/active regulation (.83), although children in State 6 were the most likely to engage in tension reduction relative to the other states (.11). Children were most likely to transition back to State 5 (.06) from this state, or to State 3 (.02).

Comparisons between models for children from non-violent versus violent homes. Although there are currently no empirical tests available to determine whether a given state significantly differs in the probability of observing a behavior or combination of behaviors, the following section provides descriptive information on distinctions between states for children from violent versus non-violent homes. The most prominent distinction between the two groups lies in the absence of State 1 for children from homes with severe interparental violence, the

state characterized by a high probability of the child showing no negative reactivity, no regulation behaviors, and some avoidance. From the very beginning, children from violent homes appear to be immediately oriented to the source of frustration in the task (the presence of the toy within the jar) and thus have fewer states characterized by a lack of negative reactivity relative to children from non-violent homes. Although this state (State 2) was present and virtually identical in both groups of children, all toddlers from violent homes began in this state, whereas children from non-violent homes had only a 3% chance of doing so.

Although similar levels of negative reactivity characterized State 3 and State 4 for children from both violent and non-violent homes, there were notable distinctions in the regulatory behaviors observed across the two groups. For example, although State 3 was generally characterized by low negative reactivity for both groups, toddlers from non-violent homes were more likely to orient to the environment and to engage in self-soothing as children from violent homes, who were less likely to be engaging in any regulatory behaviors. In State 4, the state characterized by low to mild levels of negative reactivity for both groups of children, toddlers from non-violent homes were more likely to engage in neutral vocalizations to gesture than children from violent homes. Instead, children from violent homes were less likely to use any communicative behaviors in State 4, and were more likely to engage in rejection, actively pushing away the jar with the toy or refusing the activity.

In contrast to the previous states, State 5 and State 6 were characterized, in part, by noticeable differences across the groups in the intensity of negative reactivity observed. For example, although State 5 had the highest probability of mild negative reactivity for both groups, children from violent homes were more likely to escalate to moderate levels of negative reactivity in this state (as evidenced by greater behavior probability of observing moderate negative reactivity for children from violent homes). There were also distinctions in the

regulatory behaviors observed in State 5. Children from violent homes were more likely to engage in tension reduction and rejection, whereas children from non-violent homes were less likely to engage in any avoidant/active regulatory behaviors Similarly, although State 6 was characterized by the highest levels of negative reactivity for both groups, there was a marked distinction in the intensity of negative reactivity observed. Children from violent homes were more likely to have high negative reactivity (e.g., screaming, wailing) in this state, compared to children from non-violent homes. In contrast, moderate negative reactivity (e.g., crying) was more likely to be observed in children from non-violent homes.

Figures 3-1 and 3-2 summarize the percentage of children in each state at each observation for children from non-violent and violent homes (based on posterior probabilities). By 90 seconds into the task, a greater percentage of children from violent homes were in the state characterized by low negative reactivity (State 3) than any other state during the rest of the task (an average of 26% of children were in State 3 from observation 30). In contrast, in the non-violent group, a greater percentage of children remained in no negative reactivity states during this time frame (an average of 29% of children were in State 1 or State 2 from observation 30). Further, there were a greater percentage of children in a low to mild reactivity state over the course of the task in the violent group compared to the non-violent group (an average of 15% of children in State 4 for the violent group, versus an average of 8% in State 4 for the non-violent group). After approximately 30 seconds (observation 10), there were proportionately fewer children from violent homes in the highest reactivity state (an average of 8% of children from violent homes in State 6 after observation 10, compared to 15% of children from non-violent homes); however, it should be noted that State 6 was characterized by higher levels of reactivity for children from violent homes (e.g., screaming, wailing, breath-holding, etc.) than State 6 for children from non-violent homes (more moderate negative reactivity, e.g., crying).

Degree of Interparental Violence and State Duration for Children from Violent Homes. Using the subgroup of children from violent homes, hierarchical regression analyses were conducted to examine if the amount of severe violence present in early childhood predicted amount of time spent in each state, accounting for the potential effects of parental marital status and household income (child age, gender, and race were also explored as covariates, but as none were significant in any of the models tested, these were removed from the final models for the sake of parsimony). As can be seen in Table 3-8, higher levels of severe violence in early childhood were associated more time spent in the highest negative reactivity state (State 6 -*High negative reactivity, some looks to toy, most tension reduction state*; $\beta = .24$, $p < .05$). No other significant associations emerged between levels of violence and state duration.

Discussion

The current study sought to explore whether severe interparental violence was linked with distinct emotion regulation processes when toddlers were faced with a blocked goal, using hidden Markov modeling to explore the coordination of emotional reactivity and regulation behaviors over time. Consistent with Davies and Cummings' (1994) emotional security theory, the findings from this investigation suggest that toddlers from violent homes demonstrate unique patterns of emotional expression and regulatory actions when faced with challenge. Further, greater levels of interparental violence in early childhood predicted children spending a greater duration of time in the state characterized by the highest levels of distress.

At the most basic level, the findings from the current study highlight both the importance of using a methodological approach suited to modeling the temporal dynamics and coordination of reactivity and regulatory behaviors in the study of emotion regulation, and the effects of interparental violence. Emotional security theory underscores the importance of the overall organization of emotion and behavior in understanding children's responses to interparental

conflict. Similarly, theory and research in the realm of emotion regulation have long suggested that adaptive or maladaptive responses cannot be assessed by single mean scores on an emotion variable; the study of emotion regulation requires examining the integration of emotional expressions and regulatory actions over time, and how these facilitate or impede functioning given situational demands (e.g., Dennis et al., 2009; Cole et al., 2004; Sroufe, 1996). Although accurately assessing and understanding the temporal dynamics between multiple co-occurring behaviors is a consistent challenge for the field, these findings suggest critical insight can be gained by doing so. By using hidden Markov modeling, this study was able to provide a more complete description of regulatory processes in children from violent and non-violent homes, revealing differences in the organization of emotional expression and regulatory actions, as well as the ways in which these processes unfolded over time. Notably, although hidden Markov modeling procedures revealed differences in these patterns based on the presence of interparental violence in the home, there were few linkages between the presence of violence and reactivity and regulatory behaviors observed at a mean level.

As hypothesized, the distinct patterns of reactivity and regulation present in children from violent homes suggest possible deficits engendered by exposure to interparental violence. While children from non-violent homes were less likely to start the task by looking at the toy and more likely to physically turn away from the task (State 1), children from violent homes focused immediately on the unavailable toy (State 2). Similarly, children from non-violent homes were more likely to focus their attention on some aspect of their environment at low levels of distress, whereas children from violent homes were much less likely to do so (State 3). Given that redirecting and sustaining attention away from emotionally arousing stimuli is a foundational self-regulatory skill (Rothbart & Sheese, 2007) and most effective at low levels of negative reactivity (Stifter & Braungart, 1995), the lack of this behavior at low levels of distress in

children exposed to violence is notable. As noted by Davies and colleagues (2008), chronic security concerns triggered by exposure to interparental aggression may deplete psychobiological resources necessary for redirecting and voluntarily sustaining attention, which may be reflected in children's decreased capacity for directing attention away from the toy in this task. These findings are also in line with emerging evidence that interparental violence in infancy may impair the development of attentional control in early childhood (Towe-Goodman, Stifter, Coccia, Cox, & The Family Life Project Key Investigators, *under review*), putting this self-regulatory skill at risk.

Consistent with our hypotheses, toddlers from violent homes also demonstrated reduced communicative behaviors at low to mild levels of negative reactivity. Specifically, children from non-violent homes were more likely to engage in neutral vocalizations (e.g., talking to the mother or babbling with neutral affect) in State 4, compared to children from violent homes. Further, children from non-violent homes were more likely to gesture (e.g., pointing to the toy) at low to mild levels of negative reactivity (in State 4), whereas children from violent homes gestured the most at higher levels of negative reactivity (State 5). In the face of interparental violence, drawing caregiver attention may be potentially dangerous, and communication attempts may be suppressed in order to adapt to the demands of an unstable and threatening home environment (Davies & Forman, 2002; Davies et al., 2006). Indeed, as empirical work has shown strong linkages between marital aggression and parental violence towards children (e.g., Hughes, 1988), communicating desires or showing indications of distress may pose a very real threat to children's safety. However, communicating, help-seeking, or self –talk all represent strategies for overcoming a blocked goal before distress escalates, and the inability to engage in this behavior in other contexts may increase the risk of adjustment problems, and could underlie the linkages seen between interparental violence and higher levels of negative reactivity.

Unexpectedly, children from violent homes were also more likely to engage in tension reduction and rejection as their distress escalated, pushing and throwing away the toy in the jar or banging their hands, feet or body against the chair or floor. With less access to distraction or neutral ways of communicating mounting frustration, children from violent homes may be more likely to turn to these more disruptive forms of regulating their distress, releasing their frustration by actively banging against objects and rejecting the desired goal. Previous work suggests that avoidance behaviors are linked with escalating distress (Stifter & Braungart, 1995), and rejection of the task may reflect attempts to avoid engaging in the activity. Evidence suggests that family violence and aggression are linked with increased object-related aggression, underregulated emotional reactivity, and behavior that is disorganized or not goal oriented in response to inter-adult anger (Cummings, 1987; Maughan & Cicchetti, 2002). It has been suggested that this pattern of behavior may reflect impaired regulatory abilities due to chronic conflict exposure (Maughan & Cicchetti), or modeling of parent's aggressive, disruptive behavior (Grych & Fincham, 1990). Whether due to impaired regulation or modeling, these findings suggest that this emotion regulation pattern may carry over to other distress evoking situations, rather than being limited to patterns of responding to conflict alone, which may heighten the risk for developing behavior problems.

Focusing on reactivity levels, children from violent homes had fewer states characterized by neutral affect than children from non-violent homes, and when distressed states were reached, children exposed to violence were more likely to show higher levels of negative reactivity. Although there were a greater percentage of children from non-violent homes in the highest reactivity state (State 6) at most time points, this state was characterized by more intense negative reactivity for children from violent homes than for children from non-violent homes (e.g., screaming, wailing, face changing colors, breath-holding, etc. for children from violent

homes, as opposed to crying for children from non-violent homes). Additionally, the degree of violence exposure appeared to pose an additional risk; children with higher levels of violence across early childhood spent more time in this highly distressed state (State 6) than children from homes in which violence was present, but at lower levels. Cummings & Davies (2002) have suggested that heightened negative reactivity may be an adaptation to chronic aggression within the home, priming and energizing the child's psychological and physical resources to respond quickly to threats within the environment. Increased negative reactivity in response to stressors is also supported by animal models, which demonstrate increased neural growth in regions associated with fear and anger when repeatedly exposed to high stress environments (McEwen & Chattarji, 2004). However, as noted earlier, due to the danger associated with drawing caregiver attention in violent homes, these children may attempt to mask expressions of negative reactivity when distress is at low enough levels to do so. Indeed, our findings suggest that children from violent homes may be experiencing more negative emotions (e.g., fewer states characterized by neutral affect), but may minimize expressions of this distress (e.g., at any given time point, more children from violent homes were in low to mild negative reactivity states, and fewer in the most reactive state), until their level of distress becomes overwhelming, and extremely intense signs of distress are seen (e.g., children from violent homes showing higher intensity negative reactivity in distressed states). Given that such patterns of heightened negative reactivity may be a risk factor in more normative settings (e.g., peer group, classroom), the fact that children exposed to violence are showing altered negative reactivity patterns at such an early age is notable, particularly as it was in response to a temporarily blocked goal -- a fairly frequently occurring event in childhood.

Given the exploratory nature of this research, a number of limitations should be noted. First, the findings from the current study describe distinct patterns of emotional expression and

regulatory actions observed in toddlers from violent and non-violent homes, but the mechanisms underlying these differences are unclear. For example, there is some research to suggest that the effects of interparental violence on children's emotion regulation abilities may operate indirectly through its association with child maltreatment (Maughan & Cicchetti, 2002). Domestic violence also has known linkages with parental mental health issues (e.g., Levendosky & Graham-Bermann, 2001), which in turn may have serious implications for young children's regulatory skill development. Further research is needed to clarify the specific processes linking interparental violence and altered emotion regulation patterns. Second, although the alterations in emotional processes suggest possible risks for future adjustment problems, this link has yet to be established. Research exploring possible linkages between dynamic patterns of emotion regulation and specific mental health issues is warranted. Third, whether children are direct witnesses to interparental violence is thought to be an important predictor of their subsequent adjustment (Kitzmann, Gaylord, Holt, & Kenny, 2003), and the current study relied on maternal reports of the frequency of interparental violence, rather than directly assessing children's exposure. However, research suggests that the majority of children from violent homes do witness acts of interparental aggression (e.g., Fantuzzo & Fusco, 2007), and very young children may be disproportionately exposed to these acts (Fantuzzo, et al., 1997). Fourth, distinctions between states for children from homes with and without severe violence remain purely descriptive, with no clear empirical test available to determine whether a given state significantly differs on the probability of observing a regulatory behavior or reactivity level. Given the descriptive quality of these results, the current findings should be interpreted with caution. Finally, the current models describe reactivity and regulation processes at the group level (e.g., children from violent or non-violent homes), but there are likely to be individuals with distinct patterns of adaptation who are not adequately characterized by this group model. Given that

most children from violent homes do not develop clinically significant levels of psychopathology (e.g., Hughes, Graham-Bermann, & Gruber, 2001), investigating these patterns of adaptation may shed light on the processes that place some children at particular risk.

Despite these limitations, the current study advances research on interparental violence and child outcomes in a number of important ways. This is the first study, to our knowledge, to examine if interparental violence in early childhood is linked with alterations in the organization and unfolding of emotional expressions and regulatory actions in toddlers. Further, the current investigation used objective observational assessments of children's distress and behavioral actions to a general emotion eliciting event, providing a methodologically rigorous description of emotion regulation processes in a context that may have important implications for toddler's adjustment and development. Taking into account acts of aggression against each parent and employing a large, diverse sample (including cohabiting and low-income families), this study expands our understanding of the effects of interparental violence on young children's development.

These findings may also offer insight into potential targets for intervention for young children exposed to interparental violence -- toddlers from violent homes showed specific deficits in their use of attention shifting and communication at low levels of distress. Although interventions designed for children exposed to interparental violence have often focused on reducing aggressive behavior or changing inappropriate beliefs about gender and family violence (Graham-Bermann & Hughes, 2003), our findings suggest that building attention and emotional communication skills may be particularly important to offset the effects of violence exposure. As research suggests children's emotional regulatory processes are a critical pathway through which interparental aggression may influence children's socio-emotional, behavioral, and cognitive

development (Cummings et al., 2009), bolstering foundational regulatory skills may be critical for children's long-term adjustment.

Jeopardizing children's feelings of safety and security in the family, interparental violence poses a serious threat to young children's development. Findings from the current study suggest that violent relationships may alter the ways in which children express and act to regulate their emotions, at a time when self-regulatory development is critical. Further consideration of the ways in which violence may impact early emotion regulation processes could provide important insight into ways to offset the damage that violence may incur.

Table 3-1

Primary Study Variables for Children from Non-Violent and Violent Homes.

	Non-Violent		Violent		*t*
Variables	*M*	*SD*	*M*	*SD*	
Toy Removal- Proportion Observed Behavior					
No negative reactivity	.70	.27	.75	.29	-1.54
Mild negative reactivity	.18	.18	.12	.13	2.61**
Moderate negative reactivity	.08	.14	.06	.11	1.02
High negative reactivity	.05	.15	.07	.18	-.97
Orienting to environment	.10	.15	.12	.17	-1.42
Looks to mother	.08	.09	.05	.07	2.07*
Looks to toy	.49	.20	.48	.20	.12
Self-comforting	.05	.11	.05	.13	.13
Neutral vocalizations	.05	.10	.05	.10	.43
Gesture	.95	.13	.95	.13	-.47
Avoidance	.06	.10	.05	.07	.62
Tension reduction	.03	.06	.04	.09	-1.09
Rejection	.02	.06	.02	.05	.50

Table 3-2

Intercorrelations of Primary Study Variables (*n* = 427).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Total severe violence (7-, 15-, 24-m)	--														
2. Severe interparental violence in home (0 = Non-violent, 1 = Violent)	.58**	--													
Toy Removal - Reactivity															
3. No negative reactivity	-.07	.08	--												
4. Mild negative reactivity	-.06	-.13**	-.58**	--											
5. Moderate negative reactivity	.03	-.05	-.67**	.09†	--										
6. High negative reactivity	.16**	.05	-.58**	-.14**	.22**	--									
Toy Removal - Orienting															
7. Orienting to environment	-.04	.07	.09†	-.04	-.09†	-.04	--								
8. Looks to mother	-.07	-.10*	-.23**	.18**	.21*	.02	-.14**	--							
9. Looks to toy	.04	-.01	.02	.04	.01	-.09†	-.23**	-.19**	--						
Toy Removal - Soothing/Communication															
10. Self-comforting	-.02	-.01	.01	-.09	.02	.06	.08	-.08	-.13**	--					
11. Neutral vocalizations	-.01	-.02	.10*	.10*	-.15**	-.16**	.18**	.01	.04	-.08	--				
12. Gesture	-.08	.02	.28**	-.06	-.20**	-.26**	-.07	.01	.12*	-.09†	.04	--			
Toy Removal - Avoidance/Active Regulation															
13. Avoidance	-.01	-.03	-.06	.08†	.02	-.01	.07	-.08	-.31**	-.02	.02	-16**	--		
14. Tension reduction	.02	.05	-.21**	.04	.17**	.18**	.08	-.02	.02	-.03	.09†	.02	-.05	--	
15. Rejection	.08	-.02	-.31**	.11*	.24**	.22**	.07	-.01	-.16**	.06	-.07	-.75**	.12*	.07	--

Note: † p < .10; * p < .05; ** p < .01

Table 3-3

Fit indices for hidden Markov models for 24-month toy removal task for children from non-violent and violent homes.

Non-Violent (*n* = 345)							
	2-state	***3-state***	***4-state***	***5-state***	***6-state***	***7-state***	
AIC	89895.71	86294.40	83034.12	81007.24	79380.4	90379.26	
BIC	90105.12	86635.65	83522.72	81658.70	80210.24	91403.00	
Logliklihood	-44920.86	-43103.20	-41454.06	-40419.62	-39583.2	-45057.63	
Violent (*n* = 82)							
	2-state	***3-state***	***4-state***	***5-state***	***6-state***	***7-state***	***6-state constrained****
AIC	19966.09	19061.32	18191.51	17716.01	17496.83	17801.25	17996.86
BIC	20136.7	19339.35	18570.64	18221.51	18172.94	18635.32	18218.02
Logliklihood	-9956.04	-9486.66	-9035.76	-8778.00	-8641.42	-8768.63	-8963.43

Table 3-4

Initial probabilities and behavior probabilities for 6-state model of 24-month children with no severe interparental violence in the home (n = 345).

	State 1	State 2	State 3	State 4	State 5	State 6
Initial Probabilities	.97	.03	0	0	0	0
Negative Reactivity						
None	.96	.97	.91	.58	.23	.11
Mild negative reactivity	.04	.03	.09	.35	.71	.04
Moderate negative reactivity	.00	.00	.01	.07	.06	.48
High negative reactivity	.00	.00	.00	.00	.00	.37
Orienting						
None	.89	.06	.21	.11	.36	.43
Orienting to the environment	.02	.01	.61	.16	.01	.08
Looks to mother	.03	.05	.03	.15	.16	.11
Looks to toy	.05	.89	.14	.59	.48	.39
Soothing/Communication						
None	.94	.94	.70	.45	.81	.82
Self-comforting	.01	.01	.24	.02	.02	.09
Neutral vocalizations	.04	.02	.04	.32	.03	.00
Gesture	.02	.03	.01	.21	.13	.09
Avoidance/Active Regulation						
None	.88	.96	.88	.63	.88	.83
Avoidance	.11	.00	.11	.00	.08	.07
Tension reduction	.01	.03	.01	.08	.03	.07
Rejection	.00	.00	.00	.02	.01	.04

Table 3-5

Transition matrix for 6-state model of 24-month children with no severe interparental violence in the home (n = 345).

		To this State:					
		State 1	State 2	State 3	State 4	State 5	State 6
From this State:	State 1	.68	.24	.03	.00	.05	.01
	State 2	.11	.81	.01	.02	.04	.00
	State 3	.03	.06	.86	.03	.02	.00
	State 4	.01	.03	.06	.88	.01	.01
	State 5	.04	.06	.01	.00	.86	.04
	State 6	.01	.03	.01	.00	.02	.94

Note: Shaded cells reflect the probability of remaining in that state.

Table 3-6

Initial probabilities and behavior probabilities for 5-state model of 24-month children with severe interparental violence in the home (*n* = 82).

	State 2	State 3	State 4	State 5	State 6
Initial Probabilities	1	0	0	0	0
Negative Reactivity					
None	.98	.92	.81	.19	.02
Mild negative reactivity	.02	.07	.19	.42	.00
Moderate negative reactivity	.00	.01	.01	.38	.03
High negative reactivity	.00	.00	.00	.01	.96
Orienting					
None	.19	.81	.01	.29	.57
Orienting to the environment	.00	.13	.45	.05	.11
Looks to mother	.04	.01	.07	.16	.05
Looks to toy	.77	.06	.47	.50	.27
Soothing/Communication					
None	.94	.83	.73	.79	.85
Self-comforting	.01	.10	.09	.00	.06
Neutral vocalizations	.03	.06	.11	.03	.00
Gesture	.03	.02	.06	.18	.09
Avoidance/Active Regulation					
None	.99	.90	.75	.74	.83
Avoidance	.01	.07	.10	.09	.05
Tension reduction	.01	.03	.04	.08	.11
Rejection	.00	.00	.11	.09	.02

Table 3-7

Transition matrix for 5-state model of 24-month children with severe interparental violence in the home (*n* = 82).

		To this State:				
		State 2	State 3	State 4	State 5	State 6
From this State:	State 2	.90	.05	.02	.03	.00
	State 3	.09	.88	.01	.01	.00
	State 4	.01	.03	.96	.01	.00
	State 5	.06	.02	.00	.88	.04
	State 6	.01	.02	.00	.06	.91

Note: Shaded cells reflect the probability of remaining in that state.

Table 3-8

Summary of Hierarchical Regression Models of Interparental Violence Predicting State Duration (*n* = 82).

	Model for State 2			Model for State 3			Model for State 4			Model for State 5			Model for State 6		
Variable	*B*	*SE*	*β*	*B*	*SE*	*β*	*B*	*SE*	*β*	*B*	*SE*	*β*	*B*	*SE*	*β*
Constant	21.39	3.53		10.12	2.68		7.49	3.15		6.43	2.58		4.58	2.16	
Household income to needs ratio	1.68	3.85	.05	.98	2.92	.04	2.01	3.42	.07	-.91	2.81	-.04	-3.76	2.35	-.18
Marital status	-.53	2.02	-.03	.36	1.53	.03	2.00	1.80	.13	-.97	1.47	-.08	-.85	1.23	-.08
(0 = Cohabitating, 1 = Married)															
Total Severe Violence	-.90	1.07	-.10	-.45	.82	-.06	-1.45	.96	-.17	1.35	.78	**.20**[*]	1.45	.66	**.24**[*]
(across 6-, 15-, & 24m)															
Adjusted R^2		-.03			-.03			.03			.05			.08	
F		.32			.89			1.71			1.41			**3.37**[*]	
F for change in R^2		.70			.30			2.32			**2.96**[†]			**4.91**[*]	

Figure 3-1. Percent of children in each state over time for the 6-state model of children from non-violent homes.

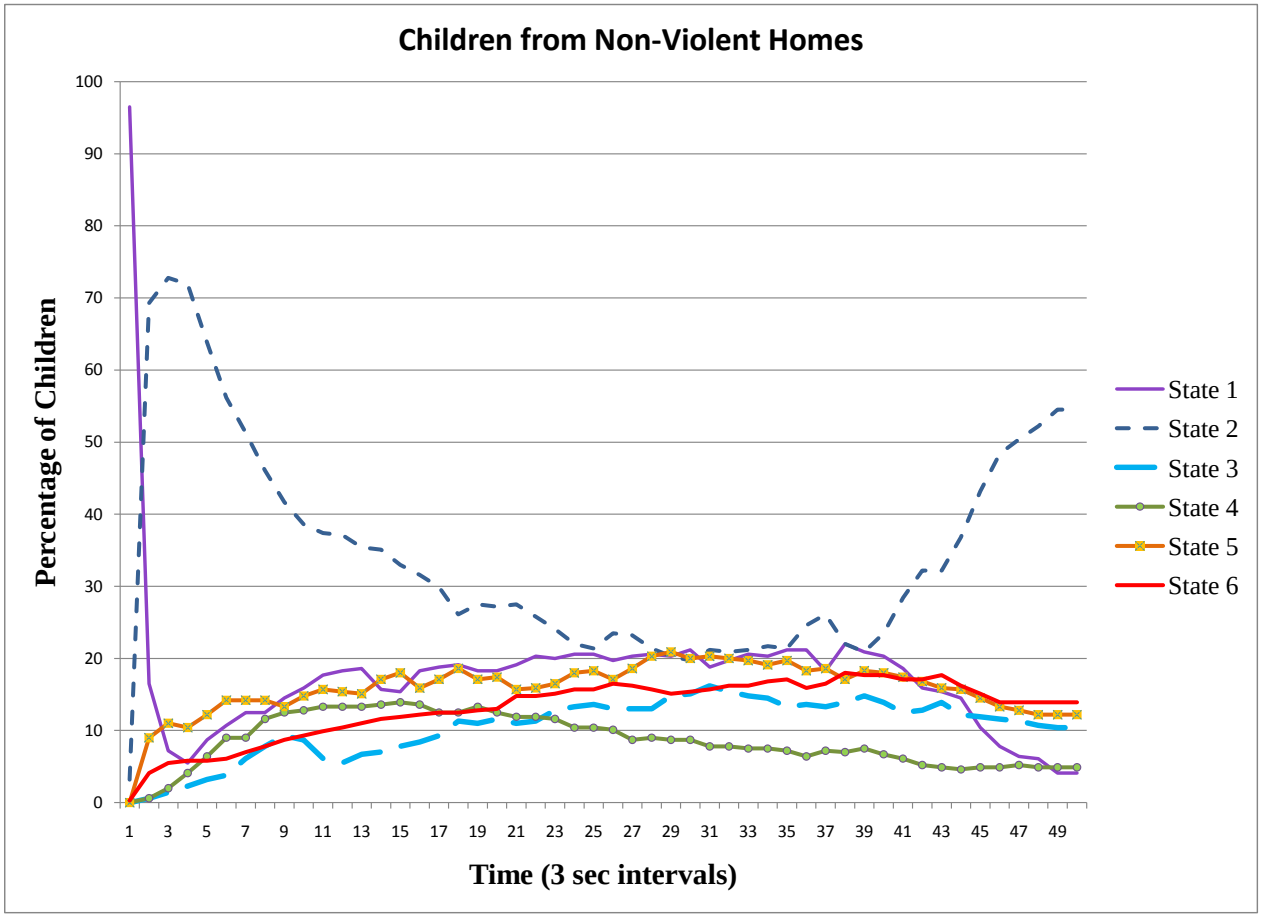
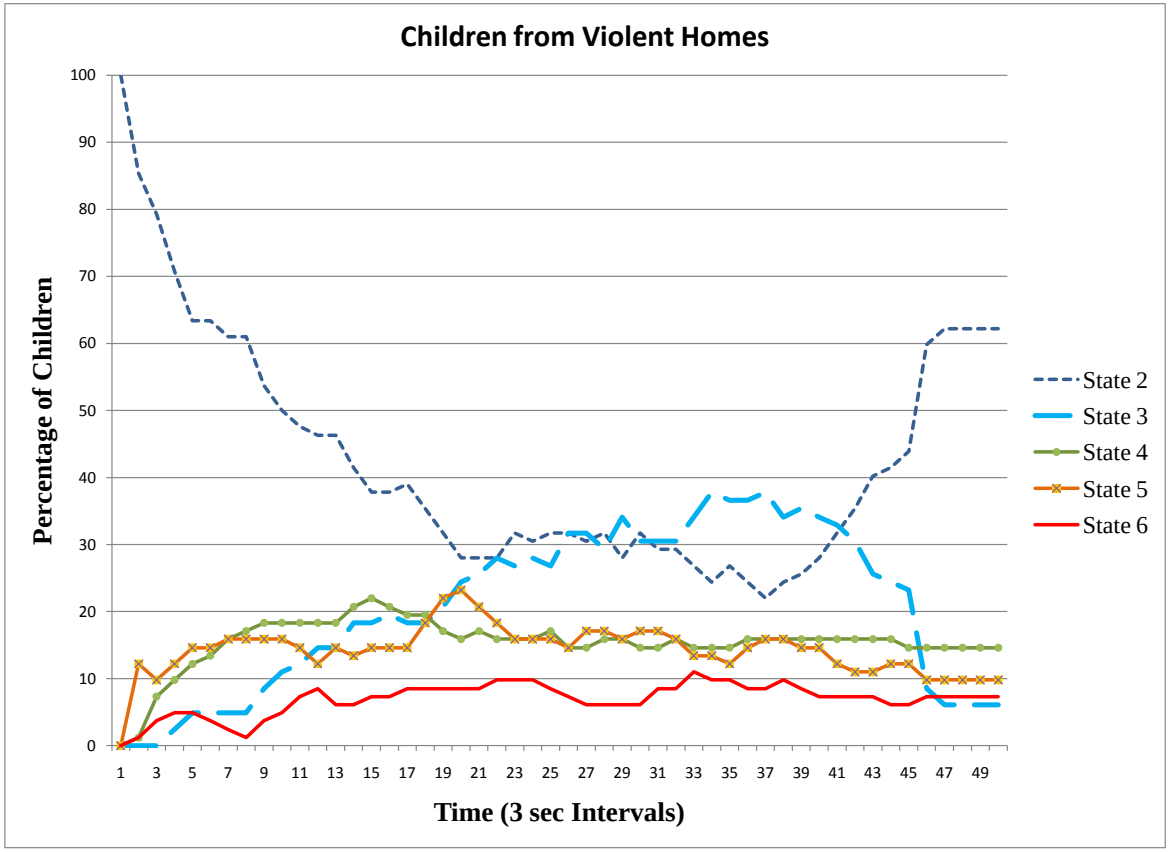


Figure 3-2. Percent of children in each state over time the 5-state model of children from violent homes.



Chapter 4

General Discussion

Emotional security theory suggests that interparental violence undermines children's sense of safety and security in the family, altering children's emotional and regulatory responses to the world around them (Davies & Cummings, 1994). Although evidence suggests millions of infants and young children are exposed to interparental aggression each year (Fantuzzo & Fusco, 2007; McDonald et al., 2006), the majority of research to date has focused on older children, ignoring the potential effects of violence on early emotional competencies and regulatory skills. Further, there is a notable lack of information on the linkages between violence within the home and the coordination of physiological and behavioral responses to stressors, or the ways in which regulatory processes may differ for children exposed to violence. Given that the family context is considered critical for the development of foundational regulatory skills and emotional competencies across multiple domains (e.g., Morris et al., 2007; Thompson, 1994), there is a pressing need for research in this area. The primary aims of the current investigation were designed to address these gaps.

The first aim was to examine the linkages between interparental violence, self-regulatory behaviors, and the development of stress response profiles across early childhood. Distinct patterns of adrenocortical and behavioral stress responses were identified, suggesting possible patterns of adaptation in the face of interparental violence. During infancy, interparental violence was linked with children showing the highest adrenocortical responses to challenge, yet only moderate elevations in negative reactivity. This stress response pattern was also linked with less looking to adults to regulate distress, suggesting that these infants may be less likely to engage in

behaviors that draw in the attention of caregivers in violent households, despite high levels of physiological arousal. Unexpectedly, stress response profiles at 15-months of age appeared unrelated to family functioning or self-regulatory strategies. At 24-months of age, however, severe interparental violence and avoidant regulatory behavior were linked with a stress response profile involving high basal levels of cortisol, a muted adrenocortical response to challenge, and moderate levels of negative behavior, suggesting that chronic stress associated with violence in toddlerhood may contribute to the formation of an avoidant coping style and suppressed adrenocortical activity to acute stressors. Contrary to our hypotheses, there were no clear longitudinal links between stress response classes associated with interparental violence in infancy and subsequent stress responses observed across early childhood; linkages were limited to violence occurring within the past year of the child's life. Indeed, there was substantial reorganization in stress responses across early childhood, and children were most likely to transition to more normative, well-regulated stress response profiles regardless of initial class status. However, if this adaptation did not occur, infant stress responses linked with violence exposure were likely to follow a trajectory involving high levels of negative affect and cortisol reactivity, and by toddlerhood, these children were communicating less to their mothers and engaging in more avoidance and tension reduction. Although much work remains to be done in understanding the linkages between family stress and the development of integrated stress responses in early childhood, the current findings suggest that interparental violence is associated with alterations in children's stress response patterns across behavioral and physiological domains, which may have serious implications for their health and development.

The second aim was to examine whether the presence of severe interparental violence in the home was associated with differences in emotion regulation processes in toddlerhood. Using

hidden Markov modeling, differences in the organization and unfolding of emotional expressions and regulatory actions were found for children from violent homes, suggesting possible deficits engendered by violence exposure. Specifically, toddlers from violent homes appeared to have difficulties redirecting attention away from the source of their frustration or communicating their desires to caregivers at low levels of negative reactivity, and engaged in more disruptive forms of releasing their anger than children from non-violent homes as they became more upset. The presence of severe interparental violence was also linked with higher levels of negative reactivity when children became distressed, as well as fewer states characterized by neutral affect. Further, the degree of violence appeared to make a difference, as children from more violent homes spent a greater amount of time in highly distressed states. However, distinctions between states for children from homes with and without sever interparental violence remain descriptive, and further research is needed to empirically assess emotional expression and regulatory differences for children exposed to violence. Although preliminary, the current findings suggest that building attention and emotional communication skills may be particularly important to offset the effects of violence exposure.

Although each of these investigations offer unique insight, taken together they present an intriguing perspective on interparental violence and children's responses to emotional challenges across early childhood. For example, the stress response profile linked with interparental violence in infancy suggests heightened adrenocortical responses to emotional challenges, and persistent activation of the stress-response system may promote atrophy in developing brain systems responsible for selective attention and inhibitory control (Bremner & Vermetten, 2001; McEwen, 2006). Indeed, toddlers from severely violent homes appeared to have deficits in their ability to use distraction as a regulatory technique at low levels of distress, failing to redirect

their attention away from the unavailable toy -- a regulatory deficit which may have contributed to these children transitioning to higher levels of negative reactivity when they became distressed. The stress response profile linked with violence in infancy also suggests that children from violent homes may try to behave in ways that do not elicit caregiver attention, looking less to adults to reduce their distress and only showing moderate behavioral reactivity despite high physiological arousal. As interactions with caregivers during infancy are thought to scaffold the development of adaptive self-regulatory skills, it is perhaps not surprising that toddlers from severely violent homes showed reduced communicative behaviors at low levels of distress, and engaged in more disruptive regulatory behavior as they became more upset. Although the coherency of these findings across studies lends further support to the potential role of early violence exposure in altering emerging regulatory skills, future investigations will need to directly explore these linkages.

Strengths and Limitations

The current studies share a number of limitations. First, although the findings regarding interparental violence and children's stress responses are in line with emotional security theory, the techniques used were largely exploratory and sample dependent. Although this allowed for a rich description of stress responses and emotion regulation processes in children from violent and non-violent households, it is possible that different patterns might emerge in different samples, or across different emotion-eliciting contexts; replication of these findings is a clear priority for future research. Second, as noted in each study, although the findings describe links between interparental violence and child functioning, further work must be done to uncover the specific processes responsible for these associations. Third, methods that involve aggregation

can only, at best, provide a rough approximation of processes occurring for individuals. Although care was taken in the current studies to explicitly recognize the presence of subgroups in the population with unique patterns of functioning and development (either a priori in the case of analyzing children from violent households vs. not, or in an exploratory manner using latent profile analysis), there are likely to be individuals within each of these subgroups with unique patterns of functioning. As noted by Box (1976), "Since all models are wrong the scientist must be alert to what is importantly wrong. In is inappropriate to be concerned about mice when there are tigers abroad" (p. 792); the current work represents two attempts to move beyond glaring issues of aggregation at the population or processes level, yet there are still areas for improvement in adequately capturing differences in development occurring within individuals. Fourth, contrary to hypotheses, there were no associations found between family functioning and children's stress responses at 15-months of age, or clear longitudinal linkages between interparental violence and the development of stress responses across early childhood. Further work is needed to understand the processes contributing to the substantial reorganization in stress response profiles across early childhood, and the factors contributing to the coordination of behavioral and adrenocortical stress responses in late infancy.

However, taken as a whole, these studies have a number of noteworthy strengths. First, they expand our understanding of the processes and pathways through which interparental violence may influence child outcomes in the first few years of life -- a foundational period for the development of adaptive self-regulatory skills, and an understudied area to date. Second, the use of person- and process- oriented methodological approaches allowed for a more comprehensive and nuanced view of young children's emotional responses and regulatory skills, answering repeated calls for integrating biology and behavior, and for examining emotion

regulation as a dynamic process. Third, using tasks designed to elicit negative emotions, each study incorporated independent, objective observational assessments of children's negative reactivity and purported regulatory behaviors, providing greater confidence in inferring emotional responses have been appropriately assessed. Fourth, these longitudinal studies involved a large, diverse sample of couples with young children, including economically-strained and more affluent households, as well as cohabiting and married partners, extending our understanding of interparental violence and child development in a wide range of families.

Future Directions

Although the findings from this investigation point to a number of unanswered questions, there are three notable gaps for future research and development: exploring how violence and alterations in early regulatory processes contribute to the early development of psychopathology, understanding the specific processes linking interparental violence and alterations in early emotional, behavioral, and physiological responses, and the need for early interventions directly addressing the problems incurred by early violence exposure.

First, although the current findings suggest specific deficits that may place children's mental health at risk, a great deal of work remains to be done in understanding how violence in the home and alterations in the way children process and manage emotions may translate into early emerging psychopathology. For example, the current findings suggest linkages between interparental aggression and heightened negative and adrenocortical reactivity, increased general distress, reduced support-seeking from caregivers, and avoidant regulatory behavior in early childhood, patterns of functioning with linkages to childhood anxiety and depression (e.g., Ashman et al., 2002; Campbell-Sills & Barlow, 2007; Garber, Braafladt, & Zeman, 1991).

However, surprisingly little is known about the linkages between interparental aggression and clinically significant anxiety or depressive symptoms during the preschool period, or whether alterations in early emotional responses and regulatory skills may mediate these associations. As research with older children and adolescents suggests pervasive links between exposure to conflict and internalizing problems (e.g., Davies & Cummings, 1998; Harold, Fincham, Osborne, & Conger, 1997), this is a notable gap. Similarly, the current findings suggest deficits in the ability to redirect and voluntarily sustain attention in toddlers from violent homes, perhaps due to chronic stress in the home environment. Given linkages between attention impairments and peer problems (e.g., Raver, Blackburn, Bancroft, & Torp, 1999), increased physical aggression (Eisenberg, Fabes, Nyman, Bernzweig, & Pinuelas, 1994), and externalizing disorders in general (Olson, Sameroff, Kerr, Lopez, & Wellman, 2005), exploring whether these attention difficulties link violence exposure and early emerging behavior problems warrants further investigation.

Second, the findings from the current investigation suggest intriguing links between interparental violence and children's emotional responses and regulatory skills, yet the specific processes accounting for these associations remain unclear. Of particular interest is the role of parenting processes. Consistent with a family systems perspective, evidence suggests disturbed parenting may partially mediate associations between interparental aggression and children's adjustment (e.g., Webster-Stratton & Hammond, 1999). For example, unresolved parental trauma due to violence may be linked fearful, threatening, or dissociative parental behavior (Zeanah et al., 1999), and such disrupted affective communication may impact regulatory skill development across multiple domains. Alternatively, interparental aggression may strain parent's abilities to sensitively scaffold interactions that aid in early attention skill development. Also of interest are alternative aspects of child functioning that may partially account for associations between

exposure to violence and children's emotional responses and regulatory skills. For example, research with older children suggests intriguing links between sleep disruption, behavioral and adrenocortical functioning, and interparental conflict (e.g., Davies et al., 2007; El Sheikh et al., 2006), yet little is known about how these processes may operate in early childhood. Further, whether the chronic stress associated with interparental violence alters the functional development of neural networks in early childhood remains an open area for investigation.

Third, there is a pressing need for interventions addressing early emerging deficits for young children from violent homes. Extant "exemplary" interventions for children exposed to interparental violence have mainly involved older children, focusing on reducing maternal stress, improving child management skills, or targeting child aggression or changing inappropriate beliefs about gender and family violence (Graham-Bermann & Hughes, 2003). However, alterations in emotional responses and regulatory skills may be present in early childhood, and children's functioning in these domains may have wide ranging implications for their health and development. Although providing children with a sense of security and safety within the home should be a primary goal, the findings from the current study suggest that improving attention skills and scaffolding emotional communication and regulatory skills may help offset early emerging problems. Although yet to be applied to toddlers or children exposed to violence, attention training has been successfully used with preschool-aged and older children, with improvements seen in performance on attention tasks and in the neural activation of the executive attention network (Rueda, Rothbart, McCandliss, Saccomanno, & Posner, 2005; Kerns, Esso, & Thomson, 1999). Similarly, parenting and classroom programs designed to improve children's emotion communication skills and emotional competencies have been successfully employed with preschool-aged children (Domitrovich, Cortes, & Greenberg, 2007;

Havighurst, Harley, & Prior, 2004), although these have yet to be targeted directly to children exposed to violence.

Additionally, findings regarding children's stress responses suggest that tailored interventions may be important for children exposed to violence in the home. If interparental aggression has distinct implications for children's stress system functioning depending on whether children are exposed to interparental violence in infancy or toddlerhood, an intervention program that ignores these important differences may not be as effective at addressing the particular needs of individuals, or as efficient (Collins, Murphy, & Bierman, 2004). For example, Gunnar and Fisher (2006) note that children with blunted or heightened adrenocortical activity to challenge may require distinct interventions to improve their relative functioning; children with established patterns of hypocortisolism may not be as responsive to typical interventions, requiring more intensive programs to ameliorate risk (van de Wiel et al., 2004). However, children with heightened adrenocortical activity may respond well to programs targeting disruptive behavior, but may need particular help in managing fear and anxiety (van Goozen, Matthys, Cohen-Kettenis, Buittelaar, & van Engeland, 2000). Although these findings are but a preliminary step in guiding intervention efforts for children exposed to violence, this remains an important area for future work.

Conclusions

The current studies suggest that interparental violence may undermine foundational emotional and regulatory skills necessary for adaptation and development. Given the prevalence of interparental aggression and the damage it may have on young children's adjustment, violence within the home is a pressing societal concern. Increased awareness that infants and toddlers are

particularly susceptible to interparental aggression is important, and knowledge of the processes and pathways linking interparental violence and children's health and development is essential to inform effective interventions. Although substantial work remains to be done in this area, the importance of this work is clear.

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PUBLICATIONS

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