An Examination of the Impact of Harsh Parenting Contexts on Children’s Adaptation Within an Evolutionary Framework

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Abstract

The current study tests whether propositions set forth in an evolutionary model of temperament (Korte, Koolhaas, Wingfield, & McEwen, 2005) may enhance our understanding of children’s differential susceptibility to unsupportive and harsh caregiving practices. Guided by this model, we examined whether children's behavioral strategies for coping with threat and challenge cohered into two broad, phenotypic dimensions--Hawk and Dove--that have been maintained by frequency-dependent selection throughout our ancestral history: Hawk-like strategies characterized by approach, dominant-negative affect, and activity; and Dove-like strategies evidenced by avoidance, inhibition, and vulnerable affect. In turn, we examined the moderating effect of Hawk or Dove profile membership on children’s physiological and psychological adaptation to harsh rearing environments. Participants included 201 two-year-old toddlers and their mothers. Consistent with the Korte model, latent profile analyses extracted two profiles which cohered into Hawk and Dove strategies. Children were classified within Hawk or Dove profiles and separately examined in a process model of harsh caregiving. As predicted, associations between harsh caregiving practices and children’s basal cortisol, parasympathetic nervous system, and sympathetic nervous system activity were moderated by profile membership. In turn, basal physiological levels were differentially predictive of children’s psychological adaptation over time. Collectively, findings highlight the potential value of translating the study of evolutionary models to understanding developmental outcomes associated with harsh caregiving.
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Research investigating the course and consequences of adverse rearing environments has detailed predictive associations between harsh and insensitive parenting practices with a wide array of outcomes in children (e.g., Joussemet et al., 2008; MacKinnon-Lewis & Lofquist, 1996; Patterson, Reid, & Dishion, 1992). At the physiological level of analysis, insensitive and hostile parenting practices have been linked with various indices of the stress response system in children (e.g., Blair, et al., and Family Life Project Investigators, 2008; Bugental, Martorell, & Barraza, 2003; Hill-Soderlund, et al., 2008). At the behavioral level of analysis, harsh caregiving has been associated with higher levels of aggression (e.g., Denham, et al., 2000; Gershoff, 2002), depression (McLeod, Weisz, & Wood, 2007), anxiety (McLeod, Wood, & Weisz, 2007), and social withdrawal in children (e.g., Booth-LaForce & Oxford, 2008). From an evolutionary-developmental perspective, these non-random effects of harsh and insensitive rearing contexts on social-developmental outcomes may reflect conditional adaptation to adversity. Specifically, evolutionary-developmental models posit that ‘when people encounter stressful environments, this does not so much disturb their development as direct or regulate it toward strategies that are adaptive under stressful conditions, even if those strategies are currently harmful in terms of the long-term welfare of the individual or society as a whole’ (Ellis et al., 2011, p. 8).

The theory of conditional adaptation may provide an umbrella for demarcating the broad array of children’s functioning within resource poor environments, however it does
not allow for adequate precision in determining for whom and how environmental adversity will eventuate in different patterns of adaptation. This gap in knowledge is critical, as greater precision in evolutionary models may better distinguish developmental outcomes associated with conditional adaptation to environmental adversity. Differential susceptibility formulations provide a valuable heuristic for explaining individual variation in developmental outcomes associated with stressful rearing environments (e.g. Belsky, 2991; Boyce & Ellis, 2005; Ellis, Boyce, Belsky, Bakermans-Kranenburg, & van IJzendoorn, 2011). Within these formulations, scholars argue that children vary in their susceptibility to environmental influences, for better and for worse, with some children more likely than others to channel resources and direct or regulate their development to match stressful (and supportive) environmental conditions (Ellis et al., 2011).

According to differential susceptibility frameworks, children’s phenotypic behaviors may serve as markers for individual differences in neurobiological susceptibility. Particularly, scientists have theorized that children characterized by difficult temperament (i.e., high negative emotionality, proneness to distress, low adaptability, high activity level; Chess & Thomas, 1989) appear to be more susceptible to influence by their rearing environment, for better or for worse (Belsky, 2005; Belsky, Hsieh, & Crnic, 1998). Empirical research has supported this contention by demonstrating children’s differential susceptibility to poor rearing conditions. In the seminal study in this area, Belsky, Hsieh, and Crnic (1998) reported that negative parenting was a stronger predictor of both later occurring externalizing behaviors and inhibited/withdrawn behaviors in infants rated as higher on negative temperament. Additional research findings have further implicated difficult temperament-by-parenting
interactions in the development of externalizing behaviors (e.g., van Zeijl, et al., 2007), poor social functioning (e.g., Pluess & Belsky, 2010), and general behavior problems (e.g., Belsky, 2005). These studies highlight the utility of this framework for developmental research. However, the moderating role of difficult temperament in associations between adverse rearing contexts and children’s development is widely variable in its ability to predict specific outcomes (e.g., Obradovic & Boyce, 2009). Thus, greater precision in the conceptualization of temperament in differential susceptibility frameworks may better distinguish developmental outcomes associated with rearing contexts. Towards this goal, the current study tests whether propositions set forth in an evolutionary conceptualization of temperament (Korte, Koolhaas, Wingfield, & McEwen, 2005) may enhance our understanding of children’s differential susceptibility in their physiological and psychological adaptation to unsupportive and harsh caregiving practices.

The evolutionary account of temperament proposed by Korte and colleagues (2005), proposes that two broad-band characteristic responses to stress and challenge involving distinct configurations of behavioral strategies, coping styles, and emotional states have been maintained in our population through negative frequency-dependent selection (see Table 1). Individuals with Hawk-like temperaments are primarily identified by proactive coping, bold approach behaviors, and fast and superficial exploration. In contrast, Dove-like profiles are characterized by a vigilant, non-aggressive and cautious manner when faced with challenge or threat. Research endeavors examining the construct of temperament in human populations support the existence of these two orthogonally distinct profiles proposed in the Korte model, including a negative
affectivity/inhibition (Dove-like) profile and a surgency/approach (Hawk-like) profile during infancy and childhood (e.g., Belsky, et al., 1998; Goldsmith & Campos, 1990; Putnam & Stifter, 2005; Rothbart, Ahadi, Hershey, & Fisher, 2000), as well as in adulthood (Watson, 1988; Diener, Smith, & Fujita, 1995). In addition, the stability of these profiles has also been documented longitudinally over childhood (e.g., Pfeifer, Goldsmith, Davidson, & Rickman, 2002). For the present study, the value of the Hawk-Dove conceptualization of temperament for understanding children’s differential conditional adaptation to harsh rearing contexts lies in its integration of both phenotypic and endophenotypic levels of functioning (Ellis, Jackson, & Boyce, 2006). As such, it places emphasis on understanding how the distinct behavioral phenotypes of Hawk and Dove temperamental profiles may be systematically associated with children’s stress physiology and how they may be differentially calibrated to ontogenetic challenge. Thus, children’s histories of experience in adverse rearing environments may engender distinct patterns of physiological activity and ultimately different developmental outcomes depending upon temperamental profile.

_Hawk-Dove Profiles and Differential Susceptibility in Physiological Stress Response Systems_

The Hawk-Dove model proposes that differences in the underlying stress physiology of each temperamental phenotype were maximally adaptive in promoting survival and reproduction. This is accomplished through two pathways of the neuroendocrine system: the autonomic nervous system (ANS) and the hypothalamic-pituitary-adrenal axis (HPA). The ANS further consists of two separate systems: the sympathetic nervous system (SNS) and the parasympathetic nervous system (PNS). The
parasympathetic nervous system serves to shift physiological resources towards restorative, homeostatic functioning and reduce physiological arousal (Porges, 1995). In contrast, the sympathetic nervous system primes the body for fight-or-flight responses in the face of threat by increasing cardiac output, oxygen flow, and blood glucose levels (Berntson et al., 1997; Porges, 2006). Finally, the HPA axis is charged with the function of mobilizing energy resources (e.g., glucose, oxygen) and modulating the processing, encoding, and memory consolidation of emotionally significant and stressing events (Gunnar & Quevedo, 2007; Munck & Naray-Fejes-Toth, 1994). Although extensive cross-regulation among the three components of the stress response system exists via the central control center located in higher-order limbic structures (e.g., Gold & Chrousos, 2002), different systems can assume dominance within the response hierarchy (e.g., El-Sheikh & Erath, 2011). For example, if the sympathetic nervous system is effective in dealing with environmental threats, the SNS may supersede, and thus limit, the activation of the HPA axis.

In the present study, we examine basal levels of these two physiological stress response systems. Basal functioning represents homeostatic set-points from which system activation is generated and has been implicated in developmental models as being shaped by early caregiving experiences (e.g., Leucken & Lemery, 2004; Tarullo & Gunnar, 2006). Although the evolutionary framework by Korte and colleagues does not distinguish between physiological activity and reactivity, it is centered on the general physiological functioning of organisms within the context of their ecological niches. Thus, examination of basal functioning provides the first, most direct test of the primary predictions that structural differences in the set-points and activation thresholds of the
ANS and HPA systems within stressful and threatening interpersonal environments underlie each profile (see Table 1). In this, Korte and colleagues (2005) propose that an underlying sympathetic dominance supports the quick fight-or-flight response to external threats characteristic of the Hawk profile. In contrast, increased parasympathetic activity and cortisol activation are proposed to provide the foundation for greater orienting, attentional focus, and inhibitory control associated with the Dove profile.

Although no study to our knowledge has utilized the Hawk/Dove framework for parenting contexts, some earlier research examining components of the theory in human populations provide initial support for its propositions. For example, Kertes and colleagues (Kertes, Donzella et al., 2009) report differential activation of the HPA system to novelty and threat depending upon temperament behavior in a sample of preschool-aged children and caregiving environment. First, greater cortisol reactivity to challenging laboratory tasks were evident in children exhibiting Dove-like characteristics of inhibition when they experienced diminished parenting quality. Second, parenting quality did not predict cortisol reactivity for children with Hawk-like characteristics of approach and exuberance in the face of novelty. In a separate study examining associations between behavioral inhibition and behavioral approach with physiological correlates in a sample of preschool children, findings also cohered to hypothesized associations with Hawk and Dove phenotypes. Specifically, Blair et al., (2004) found that children with higher levels of parent-reported withdrawal and inhibition evidenced amplified cortisol and increased vagal baseline activity and reactivity during laboratory tasks, whereas higher approach was linked with cortisol decrease and lower resting vagal tone.
Hawk-Dove Profiles and Psychological Ontogeny

The utility of the Hawk-Dove profile for developmental models is predicated on whether differences in activation of physiological mediators in stressful interpersonal ecologies predict meaningful associations with children’s long-term psychological outcomes. Within the model, the benefit to Hawk temperamental profiles of an amplified sympathetic pattern of accommodation to environmental challenges is proffered to result in higher levels of aggression, poorer impulse control, and greater attentional difficulties over time. Conversely, the amplified parasympathetic and cortisol activity in response to stressful environmental conditions associated with the Dove profile is specifically proposed to be a physiological pathway towards increased depression and heightened levels of anxiety and emotional vulnerability over time. Supporting predictions regarding with the HPA system, previous research has documented significant associations between children’s heightened cortisol activity and increases in internalizing symptoms (e.g., Granger, Weisz, & Kauneckis, 1994; Klimes-Dougan, Hastings, Granger, Usher, & Zahn-Waxler, 2001). However, previous findings concerning associations between ANS functioning and externalizing (e.g., aggression, inattention) and internalizing (depression, anxiety) problems are less clear. For example, in a single study examining both internalizing and externalizing symptoms with parasympathetic and sympathetic activation, Boyce et al., (2001) reported that children with internalizing behavior problems had higher parasympathetic reactivity whereas children with externalizing problems evidenced low activation in both PNS and SNS branches of the autonomic nervous system.

Developmental Considerations
In the present study we explored children’s physiological and psychological functioning within the context of harsh maternal caregiving during the toddler period. Toddlerhood is consistently posited as a significant period of developmental plasticity including rapid changes in emotion regulation and emerging abilities in mobility and exploratory behavior (e.g., Edwards & Liu, 2002). Early childhood is also a particularly vulnerable period for children’s exposure to harsh and insensitive maternal caregiving behaviors (e.g., Edwards & Liu, 2002). During this time period, children are highly dependent upon their caregivers to provide support, consistency, and sensitive caregiving. Because unresponsive, insensitive, and harsh caregiving behaviors fail to provide a haven of protection and commonly serve as a source of threat, harsh caregiving environments are an important context for examining children’s differential susceptibility (Cicchetti, 2003; Ellis et al., 2011). Thus, our exploration of the developmental ontogeny of neurobiological factors during this developmental period allows us to begin to chart the possible presence of adaptive plasticity in response to harsh environmental contexts.

In summary, our multivariate, developmental analysis tests whether children’s Hawk or Dove temperamental dispositions may offer greater precision in delineating differential susceptibility to harsh rearing contexts. To provide a richer indication of behavioral displays for the Hawk and Dove profiles, we utilized both mothers’ ratings and observational assessments of children’s temperamental dispositions.

1. We hypothesized that a latent profile analysis would reveal two distinct temperamental profiles in accordance with the Hawk/Dove model. Harsh/insensitive caregiving environments were also multi-informed, with both maternal self-reports and observational assessments guiding our operationalization of this
construct. Next, we examine whether Hawk or Dove profile membership moderates pathways between maternal harsh parenting and children’s physiological activity. In accordance with the model, we hypothesized:

2. Higher levels of maternal harsh parenting would be linked with elevated SNS activity in children identified as having primarily Hawk-like temperaments,

3. Higher levels of maternal harsh parenting would be associated with elevated PNS and cortisol activity children having Dove-like temperaments.

Theories of differential susceptibility also underscore the importance of determining whether behavioral phenotypes are generally associated with trademark physiological responses across caregiving environments or whether it emerges only in the context of threatening rearing contexts. To test this prediction, we also examined if there were differences in the stress response system activity based on hawk-dove classification alone to determine if differences were due primarily to early caregiving or naturally present within the profiles. We hypothesized:

4. There would be no significant mean differences across Hawk and Dove profiles in SNS, PNS, and cortisol indicators.

Finally, we examined whether physiological variables were differentially linked to developmental outcomes according to profile membership. We hypothesized that:

5. Heightened SNS activity would drive increases in externalizing behaviors over time in the Hawk profile.

6. Heightened PNS and cortisol activity would primarily be associated with changes in internalizing behaviors in the Dove profile.
Methods

Participants

Participants included 201 two-year-old children and their mothers in a moderately-sized metropolitan area in the Northeastern United States. A recruitment process was implemented to enroll a high-risk sample of families experiencing elevated levels of sociodemographic adversity. To accomplish this, we recruited participants through agencies serving disadvantaged children and families, including Women, Infants, and Children, Temporary Assistance to Needy Families rosters from the Department of Human and Health Services, and the county family court system. Additional inclusionary criteria for the study consisted of: (a) the adult female participant is the biological mother and primary caregiver of the target child; (b) the child participant is 27-months old (+/- 5 months); and (c) the child has no serious cognitive, sensory, or motor impairments. In the sample, 73% of the participants lived with the mother and biological father. The remaining children in the study lived with the mother and the target partner was either a step-father or partner.

Median annual income for the family household was $18,300 (US) per year and a substantial minority of mothers (30%) did not complete high school. Most families received public assistance (95%) and were impoverished according to the US Federal Poverty Guidelines (99.5%). The majority of mothers and children were African-American (56%), followed by smaller proportions of family members who identified as European-American (23%), Latino (11%), Multi-Racial (7%), and “Other” (3%).

Data for this study were collected at two measurement occasions each spaced one year apart. The mean age of the children at Wave 1 was 26 months ($SD = 1.69$) and at
Wave 2 was 37 months ($SD = 1.58$), with 44% of the sample consisting of girls ($n = 92$). The retention rate across the two annual measurement occasions was 83%. Comparisons between mother-child dyads who participated in all measurement occasions and dyads who dropped out of the study did not differ from each other along family and child measures at Wave 1 (e.g., maternal parenting, child temperament, and child psychological problems) and ten additional demographic (e.g., maternal age, race; income, education, occupational prestige, child age and gender).

**Procedures**

Mothers and their toddlers made three visits to our laboratory within a one- to two-week time period to obtain the primary measures. The research procedures were approved by the Institutional Review Board at the research site prior to conducting the study. Assessments were spaced accordingly to minimize potential overlap across paradigms. Mothers also completed questionnaires and interviews across the three visits. Procedures were standardized across participants.

**Mother-Child Interaction Task.** Mothers and their children participated in an observational free-play/compliance task at the laboratory which was videotaped for later coding. The mothers were instructed to play with their child as they would at home after the dyad was escorted into a room containing several developmentally appropriate toys. After seven minutes, an experimenter knocked on the door to signal the end of the free-play session to the mother. Mothers were then instructed to ask their children to stop playing and clean up the toys without providing assistance. The experimenter continued to knock on the door at one-minute intervals, up to three minutes, if the child appeared to be off-task. By the third knock mothers were told that they could provide assistance to
their child with picking up the toys. The compliance portion of the task was recorded for six minutes, regardless of progress, making the entire session approximately 13 minutes.

*Unfamiliar episodes.* Following comparable procedures to previous temperament batteries (e.g., Fox, Henderson, Rubin, Calkins, & Schmidt, 2001; Kagan, Reznick, & Snidman, 1987; Putnam & Stifter, 2005), children were exposed to a series of novel objects and events. The mothers, who were in the same room, were instructed to complete questionnaires and only intervene with their children during the procedure if they were concerned about their well-being. In the first episode, the experimenter escorted the child into the room containing a number of unusual objects (e.g., funnel, goggles, windshield cover). After the experimenter departed, the child was free to explore the room and play with the objects for three minutes. In the second task, the experimenter returned and instructed the child to manipulate the objects in different ways (e.g., windshield cover: “Poke it!”; funnel: “Put it on your head!”). In the third episode, an unfamiliar female experimenter dressed as a clown invited the child to play with a sack of toys for two minutes after introducing herself. In the final event, the primary female experimenter instructed the children to imitate the following events after first enacting them herself: (a) reaching behind a black curtain to pull out a doll, (b) placing a finger in glasses of water and prune juice, and (c) picking up a rubber snake and letting it slide back on to the table. All episodes were videorecorded for subsequent behavioral coding.

*Salivary cortisol collection.* The end product of hypothalamic-pituitary-adrenal axis activation is cortisol. Basal cortisol measures were obtained through a saliva sample collected from each child at the beginning of the first visit to the laboratory. Samples were collected in the presence of the mother upon arrival to the laboratory. To limit the
effects of diurnal patterns, samples were collected within a narrow time window in the morning (M= 9:37 A.M.; SD = 30 minutes). All toddlers had been awake at least one hour prior to providing the morning saliva samples, thus avoiding the period of the dynamic cortisol awakening response (Susman et al., 2007). Toddlers were also monitored to insure they did not eat or drink for 30 minutes before sample collection to limit saliva contamination. Due to the age of the participants, a sorbette was held under the child’s tongue by a research assistant for one minute to ensure a sufficient quantity of saliva was obtained. Each sorbette was placed in a 2 mL cryovial and immediately stored at -80°C until shipped on dry ice to Salimetrics, LLC. (State College, PA).

Cardiac autonomic functioning. Basal heart rate data were collected on each child at the beginning of the second laboratory visit using a MiniLoger 2010 Series (Mini Mitter, Inc., Bend, OR). The MiniLoger detects each R-Wave and records every interval between successive R-Waves to the nearest millisecond. Mothers held their children on their laps while a trained experimenter placed two electrodes on the child’s chest; one medially on the right collar bone and one on the child’s left side below the rib cage. Consistent with prior research, children were given low arousal activities (e.g., quiet reading of a book) during recording to keep them calm and facilitate a basal data collection (Hastings et al., 2008).

Measures

Child temperament. Maternal report and observational assessments were used to assess children’s temperament dimensions. First, mothers completed the Soothability/Falling Reactivity, and Anger/Frustration Subscales of the Child Behavior Questionnaire (CBQ; Rothbart, Ahadi, Hersey, & Fisher, 2001). The Anger subscale
captures negative affect dispositions in response to interruption of goals and activities ($\alpha = .76$), and the Soothability scale captures recovery from distress, arousal, and/or excitement activities ($\alpha = .81$).

Second, video records of children’s behavioral expressions of emotion in response to each of the four unfamiliar episodes were coded by another set of coders along five-point scales. Consistent with behavioral distinctions between the Dove and Hawk personalities (Ellis, et al., 2006; Korte et al. 2005), the coding system differentiated between inhibited and approach dimensions of temperamental reactivity through five different scales including activity level, approach, avoidance, inhibition, and vulnerable negative affect. Activity level was adapted from previous coding systems (e.g., Fox et al., 2001; Putnam & Stifter, 2005), and assessed in each episode using a scale ranging from 0 (none = child is completely or nearly still) to 4 (intense = child engages in multiple, intense gross motor activity throughout the segment). The Approach code reflected physical movement toward the novel stimuli that was commonly accompanied by self-confidence, unbridled curiosity, and excitement about the objects or events. The Avoidance scale assessed the extent to which the child actively avoided or withdrew from stimuli such as covering eyes, hiding, asking to go home. The Inhibition scale characterized children’s tendency to restrain behavior in order to assess the situation through signs of vigilance and hesitant or apprehensive forms of curiosity. Finally, Vulnerable Negative affect was defined as subordinate affective responses manifested in fear, freezing, anxiety, crying, self-soothing, and comfort seeking (e.g., hiding behind mom). Two coders, who were extensively trained to reliability, were randomly assigned to code approximately 60% of the children in the unfamiliar episodes, overlapping on
approximately 24% of the video records for purposes of calculating reliability. Intraclass correlation coefficients, which examined interrater reliabilities, ranged from .89 to .96. Due to the satisfactory internal consistency of each of the temperament codes across the four novel episodes (α range .74 - .82), the ratings of each code were aggregated across the episodes to obtain composites of the five temperament dimensions.

**Maternal Harsh Parenting.** To create a multi-informant assessment of parenting, indices of maternal harsh parenting included maternal questionnaire data and behavioral observation. First, observer ratings on three scales of maternal caregiving behaviors during the free play and compliance tasks were completed using the Iowa Family Interaction Rating Scales (IFIRS; Melby & Conger, 2001). The *Harsh* subscale assesses the extent to which the mothers display harsh, angry, critical, disapproving and/or rejecting behavior toward the child’s behavior, appearance, or state. The *Verbal Aggression* subscale assesses mothers’ curt, abrupt, and demeaning verbalizations with the child. The *Insensitivity* subscale assessed the extent to which the mother was unaware or uncaring of the needs or abilities of her child, and consistently put her own preferences ahead of her child’s. Ratings were assessed on nine-point Likert-type scales ranging from 1 (not characteristic at all) to 9 (mainly characteristic). The intraclass correlation coefficient of the inter-rater reliability of three independent coders for 25% of the interactions ranged from .89 to .97 across the three coders across the two interactions. Observational rating codes across the three indicators covered the possible range from 1 to 9.

One additional indicator was assessed from maternal report on the Lack of Empathy scale from the Adult-Adolescent Parenting Inventory (AAPI; Bavolek, 1984).
The Lack of Empathy scale consists of eight items designed to assess maternal harsh caregiving in response to the child’s needs (e.g., “Parents will spoil their children by picking them up and comforting them when they cry.”). The internal consistency for the scale was satisfactory ($\alpha = .82$) and the validity of the measure is supported by its associations with related parenting constructs (Bavolek, 1984; Fischer & Corcoran, 2007). Range of scores in the current study was from 8 to 33.

Child Psychological Outcomes. Mothers completed the Child Behavior Checklist at Waves 1 and 2 (CBCL: Achenbach & Rescorla, 2000) to assess children’s behavioral and emotional difficulties. The CBCL is one of the most widely used standardized measures of children’s functioning. Mothers reported on four syndrome scales assessing Emotional Reactivity, Anxious/Depressed behaviors, Attention Problems, and Aggressive Behaviors. Internal consistency estimates of the CBCL scales in this sample ranged from .59 to .90 at Wave 1 and .65 to .91 at Wave 2.

Cortisol. All samples were assayed for salivary cortisol in duplicate using a highly sensitive enzyme immunoassay (Salimetrics, PA). The test uses 25 µl of saliva per determination, has a lower limit of sensitivity of 0.003 µg/dl, standard curve range from 0.012 to 3.0 µg/dl, and average intra-and inter-assay coefficients of variation 3.5 % and 5.1 % respectively. Method accuracy, determined by spike and recovery, and linearity, determined by serial dilution are, 100.8 % and 91.7 %. Values from matched serum and saliva samples show the expected strong linear relationship, $r (63) = 0.89$, $p < 0.0001$ (Salimetrics, 2005).

Parasympathetic Nervous System and Sympathetic Nervous System Functioning. Interbeat interval (IBI) data were extracted from the EKG assessment using Mini-Log
2000W software (Mini Mitter, Inc., 2001), edited for artifacts, and analyzed using CMet software (Allen, 2002). Putative measures of parasympathetic nervous system and sympathetic nervous system activity were calculated using a method developed by Toichi et al. (1997). The Toichi method falls within the time-domain methods for analyzing the interbeat-interval (IBI) typically employed in the child development literature, however it is more adept at parceling out influences on the IBI due to primarily parasympathetic activity against those due primarily to sympathetic activity (Allen, Chambers, & Towers, 2007), when considering the IBI series alone. Calculations are based on a Lorenz plot of the IBI data. In the resulting ellipsoidal graph, the transverse axis (T) reflects variability from one IBI to the next while the longitudinal axis (L) reflects the range of variability in all of the IBIs. The cardiac sympathetic index (CSI) is calculated as the ratio L/T, while the cardiac vagal index (CVI) is measured as the $\log_{10}(L \times T)$.

Toichi and his colleagues demonstrated the validity of the CVI as an index of parasympathetic activity and the CSI as an index of sympathetic activity through the use of pharmacological blockades. First, Toichi et al. found that the CSI index is unaffected by parasympathetic blockade due to atropine, but decreases with administration of propranolol (a sympathetic blockade). Conversely, the CVI was determined to be subject to action by atropine, but unaffected by sympathetic blockade due to propranolol. In addition, Newlin et al. (2000) determined that results from Toichi’s CVI were congruent to results obtained using the Porges (1995) method for HRV. Additionally, using calculations from CMet, Allen et al. (2007) found Toichi’s CVI was highly correlated (.95) with respiratory sinus arrhythmia, a widely used measure of vagal tone in psychological research (e.g. El-Sheikh et al., 2001). Finally, although primarily used in
adult populations, Toichi’s CSI and CVI have been validated as measures of autonomic activity in physiological research with young children (e.g., Diego et al., 2005).

Results

To explore the level of functioning in children on our outcome assessments in the sample, we examined the frequency of children who evidenced clinically elevated levels (T scores > 62) on measures of child outcomes averaged across domains. At Wave 1, 9% of children evidence heightened levels of internalizing behaviors, and 14% displayed elevated levels of externalizing behaviors. At Wave 2, 12% of children evidence heightened levels of internalizing behaviors while 14% displayed elevated levels of externalizing behaviors. Table 2 provides the raw means, standard deviations, and correlations for the variables in primary analyses obtained. Relationships among study variables were in the expected directions.

Missing data ranged from 1% to 17% due to data loss across the different measures (e.g., equipment malfunctions), and subject attrition within and across waves. To evaluate whether data were missing completely at random (MCAR), we examined the patterns of missing data using Little’s MCAR test (Little, 1988). Little’s test suggested that the data were indeed MCAR [$\chi^2 = 216.59 (208), p = .33$]. Therefore, in order to retain the maximum amount of statistical power, we retained the entire sample in analyses and utilized maximum likelihood estimation for missing values available in software packages.

**Determination of Hawk/Dove profiles.**

Latent Profile Analysis (LPA; e.g., Hagenaars & McCutcheon, 2002) was utilized to identify the presence of the Hawk and Dove profiles in the data. Latent profile
analysis is a variant of latent class analysis techniques and is used when manifest indicators of the categorical latent variable are on a continuous scale. As in other latent variable modeling techniques, the profiles in LPA are not observable directly from the data but are identified based on a function of a set of the continuous manifest indicators. The manifest indicators utilized in our LPA included assessments of children’s activity, approach, avoidance, inhibition, and vulnerable behaviors during laboratory tasks. In addition, mothers reports of children’s levels of distress/falling reactivity and anger on the CBQ were also used as indicators. LPA models were estimated using maximum likelihood to account for missing data within Mplus, Version 6.1 (Muthén & Muthén, 2006). One subject was missing data across the indicators of the model and was therefore excluded, reducing the overall sample size to 200 children. Given a large body of research which has documented sex differences in aspects of temperamental profiles studied here (e.g., Taylor et al., 2002), we also included child gender as a possible covariate in determining class membership. Within MPlus, child gender is related to the categorical latent class variable by way of multinomial logistical regression.

In order to determine the optimal number of profiles, we followed recommendations to consider fit indices, parsimony, theoretical justification, and interpretability (e.g., Jung & Wickrama, 2008; Muthen & Muthen, 2000). To examine fit indices, we utilized two likelihood tests for comparing nested models including the Bayesian Information Criterion (BIC; Schwartz, 1978) and the Vuong-Lo-Mendell-Rubin likelihood ratio test (VLMR; Lo, Mendell, & Rubin, 2001). The model with the lowest BIC value is generally considered the best-fitting model. As a further test of model fit, the VLMR provides a p value which indicates whether the k-1 profile model is rejected in
favor of the k profile model (see Nylund, Asparouhov & Muthen, 2007 for more details). We also considered entropy, which is an indicator of classification fit in the posterior probabilities of class membership, with a maximum value of 1.0. Finally, we heeded recommendations on the importance of considering the theoretical justification and practical applications of profile solutions (Muthen, 2004). Therefore, substantive implications were weighted equally with statistical indices when determining optimal number of profiles.

To examine the best profile solution, we extracted a series of profile solutions (see Table 3). Results revealed that although there was a substantial drop in BIC from the one-two profile solutions, other fit indices suggested that the three profile solution was a well fitting model. We next explored the substantive composition and theoretical interpretation of the two and three profile solutions. The two-profile solution cohered into the hypothesized hawk and dove temperamental patterns among indicator variables. The three-profile solution contained the two profiles as culled in the two group solution, as well as one profile with 15 children who evidenced higher levels of dovelike temperamental traits coupled with lower levels of hawklike temperamental traits. Accordingly, this small group of children mirrored the profile of the dove pattern identified in the two-profile solution, albeit at higher levels. Given the conceptual overlap of the Dove profiles between the two and three profile solutions, as well as the extremely small sample size in the third profile, we elected to retain the two-profile solution for analyses. We also examined whether child gender increased the log-odds of being classified into the Hawk profile compared to the Dove profile. Child gender was
not associated with the probability of profile membership (logistic regression coefficient $\beta = .33, \ p = .32$)

To formally classify children formally into either the Hawk or Dove profile, we utilized the posterior (Bayesian) probabilities of likelihood of membership in each latent profile produced by the LPA. Subjects are classified into the latent profile for which the posterior probability is highest. The probabilities are a function of the model's parameters (estimated conditional response probabilities and estimated prevalence of each latent class). Inspection of these classifications and posterior probabilities is necessary to ensure that children have a high likelihood of being classified correctly. In the present study, average latent class probabilities for most likely latent class membership by classified latent class were excellent. Specifically, children who were profiled as Hawks had a 93.0% average probability of fitting the profile, while children who were profiled as Doves had a 95.0% average probability of fitting the profile. Inspection of the cases revealed that nine children displayed some indiscrimination among profiles. Their highest profile probability (range = .50 - .56) suggested that their scores did not discriminate between the latent profiles (e.g., Nagin, 2005). Because analyses conducted with and without these children yielded the same pattern of results, we elected to include all children in the sample in the final analysis.

Table 4 shows the means and standard deviations of the standardized measures of the latent profile variable indicators of temperamental characteristics for the Hawk and Dove profiles as well as the results of ANOVA comparisons between the two groups. The Hawk profile displayed higher levels of activity and approach behaviors during laboratory tasks. In addition, mothers of these children reported higher levels of anger on
the CBQ. Children in the Dove profile displayed higher levels of avoidance, inhibition, and vulnerable affect in the laboratory tasks while mothers reported them as higher on falling reactivity in the CBQ assessment.

**Primary Analyses**

To examine children’s differential susceptibility to harsh parenting and psychological outcomes, we utilized a multiple group approach in Structural Equation Modeling (SEM). Children classified in our LPA as Hawks in behavioral characteristics comprised one group, while children classified as Doves were the other group. Our models were specified with Amos 17.0 statistical software using full-information maximum likelihood estimation to accommodate missing data (Arbuckle, 2008). We utilized pairwise parameter comparisons available in AMOS’s Critical Ratio of Differences command for testing the equivalence of model parameters across groups, or in other words the moderating effect of temperamental profile. Pairwise parameter comparisons test whether two parameters are significantly different from one another by calculating the difference between the two estimates divided by the estimated standard error of the difference. The resulting difference statistic is normally distributed and tested against the z-score distribution (CR > 1.96). In our analysis section below, we report the difference statistic (indicated by $ds$ in results section) for pairwise tests.

**Hawk/Dove Profiles in Associations Between Harsh Parenting and Physiological Activity**

We first examined whether Hawk and Dove profiles evidenced differential susceptibility to maternal harsh parenting in SNS, PNS and HPA activity (see Figure 2). The model provided an adequate fit to the data, $\chi^2 = 32.18$ ($22$, $N=200$, $p = .06$, RMSEA = .05, CFI = .97, $\chi^2$/df = 1.51). In the Hawk profile, maternal harsh caregiving was
significantly associated with elevated CSI activity ($\beta = .21, p = .04, R^2 = .05$) and was not associated with CVI ($\beta = -.05, p = .63, R^2 = .001$) or cortisol ($\beta = .12, p = .32, R^2 = .01$) activity. In the Dove profile, maternal harsh caregiving was associated with elevated CVI ($\beta = .47, p = .001, R^2 = .22$) and cortisol ($\beta = .30, p = .018, R^2 = .09$) levels, coupled with significantly dampened CSI activity ($\beta = -.32, p = .01, R^2 = .10$). These associations cohered to hypothesized relationships within each profile. Although in the present sample, maternal harsh caregiving with the Dove profile was associated with functioning in multiple systems, the Hawk profile primarily determined CSI activity.

Authoritative tests of differential susceptibility, or differences between groups on associations between harsh parenting and physiological activity, require examining if the regression parameters are significantly different from one another across groups. Comparisons of model parameters revealed that associations between maternal harsh caregiving and CVI activity ($ds = 2.72, p < .05$) and CSI activity ($ds = 2.96, p < .05$) were significantly different from one another when comparing Hawk to Dove profiles. Although harsh caregiving was primarily associated with cortisol activity in the Dove profile, this association was only marginally different from the Hawk profile, $ds$ score = 1.20.

To further test whether the differences in stress response systems occurred within the context of harsh parenting or at a general level of behavioral phenotype, we examined univariate ANOVA comparisons between the two groups on mean differences in CSI, CVI, and cortisol levels (see Table 4). It is noteworthy that the groups did not differ in mean levels of CVI, CSI and cortisol constructs. The lack of differences at the average
level of functioning supports the contention that physiological activity of the behavioral profiles in young children is more evident as stressors within the environment increase.

**Hawk/Dove Physiological Activity and Psychological Outcomes**

We next examined whether activation within the different physiological systems led to changes in externalizing and internalizing behaviors. To parameterize change in outcomes from Time 1 to Time 2 within Hawk and Dove profiles, we utilized a two-indicator latent difference score (LDS) model across the two measurement occasions (e.g., Ferrer, Balluerka, & Widaman, 2008; McArdle, 2009). The versatility of LDS is reflected in its ability to identify overall sample changes and individual differences in change (McArdle, 2009). Of further relevance to our main research questions, LDS further allows for an analysis of the predictors of individual differences of subsequent changes in children’s psychological outcomes over time (e.g., Geiser, Eid, Nussbeck, Courvoisier, & Cole, 2010; Maikovich et al., 2008). To test for the presence of significant variability in the latent difference score we first examined the unconditional latent difference score for both internalizing and externalizing behaviors in both the Hawk and Dove groups.

Our first model examined change in children’s internalizing behaviors. The model fit the data well, $\chi^2 = 16.90$ (8, N=201, $p < .05$, RMSEA = .07, CFI = .97, $\chi^2 / df = 2.11$). In the Hawk sample, the mean level of initial status for internalizing behaviors was significantly different from 0, (3.16, $p < .001$) and levels of internalizing behaviors decreased over time, although change was not significant (-.15, $p = .39$). Importantly, the latent intercept and mean difference factors has statistically significant variances of 3.68 ($p < .01$) and 1.59 ($p < .05$), respectively. In the Dove sample, mean initial status was
significant (2.88, \( p < .001 \)) and levels of internalizing symptoms increased over time, although this was not significant (.20, \( p = .41 \)). Both initial status and mean change over time had significant variances of 2.48 (\( p < .001 \)) and 2.81 (\( p < .001 \)), respectively.

Given the presence of significant variability in change over time, our final analysis examined if activity within the three different stress response systems predicted changes in children’s internalizing behaviors over a one year time span. The model provided an adequate fit to the data, \( \chi^2 = 148.93 \) (82, N=200, \( p < .01 \), RMSEA = .06, CFI = .90; \( \chi^2 / df = 1.81 \), see Figure 3). Findings for the Dove profile indicated that CVI and cortisol level were significant predictors of increases in children’s internalizing behavior over time (\( \beta \)'s = .41 and .37 respectively, \( p < .05 \), \( R^2 = .11 \)). Finally, no significant pathways between physiological variables and children’s internalizing behaviors were found in the Hawk profile. Attesting to differential susceptibility in profile status, the pathways between cortisol and CVI activity and internalizing outcomes were significantly stronger in magnitude for the Dove children compared to those pathways within Hawk children (\( ds = 2.49 \) and 2.44, respectively).

We next examined change in children’s externalizing behaviors over time. The unconditional latent difference score model fit the data well, \( \chi^2 = 5.02 \) (8, N=201, \( p = .74 \), RMSEA = .00, CFI = 1.00, \( \chi^2 / df = 0.58 \)). In the Hawk sample, average externalizing at T1 was significant (3.38, \( p < .05 \)), and levels of externalizing behavior decreased over time, although this change was not significant (-0.19, \( p = .26 \)). In addition, both initial status and the latent mean difference factor had statistically significant variances of 2.86, (\( p < .001 \)) and 1.58 (\( p < .001 \)), respectively. In the Dove sample, while initial levels of externalizing behaviors were significantly different than zero (2.61, \( p < .05 \)), levels of
externalizing behaviors evidenced a slight although not significant decrease over time (-.22, \( p = 0.11 \)). Finally, both initial status and the latent difference score had significant variances of 1.28 (\( p < .001 \)) and 0.77 (\( p < .001 \)), respectively.

Our final analysis examined how children’s physiological functioning was associated with children’s externalizing behaviors over time (see Figure 4). The model estimated pathways from physiological variables to children’s externalizing LDS score and provided an adequate fit to the data, \( \chi^2 = 59.14 \) (46 N=201, \( p = .09 \), RMSEA = .04, CFI = .97, \( \chi^2 / \text{df} = 1.29 \)). Findings indicated that in the Hawk profile, our indicator of CSI activity was associated with increased aggressive behaviors over time (\( \beta = .55, p < .05, R^2 = .25 \)). The pathway was marginally different from Dove profile (\( ds = 1.53 \)). No significant pathways between physiological variables and externalizing were found in the Dove profile.

Discussion

Guided by evolutionary theory (Korte et al., 2005; Ellis et al., 2011), the present study was designed to extend empirical knowledge on children’s biological sensitivity to interpersonal stress by examining how children’s bold and inhibited temperament shapes their physiological functioning and psychological development within adverse rearing environments. As an initial foray into testing differences across behavioral traits in associations between harsh caregiving, children’s stress response systems, and children’s functioning over time, we employed a multi-method, prospective measurement design to test whether model pathways cohered to predicted hypotheses. Findings revealed a pattern of relationships among study variables that, to a large extent, cohered to hypothesized associations with the theorized Hawk/Dove profiles.
First, our findings provided empirical support for the applicability of two broad-band classes of stable behavioral strategies for coping with environmental demands in childhood, as outlined in evolutionary models (Korte et al., 2005). In accordance with the Hawk/Dove model, latent profile analysis revealed two distinct profiles of children which were culled across assessment techniques including observational assessments of toddlers’ behaviors in response to novelty and threat, as well as maternal reports of children’s temperamental dispositions. Our ability to distinguish two broad behavioral profiles has several implications for differential susceptibility research. First, it suggests that forward movement in our understanding of children’s characteristic ways of responding requires discernment of the ways in which different dimensions of temperament cohere together in meaningful profiles/patterns. Prevailing developmental frameworks agree in proposing temperament as encompassing multiple forms of behavioral traits (e.g., anger, irritability, inhibition, fearfulness) and typically within differential susceptibility endeavors researchers have collapsed these domains into a “difficult” temperament construct. However, we would argue that this broad and encompassing assessment fails to provide sufficient precision in developing testable hypotheses for examining how children’s characteristic ways of responding to challenge and stress increase their susceptibility to environmental influences. This impediment to generating knowledge is further explicated in the assertion by Ellis and colleagues (2011) that progress in differential susceptibility research hinges upon methodological precision in identifying phenotypic variations in susceptibility. Yet, even as psychologists increasingly recognize the importance of distinguishing between different types of difficult temperament, a longstanding challenge to our field is to also formulate theories
that generate well-developed hypotheses that identify *how* and *why* specific patterns of temperament operate within specific environments in ways the result in distinct patterns of adjustment at multiple levels of analysis. The present findings highlight the value that evolutionary theories offer for developmental psychology in terms of increasing the depth and precision of our theories in such a way that can move the field forward towards this goal.

The present study also provides evidence for the utility of integrating these temperamental profiles for increasing precision in understanding children’s stress response system activity in response to harsh ecological niches. The Hawk/Dove model hypothesizes that phenotypic distinctions reflect individual differences in the constitutional calibration of stress-sensitive neurobiological systems in response to environmental threat (e.g., Ellis, et al., 2006; Korte et al., 2005). In the present sample, differentiation in the activation of physiological systems within each profile was only evident in association with harsh and insensitive rearing environments. This finding is consistent with the notion that children may exhibit progressively heightened neurobiological responsiveness within extraordinary socialization contexts (Boyce & Ellis, 2005; Obradovic, Bush, Stamperdahl, Adler, & Boyce, 2010). For children evidencing Hawk characteristics, a stressful rearing environment was primarily associated with elevated indicators of sympathetic nervous system activity. Thus, it may be that the early aggressive and bold dispositions of the Hawk profile are a phenotypic marker of a sympathetic nervous system that is calibrated to progressively amplify following exposure to harsh socialization contexts (Ellis et al., 2006; Korte et al., 2005). In contrast, within the Dove profile, harsh parenting was primarily associated with
elevated parasympathetic and cortisol activity, as well as dampened sympathetic nervous system activity. In the context of our findings, the heightened activation within the HPA and PNS systems in response to environmental threat cues are marshaled to support the reticent, cautious and vigilant behaviors of the Dove profile which bolster survival within stressful interpersonal ecologies. Children with Dove tendencies also experienced dampened SNS activity in the wake of harsh caregiving suggesting that their sympathetic system may be downregulated in adverse socialization contexts. It is noteworthy that the Dove profile evidenced more susceptibility in stress physiology than Hawks in response to harsh caregiving practices examined here. It would be important for future research to further explore the stability of the differences in susceptibility between Hawks and Doves found in the current study through examination of these profiles in other adverse/threatening environmental contexts as well as within resource rich environments.

Model analyses also revealed non-significant mean differences in stress response systems across the two profiles. The discrepancy in findings with stress response systems at the mean-level versus process-level also bear some discussion as well. First, the Hawk/Dove model outlined by Korte and colleagues (2005) is predicated on the notion that the activation of physiological stress response within each behavioral profile will be most evident under environmental conditions of threat or challenge, a notion that is supported by our process-model. Second, the findings, to some extent, substantiate developmental notions of plasticity suggesting that changes in children’s sensitivity and organization of responding to threat may be first evident at the level of their behavior, as the set points of physiological systems remain relatively flexible during early developmental stages (Beauchaine, 2001; Obradovic & Boyce, 2009). Characteristic
patterns of behavioral response may, with time, eventuate in increasingly specified and immutable physiological functioning. This developmental rationale for increased precision in understanding the development of stress response system processes has been noted by Beauchaine (2001) who detailed that PNS activity during infancy was associated with both approach/anger and inhibited/avoidant responses with differentiation in PNS activity and behavior becoming increasingly evident over the course of childhood and adolescence. Although the Hawk/Dove model postulated by Korte and colleagues does not provide an explicit developmental framework for understanding changes in the profiles, developmental considerations of stress response system functioning are presented in a recent theoretical framework proposed by Del Giudice, Ellis, and Shirtcliffe (2011). In their Adaptive Calibration Model (ACM), they suggest that children adaptively calibrate their stress response processes according to both developmental stages and ecological niches varying in levels of adversity and threat, eventuating in four possible typologies of functioning across components of the stress response system. Thus, the physiological profiles outlined within ACM may help to inform an understanding of the development of the physiological profiles noted in the Hawk/Dove model. For example, there are notable parallels between the Hawk physiological pattern and the vigilant ACM profile, and between the Dove physiological pattern and the Sensitive/Buffered ACM profile. Although integration of the Korte and ACM models are beyond the scope of the present study, they provide interesting parallels of evolutionary accounts of children’s adaptation to stressful rearing contexts across behavioral and physiological components. Future work simultaneously testing these differing levels of analysis within person are paramount for advancing neuro-
evolutionary theories of development, as Ellis and colleagues have so aptly noted “genotypically, endophenotypically, and behaviorally susceptible individuals identified in various studies may actually be the same people.” (Ellis, et al., 2011, pg. 13).

We next examined the developmental implications for each of the three stress response systems for children over a one year time span. For the Dove profile, the heightened parasympathetic and cortisol levels for children with dove characteristics served to amplify the occurrence of depressive and anxious behaviors over time. In contrast, elevated sympathetic nervous system activity was singularly associated with increases in externalizing behaviors in the Hawk profile. Thus, the short-term adaptive benefit of the SNS amplification for supporting behavioral strategies in response to environmental threat within the Hawk profile appeared to increase children’s vulnerability to higher levels of aggression, inattention, and oppositionality. This finding may be surprising when considered against the backdrop of previous research suggesting associations between decreased SNS arousal and externalizing disorders (e.g., Lorber, 2004; Beauchaine, 2001). However, recent work has documented links between increased SNS arousal and externalizing disorders (e.g., Scarpa, Haden, & Tanaka, 2010), while others have found no such associations (Van Hulle, Corley, Zahn-Waxler, Kagan, & Hewitt, 2000). Thus, these equivocal findings seem to suggest that the relationship between SNS and externalizing may be more complex than previously thought, and consideration of evolutionary models of temperament and biological sensitivity to context may help to provide increased precision in identifying possible pathways by which SNS activity may eventuate in the development of externalizing behaviors.
Finally, the adherence of the hypothesized associations between the different stress systems and children’s internalizing and externalizing outcomes supports the evolution-based contention that variation in neurobiological sensitivity eventuates in differential fitness payoffs (e.g., Ellis et al., 2006; Ellis et al., 2011). However the findings in the present study were very specific within each profile. For example, the trademark physiological pattern of heightened activation in the PNS and HPA systems in the Doves in the sample as a whole only predicted internalizing problems. Yet, according to the theory, dampened SNS levels within the Dove profile should also afford some protection from the development of externalizing behaviors. This was not evident in our study. Thus, it may be that our limited assessment of psychological outcomes precluded more fine-grained analysis of the possible developmental benefits of dampened activation in a stress system and future research endeavors may bear this distinction out.

Fully interpreting the results of this study also requires consideration of some additional limitations. First, our sample contained higher proportions of families who were characterized as experiencing higher risk from lower socioeconomic backgrounds. Our focus on challenging environments provided a wider variation in stressful socialization contexts that also more closely approximate stimuli that may trigger calibration of physiological systems. However, it remains to be seen whether similar patterns of associations are evident in more advantages or resource-rich environments. Second, process model pathways would be bolstered by the examination of physiological indices over time in order to better define the nature of predictive pathways within our theoretical model. Third, our physiological assessments were analyzed at basal levels of functioning and did not include reactivity constructs. Basal indicators of homeostatic set-
points provide the first, most direct test of the primary predictions of the Korte model, however it will be interesting to see if results are similar or distinct across both basal and reactivity indices. Along these lines, only one saliva sample was used to assess HPA activity.

Finally, our analysis is restricted to a small developmental window of early toddlerhood. First, the appearance of externalizing and internalizing behaviors may be more limited in this developmental time span. Second, more definitive conclusions about the moderating influence of temperament will hinge on testing these pathways with children over longer developmental spans. For example, proactive niche selection and the tendency for increasingly differentiated and canalized responding may dilute the strength of the temperamental profiles as moderators in samples of older children and adolescents.

In summary, this study represents a preliminary attempt to systematically test the primary assumptions of an evolutionary mediational model of adaptations in stress response across phenotypic profiles (Korte et al., 2005). Multiple levels of the physiological stress response system were simultaneously assessed and meaningful variations across profiles were evident. In addition, we examined model pathways in a sample of young children, a developmental period characterized by considerable plasticity in neurobiological systems as well as a period which has not been examined extensively within an evolutionary framework (Cicchetti & Walker, 2001). Findings from the present study offer compelling support for increasing the precision of temperament conceptualizations within evolutionary models of children’s adaptation to stressful rearing environments and highlight the potential value of translating the study of
evolutionary models towards greater precision in documenting children’s development within stressful caregiving environments.
References


contributions to cortisol response to emotional arousal in young children from low-income, rural communities. Developmental Psychology, 44, 1095-1109.


dysregulation in melancholic and atypical depression: High vs. low CRH/NE

psychopathology. In: D. Cicchetti and D. Cohen, Editors, Developmental


UK: Cambridge University Press.

Hastings, P.D., Sullivan, C., McShane, K. E., Coplan, R. J., Utendale, W. T., Vyncke, J.
difficulties: Direct mothers and moderated fathers. Child Development, 79,
45-64.

Hill-Soderlund AL, Mills-Koonce WR, Propper C, Calkins S, Granger DA, Moore GA,
Gariep JL, Cox MJ. Parasympathetic and sympathetic responses to the Strange
Situation in infants and mothers from avoidant and securely attached dyads.

Joussemet, M., Vitaro, F., Barker, E. D., Cote, S., Nagin, D. S., Zoccolillo, M., Tremblay,


concept of stress: Benefits of allostasis and costs of allostatic load and the trade-


Table 1.

*Outline of differences in phenotypic and endophenotypic responses to threat across Hawk and Dove profiles*

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<thead>
<tr>
<th>Construct</th>
<th>Hawk</th>
<th>Dove</th>
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<tbody>
<tr>
<td>Behavioral reactivity</td>
<td>Fight-flight</td>
<td>Hide-freeze</td>
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<tr>
<td>Initial reaction</td>
<td>Bold, approach</td>
<td>Inhibited, withdrawal</td>
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<tr>
<td>Activity levels</td>
<td>High</td>
<td>Low</td>
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<tr>
<td>Negative affect</td>
<td>Dominant (anger, frustration)</td>
<td>Vulnerable (crying, sadness)</td>
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<td>ANS dominant system</td>
<td>Sympathetic</td>
<td>Parasympathetic</td>
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<tr>
<td>Hypothalamic-pituitary-adrenal activity</td>
<td>Diminished</td>
<td>Elevated</td>
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<tr>
<td>Developmental Cost</td>
<td>Externalizing Behaviors</td>
<td>Internalizing Behaviors</td>
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Running Head: Harsh Parenting and Children’s Adaptation

Table 2  
*Means, standard deviations, and intercorrelations of variables used in analysis*

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<td>2. Hostility</td>
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<td>3. Verbal Aggression</td>
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<td>8. T1 A/D raw score</td>
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<td>7.31</td>
<td>0.19</td>
<td>0.10</td>
<td>0.12</td>
<td>0.13</td>
<td>-0.14</td>
<td>0.06</td>
<td>0.45</td>
<td>0.62</td>
<td>0.68</td>
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<tr>
<td>12. T2 A/D. raw score</td>
<td>3.20</td>
<td>1.97</td>
<td>0.21</td>
<td>0.16</td>
<td>0.25</td>
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<td>0.12</td>
<td>-0.05</td>
<td>0.26</td>
<td>0.50</td>
<td>0.54</td>
<td>0.27</td>
<td>0.38</td>
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<tr>
<td>13. T2 E.R. raw score</td>
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<td>2.65</td>
<td>0.09</td>
<td>0.07</td>
<td>0.16</td>
<td>0.09</td>
<td>0.05</td>
<td>-0.01</td>
<td>0.02</td>
<td>0.36</td>
<td>0.58</td>
<td>0.28</td>
<td>0.41</td>
<td>0.71</td>
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<td>14. T2 A.P. raw score</td>
<td>2.85</td>
<td>1.97</td>
<td>0.20</td>
<td>0.17</td>
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<td>0.13</td>
<td>0.16</td>
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<td>0.05</td>
<td>0.31</td>
<td>0.41</td>
<td>0.63</td>
<td>0.48</td>
<td>0.43</td>
<td>0.49</td>
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<td>-0.01</td>
<td>0.01</td>
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<td>0.53</td>
<td>0.45</td>
<td>0.68</td>
<td>0.56</td>
<td>0.66</td>
<td>0.60</td>
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Table 3.

*Model Fit Indices From Latent Profile Analyses*

<table>
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<tr>
<th>Model</th>
<th>BIC</th>
<th>∆BIC</th>
<th>df</th>
<th>Entropy</th>
<th>VLMR</th>
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<tr>
<td>One-Class</td>
<td>4234.72</td>
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<td>16</td>
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<tr>
<td>Two-Class</td>
<td>3605.59</td>
<td>629.13</td>
<td>23</td>
<td>.82</td>
<td>367.87, <em>p</em> = .02</td>
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<td>Three-Class</td>
<td>3485.68</td>
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<td>32</td>
<td>.89</td>
<td>164.15, <em>p</em> = .02</td>
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<td>Four-Class</td>
<td>3455.93</td>
<td>29.75</td>
<td>41</td>
<td>.84</td>
<td>75.84, <em>p</em> = .36</td>
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<tr>
<td>Five-Class</td>
<td><em>did not converge</em></td>
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</table>

Running Head: Harsh Parenting and Children’s Adaptation
Table 4. *Means, standard deviations, and ANOVA comparisons of the Hawk and Dove typologies*

<table>
<thead>
<tr>
<th></th>
<th>Hawk (n = 115)</th>
<th>Dove (n = 85)</th>
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<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
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<td>Approach</td>
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<td>.55</td>
<td>-.87</td>
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<td>Activity</td>
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<td>.74</td>
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<td>Avoidance</td>
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<td>Inhibition</td>
<td>-.63</td>
<td>.68</td>
<td>.84</td>
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<tr>
<td>Vulnerable</td>
<td>-.57</td>
<td>.74</td>
<td>.77</td>
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<tr>
<td>CBQ Soothe</td>
<td>-.17</td>
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<td>.22</td>
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<tr>
<td>CBQ Anger</td>
<td>.19</td>
<td>.95</td>
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<td>CSI</td>
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<td>.79</td>
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<td>CVI</td>
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<td>.49</td>
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<tr>
<td>Cortisol</td>
<td>.42</td>
<td>.13</td>
<td>.40</td>
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* p ≤ .05
Figure Captions

Figure 1. Conceptual model characterizing the interplay between maternal harsh caregiving behaviors, children’s basal physiological system activation, and subsequent changes in behavioral adaptation over time. T1 = Time One, T2 = Time Two.

Figure 2. Structural equation model testing differential susceptibility in associations between maternal harsh caregiving and physiological functioning across Dove and Hawk profiles. For ease of interpretation, only significant path coefficients are included while non-significant pathways are denoted with a dashed line. T1 = Time One, T2 = Time Two. *p < .05.

Figure 3. A latent difference score analysis of the role of physiological functioning in predicting toddler internalizing behaviors across Dove and Hawk profiles. For ease of interpretation, only significant path coefficients are included while non-significant pathways are denoted with a dashed line. LDS = Latent Difference Score, T1 = Time One, T2 = Time Two. *p < .05.

Figure 4. A latent difference score analysis of the role of physiological functioning in predicting toddler externalizing behaviors across Dove and Hawk profiles. For ease of interpretation, only significant path coefficients are included while non-significant pathways are denoted with a dashed line. LDS = Latent Difference Score, T1 = Time One, T2 = Time Two. *p < .05.
Running Head: Harsh Parenting and Children’s Adaptation

**Hawk Profile**

- **T1 Child Internalizing**
  - \( \mu = 3.16^*, \sigma = 3.68^* \)
  - \( \beta = .37^* \)

- **T1 Emotion Reactivity**
- **T1 Anxiety Depression**

- **T2 Child Internalizing**
  - \( \mu = -.15, \sigma = 1.59^* \)

- **T2 Emotion Reactivity**
- **T2 Anxiety Depression**

**Dove Profile**

- **T1 Child Internalizing**
  - \( \mu = 2.88^*, \sigma = 2.48^* \)
  - \( \beta = .09 \)

- **T1 Emotion Reactivity**
- **T1 Anxiety Depression**

- **T2 Child Internalizing**
  - \( \mu = .20, \sigma = 2.81^* \)

- **T2 Emotion Reactivity**
- **T2 Anxiety Depression**

**Indicators**

- **T1 Basal CVI**
- **T1 Basal CSI**
- **T1 Basal Cortisol**

- **LDS T1-T2 Child Internalizing**

*Denotes statistical significance.
Running Head: Harsh Parenting and Children’s Adaptation

Hawk Profile

T1 Aggression  T1 Attention Problems
T1 Child Externalizing 1 .87*

T2 Aggression  T2 Attention Problems
T2 Child Externalizing 1 .88*

T1 Basal CVI
T1 Basal CSI
T1 Basal Cortisol

LDS T1-T2 Child Externalizing

μ = 3.38*, σ = 2.86*

-.46*

Dove Profile

T1 Aggression  T1 Attention Problems
T1 Child Externalizing 1 .81*

T2 Aggression  T2 Attention Problems
T2 Child Externalizing 1 .78*

T1 Basal CVI
T1 Basal CSI
T1 Basal Cortisol

LDS T1-T2 Child Externalizing

μ = 2.61*, σ = 1.28*

-.34*

μ = -.22, σ = 0.77*