Published in final edited form as:

Dev Psychol. 2013 February ; 49(2): . doi:10.1037/a0028246.

Patterns of Children's Adrenocortical Reactivity to Interparental Conflict and Associations with Child Adjustment: A Growth Mixture Modeling Approach

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Abstract

Examining children's physiological functioning is an important direction for understanding the links between interparental conflict and child adjustment. Utilizing growth mixture modeling, the present study examined children's cortisol reactivity patterns in response to a marital dispute. Analyses revealed three different patterns of cortisol responses, consistent with both a sensitization and an attenuation hypothesis. Child-rearing disagreements and perceived threat were associated with children exhibiting a rising cortisol pattern whereas destructive conflict was related to children displaying a flat pattern. Physiologically rising patterns were also linked with emotional insecurity and internalizing and externalizing behaviors. Results supported a sensitization pattern of responses as maladaptive for children in response to marital conflict with evidence also linking an attenuation pattern with risk. The present study supports children's adrenocortical functioning as one mechanism through which interparental conflict is related to children's coping responses and psychological adjustment.

Keywords

Interparental Conflict; Cortisol; Child Coping; Child Maladjustment

Children exposed to destructive interparental conflict are at risk for developing problem behaviors (Cummings & Davies, 2010). Although children's physiological functioning is conceptualized as one mechanism through which exposure to interparental conflict is linked to maladjustment (Davies, Sturge-Apple, Cicchetti, & Cummings, 2007; El-Sheikh, et al., 2009), the few studies examining this process have adopted a variable-centered approach

(e.g., Davies, et al., 2007; Saltzman, Holden, & Holghan, 2005). Variable-centered approaches examine the average relationship between variables in the sample as a whole assuming the same pattern of change for all individuals. This approach potentially masks individual differences in children's cortisol reactivity responses and, as a result, may contribute to the inconsistent findings of relations between adrenocortical functioning and conflict. Thus, examining *patterns* of children's stress reactivity (e.g., elevated responding, diminished responding) utilizing a person-centered approach may further advance our understanding of associations between interparental conflict and children's adrenocortical functioning. The goal of the present study is to investigate individual differences in children's patterns of cortisol reactivity toward identifying distinct patterns of relationships between children's adrenocortical functioning and interparental conflict, children's emotional security processes, and psychological adjustment. It is expected that three patterns of responses would emerge reflecting an adaptive response pattern and two altered patterns (e.g., elevated and flattened).

This study explores how children's cortisol reactivity relates to the primary psychosocial factors, processes, and outcomes in prevailing family process models of interparental conflict. Children's regulation of the limbic-hypothalamic-pituitary-adrenal (LHPA) axis which is responsible for assembling and activating resources for coping with distressing situations, has been linked to children's responses to witnessing interparental conflict (Davies, Sturge-Apple, Cicchetti, & Cummings, 2008). Patterns of adrenocortical functioning, as evidenced by different cortisol reactivity responses, may develop as a result of diversity in children's history of family stress, serving as an explanatory mechanism for the relations between marital conflict and children's maladjustment.

Altered physiological responses most likely occur when interparental conflict is salient and distressing to children. However, conflict is a multidimensional construct (Cummings & Davies, 2010) so delineating specific aspects of conflict and explanatory mechanisms associated with children's response patterns to stress is necessary to understand the complex associations with children's physiological functioning. Altered patterns of physiological reactivity, for example, elevated cortisol levels, have been linked to children's distress responses (Davies, Sturge-Apple, Cicchetti, & Cummings, 2008). Child-related disagreements (e.g., child discipline, child supervision) may provide a particularly distressing context for children; these types of disagreements have been associated with negative effects of interparental conflict on child adjustment (O'Leary & Vidair, 2005) and have been linked to children's feelings of distress or self-blame (Grych & Fincham, 1990). However, the specific impact of child-related disagreements on children's adrenocortical functioning is little investigated.

Family process models have indicated the importance of children's emotional insecurity (Emotional Security Theory, EST; Cummings & Davies, 1996; Waters & Cummings, 2000) and perceptions of threat (Cognitive Contextual Model, Fosco & Grych, 2008; Grych, Harold, & Miles 2003) in understanding associations between interparental conflict and child adjustment; both also assume that threat and insecurity are likely correlates of individual differences in children's reactivity to conflict when integrated into psychobiological models (Davies, Harold, Goeke-Morey, & Cummings, 2002). EST posits that feeling safe and secure in the family system is a set-goal pertinent to children's regulatory functioning (i.e., negative emotional reactivity, behavioral dysregulation, and negative internal representations) and interparental conflict threatens children's security about the family (Davies & Cummings, 1994). Physiological dysregulation is also believed to be pertinent to children's regulatory responses to witnessing conflict (Cummings & Davies, 1996). Consistent with EST's notion of the role of utilizing physiological responses in maintaining a sense of security, a recent meta-analysis reported that altered adrenocortical

functioning reflects situations in which individuals' goals of self-preservation are threatened (Dickerson & Kemeny, 2004). Children's distress in the context of marital conflict has been specifically linked with elevations in children's LHPA functioning, suggesting that perceived threat may be one mechanism through which distress and elevated cortisol levels are related. Davies, et al. (2008) posited that when children are threatened by conflict, the LHPA axis is activated to gather the resources necessary to respond effectively to conflict, consistent with children's response to threat in other social contexts (e.g., Chen, Cohen & Miller, 2010). The current study sought to examine differences in the manifestation of children's emotional security and children's perceptions of threat to interparental conflict as potential mechanisms contributing to associations between children's adrenocortical reactivity and child adjustment.

Two patterns through which interparental conflict may be linked to altered LHPA axis functioning have been proposed (e.g., Davies, et al., 2007). First, children exposed to chronic stress may experience increased activation of the LHPA axis in response to subsequent conflict. A sensitization hypothesis posits that children's subsequent exposure to interparental conflict may be linked to an elevated cortisol response in children with a greater latency in returning to pre-stress levels. Alternatively, an attenuation hypothesis suggests that children exposed to chronic stress may suppress their LHPA axis functioning with repeated exposure. This alteration in the LHPA axis may be an adaptive response to disengage and thereby minimize the effects of chronically elevated cortisol levels. Suppression of the LHPA response in the context of chronic stress is believed to develop as a function of exposure, such that exposure to stress will initially produced elevations of the LHPA axis. Over time, an attenuation of the LHPA response will emerge as a down-regulation of this system (Fries, Hesse, Hellhammer, & Hellhammer, 2005). Research supports relations among components of marital conflict process models in relation to dysregulation of the LHPA axis; marital conflict, security, and adjustment have been investigated in relation to both sensitization and attenuation of cortisol responses.

Studies examining exposure to interparental conflict and children's cortisol responses provide support for both amplified and attenuated cortisol patterns. A review of the literature on children adrenocortical functioning and family risk suggests that risk may relate differentially to daily cortisol activity and stress reactivity such that elevated cortisol activity, reflective of basal cortisol levels, and diminished reactivity to stress have been linked to higher family risk (Repetti, Robles, & Reynolds, 2011). Children's elevated cortisol activity have been linked to poor marital functioning (Pendry & Adam, 2007), interparental aggression (Davies, Sturge-Apple, Cicchetti, Manning, & Zale, 2009), and marital violence (Saltzman, Holden, & Holghan, 2005). Diminished cortisol reactivity has been linked with destructive marital conflict (Davies, et al., 2007) and interparental violence (Sturge-Apple, Davies, Cicchetti, & Manning, 2012). Recent work by Davies and colleagues suggest pathways of risk through both attenuation and sensitization patterns of reactivity (Davies, Sturge-Apple, & Cicchetti, 2011). As a next step in investigation of these questions, simultaneous examination of relations between interparental conflict and qualitatively different altered patterns of cortisol reactivity are needed. Utilizing a pattern-based approach in the current study will allow for identifying multiple patterns of altered cortisol reactivity that may be masked by traditional variable-based approaches.

Few studies have examined children's ability to cope with and regulate exposure to marital conflict in relation to cortisol reactivity to conflict. Davies, et al. (2008) reported behavioral distress was associated with increased cortisol reactivity especially at higher levels of child involvement in conflict. This provides initial support for exploring differences among children's behavioral and emotional responses, as indicators of children's emotional security, to interparental conflict and distinct adrenocortical reactivity patterns; however

additional research is necessary to examine the role of children's emotional security in these processes.

Research on relations between children's LHPA axis functioning and child psychological outcomes indicates that both elevated and diminished responses are linked to children's behavioral problems. Examinations of both cortisol activity and reactivity suggest that elevated cortisol levels have been associated with heightened internalizing symptoms (e.g., anxiety and depression), whereas higher behavioral and externalizing problems were linked to lower cortisol levels, indicative of an attenuation of this system (Davies et al., 2011; Gunnar & Vazquez, 2006). However, increased externalizing problems, in conjunction with anxious symptoms, have also been linked with increased levels of cortisol. Thus, different patterns of children's physiological reactivity in response to interparental conflict may be associated with different constellations of child problem behaviors. Results are inconsistent for relations between problem behavior and cortisol levels during childhood which may reflect an insensitivity of variable-based approaches. Examining the context and processes that contribute to both elevated and diminished responses while employing analytical techniques that allow for disentangling multiple patterns of responses is needed to further delineate relations between interparental conflict and children's adjustment difficulties.

The present study expands previous research by utilizing a person-centered approach to model distinct patterns of children's physiological reactivity; this approach allows for identifying and examining relationships among different groups of individuals based on their distinct change patterns which may be masked by variable-centered approaches (Muthén & Muthén, 2000). As such, incorporating person-centered approaches in examining children's physiological functioning is needed (Van Ryzin, Chatam, Kryzer, Kertes, & Gunnar, 2009). The aim is to examine specific patterns of change in children's adrenocortical reactivity to a marital dispute by further embedding the study of individual differences in cortisol reactivity within contexts of process models of interparental conflict. The goal is to further understand the mechanisms through which interparental conflict may alter children's adrenocortical functioning and influence child adjustment, reflected in longitudinal tests of these relations.

The purpose of the current study was to *a)* utilize person-centered approaches to model distinct patterns of children's adrenocortical functioning in response to interparental conflict, *b)* examine the role of children's perceptions of threat to interparental conflict and the frequency of child-related conflict to understand the influence on children's adrenocortical response patterns, and *c)* examine relations between children's reactivity patterns and children's emotional insecurity and problem behaviors. Notably, research at this time does not systematically favor either the attenuation or sensitization hypothesis in relation to the risk factor of interparental conflict and a pattern-based approach has promise to further address this issue.

Growth mixture modeling (Muthén, 2004) was utilized to fit different patterns of children's LHPA axis functioning in the context of interparental conflict. Heterogeneous classes of children's cortisol functioning were examined, predicted by indices of interparental conflict. Subsequently, classes of children's cortisol responses were used to predict differences in children's emotional insecurity and internalizing and externalizing problems. It was hypothesized that different patterns of reactivity would emerge reflecting both an adaptive cortisol response pattern and qualitatively different forms of altered responses. Specifically, it was expected that three distinct patterns of reactivity to interparental conflict would emerge: an adaptive pattern reflecting decreases in cortisol, a reactive pattern reflecting a sensitization hypothesis with cortisol levels increasing in response to conflict, and a low stable pattern reflecting an attenuation hypothesis. Consistent with the distressing nature of conflict, higher levels of children's perceived threat and child-related conflict were expected

to be related to an elevated pattern of cortisol reactivity. Lastly, children's emotional insecurity and psychological maladjustment were expected to be related to both forms of altered physiological functioning, whereas an adaptive response was not expected to be related to increased insecurity or psychological functioning.

Method

Participants

Data for the current study were drawn from participants taking part in a larger longitudinal project examining the effects of family functioning on child adjustment. The original sample consisted of 235 (129 girls, 106 boys) families including, mother, father, and their kindergarten-aged child; 193 families were included in the current study. Participants were excluded from the current study if their cortisol levels were three or more standard deviations above or below the mean cortisol level of the sample ($n = 6$), children did not participate in the cortisol collection ($n = 14$), participants did not provide a sufficient amount of saliva for assay procedures ($n = 9$), missing data ($n = 4$), or attrition from the beginning of the study ($n = 9$). The current analyses included 193 (109 girls, 84 boys) families, at the longitudinal study's second and third time points, for which first-grade children ($M = 6.57$ years, $SD = 0.51$) met the above analytic requirements. Families excluded from the current analyses did not differ on family demographics (e.g., family income, parent age, marital status, relationship to study child) or current study variables measured at the start of the longitudinal study.

Families were racially and ethnically representative of the communities in which they reside. Participants were recruited from the South Bend, IN and Rochester, NY areas through flyers sent to local schools, neighborhoods, churches, community events, and newspaper ads. Eligibility requirements necessitated that families cohabitated for a minimum of three years, had a child in kindergarten, and all members were English proficient at the start of the study. Seventy-two and a half percent of children were White, 16.1% African American or Black, 3.6% Hispanic or Latino, 6.2% Biracial or multiracial, and 1.5% reported "other". Mothers and fathers reported a mean age of 36.11 years ($SD = 5.60$) and 38.07 years ($SD = 6.02$), respectively. The majority of couples reported being married ($n = 174$); on average, parents reported living together for 11.91 years ($SD = 4.77$). The median family income range reported was \$40,000–\$54,999 ($n = 44$). The majority of parents were biological parents (95.3% of mothers and 87.5% of fathers).

Of the 193 families meeting study requirements during the first grade assessment, 185 (95.9%) families participated in the second grade assessment. Families lost to attrition at the second grade assessment did not differ from families retained on family demographics and most study variables. However, families lost at the second grade time point had higher levels of child-related conflict ($M = 17.75$, $SD = 7.58$) and externalizing problems ($M = 12.00$, $SD = 9.65$) than retained families ($F(1,190) = 6.37$, $p < .05$, $M = 14.39$, $SD = 3.45$; $F(1,172) = 4.64$, $p < .05$, $M = 7.58$, $SD = 5.43$, respectively).

Children's first and second grade teachers were recruited to complete questionnaire forms about the study child. Of the 193 families participating at the first grade assessment, 177 teachers (91.7%) agreed to participate in the study. First grade teachers reported knowing children for an average of 8.29 months ($SD = 6.21$). Of the 185 families participating one year later, 158 teachers (85.4%) agreed to participate. Second grade teachers reported knowing the study child for an average of 9.54 months ($SD = 8.01$). Teachers received monetary compensation for their participation.

Procedure

Simulated Phone Anger Task—Children and mothers were asked to engage in a play activity when the mother received a phone call believed to be from the child's father. Mothers were provided a scripted interaction by an experimenter to stage a marital dispute over the phone. Prior to this task, mothers received training on how to convey the appropriate emotional tone during this interaction; mothers were asked to display mild frustration and anger. Additionally, when feeding lines, the experimenter modeled the appropriate tone. Following this dispute, the mother placed a second phone call to the father in which the mother staged a resolution over the issue of the original dispute approximately ten minutes after the conclusion of the marital dispute. During this resolution, mothers were asked to display an understanding and caring emotional tone. Following the disagreement and the resolution, mothers and children separately reported their reactions to the task.

Salivary Cortisol Collection—Children provided baseline cortisol levels collected after arrival in the laboratory setting following a brief introduction to the laboratory and assent procedures. In accordance with typical sampling collection guidelines, children were asked to rinse out their mouth to reduce the influence of contaminants present in the mouth. Following a seven minute period the sample was collected through the passive drool technique with the aid of a straw; children chewed Trident sugarless gum to induce saliva production. The saliva collection was presented to children as a “spitting game” in which they were encouraged to spit as much as they could into a vial. Cortisol levels were assessed prior to the simulated phone anger task to assess a baseline indication of physiological functioning. Two subsequent saliva samples were collected in conjunction with the conclusion of the simulated phone anger task; the first post-stressor sample was collected approximately 25 minutes after the peak of the simulated phone anger task. The second post-stressor sample was collected 10 minutes later, which was 25 minutes after the peak of the resolution phone task. Saliva collection occurred in the late afternoon and early evening to limit the effects of the natural diurnal pattern of cortisol production as cortisol levels peak post awakening and decline throughout the day (M sampling time 3:40 pm; $SD = 2$ hours 19 minutes).

Marital Interaction—During a separate visit to the laboratory, couples were asked to identify topics that are hard to handle or problematic in the marital relationship. After choosing topics, couples were instructed to discuss their difficult topic for 10 minutes and work toward a solution. Interactions were videotaped and later coded for marital conflict behaviors.

Measures

Child-Rearing Disagreements—Mothers completed an eight-item abbreviated version of the Child-Rearing Disagreements scale assessing the frequency of marital conflict about child-rearing issues (CRD; Jouriles, et al., 1991). Mothers rated the frequency of conflicts on a Likert scale ranging from 1 (*never*) to 6 (*daily*). Sample items included “not sticking to agreements we made about childcare or rearing” and “not trusting the other person’s judgment in certain aspects of child-rearing.” The original CRD has high internal reliability; the current sample had adequate internal reliability ($\alpha = .76$).

Perceived Threat—Children completed the six-item perceived threat subscale of the Children’s Perception of Interparental Conflict scale for younger children assessing the degree to which children feel threatened by marital conflict (CPIC-Y; McDonald & Grych, 2006). Children were verbally administered the scale by a study experimenter. Sample items included “When my parents argue, I’m afraid that something bad will happen” and “When my parents argue, I worry about what will happen to me.” Children rated each item on a yes-

no dichotomous scale. Items endorsed as a “yes” response were summed with higher scores indicating a higher degree of perceived threat. The current sample had high internal reliability ($\alpha = .84$).

Destructive Marital Conflict—Ten minute marital interactions were coded using subscales of the System for Coding Interactions in Dyads (SCID; Malik & Lindahl, 1996). Interactions were coded for mothers’ and fathers’ individual use of destructive conflict tactics. Videotaped disagreements were coded using the verbal aggression and the negativity and conflict subscales of the SCID. The verbal aggression subscale reflects the frequency and intensity to which individuals use hostile and aggressive statements directed toward their partner. The negativity and conflict subscale assesses the degree to which each partner displayed anger, frustration, and irritation. Behaviors were coded on a 5-point Likert scale with higher scores reflecting more destructive marital conflict. Independent coders assessed 25% of the sample; interclass correlations ranged from .92 to .95. Mothers’ and fathers’ scores were highly correlated for both verbal aggression ($r = .56, p < .01$) and negativity and conflict ($r = .76, p < .01$). A composite score was created across mothers and fathers and the verbal aggression and negativity and conflict subscales to reflect an overall couple destructive marital conflict measure.

Cortisol Reactivity—All samples were assayed for salivary cortisol using a highly sensitive immunoassay at Salimetrics Inc. (State College, PA). The assay test process utilized 25 μ l of saliva; samples were tested in duplicate form. The test had a lower test sensitivity of .007 μ g/dl and an upper test sensitivity of 3.0 μ g/dl. However, samples for the current study ranged from .008 to .901 μ g/dl. The average intra-assay coefficient was 5.6% for the current sample.

Responses to Simulated Phone Anger Task—Following the phone disagreement and resolution, mothers reported how frequently they had discussions similar to the task on a 5-point likert scale. Mothers also reported how similar their child’s responses to the phone disagreement and resolution were to similar discussions occurring in the home on a 6-point likert scale. Following the disagreement and resolution children were interviewed about the intensity of their emotional feelings of anger, sadness, fear, and happiness on a 6-point likert scale.

Children’s Emotional Security—Mothers and fathers completed the Security in the Marital Subsystem scale (SIMS; Davies, Forman, Rasi, & Stevens, 2002). The SIMS measures children’s reactions to witnessing marital conflict. Parents completed the emotional reactivity (10 items), behavioral dysregulation (5 items), and involvement (9 items) subscales. The Emotional Reactivity subscale assessed the degree to which children reacted emotionally (e.g., angry, sad, scared) to conflict. The behavioral dysregulation subscale measured the degree to which children act out with angry or aggressive reactions. The involvement subscale measures the degree to which children involve themselves in marital disputes. Parents rated each reaction on a five-point likert scale ranging from 1 (*not at all like him/her*) to 5 (*a whole lot like him/her*); scores were summed with higher scores indicating more emotional insecurity. Mother- and father-report on the SIMS subscales were averaged to create parent-report composite variables (mother- and father-report emotional reactivity $r = .18, p < .05$; behavioral dysregulation $r = .52, p < .01$; involvement $r = .34, p < .01$). The internal reliability coefficients for the current sample were mother-report $\alpha = .83$, father-report $\alpha = .83$ for involvement, mother-report $\alpha = .63$, father-report $\alpha = .64$ for emotional reactivity, and mother-report $\alpha = .78$, father-report $\alpha = .80$ for behavioral dysregulation.

Child Adjustment—Mothers, fathers, and teachers completed the internalizing and externalizing problem subscales of the Child Behavior Checklist (CBCL) and the Teacher Report Form, respectively (TRF; Achenbach, 1991). Participants completed the CBCL or TRF during first and second grade to examine relations of cortisol trajectories and child adjustment concurrently and one year later. The internalizing problems subscale (30 items) reflects withdrawn, anxious, and depressive symptomatology. The externalizing problems subscale (33 items) reflects aggressive and delinquent behaviors exhibited by the child. Parents and teachers rated children's behaviors on a three-point Likert scale, with higher scores indicating more problem behavior. A composite internalizing and externalizing problem score was created by averaging across the three reporters (mother- and father-report: T1 internalizing $r=.47$, $p<.01$, T2 internalizing $r=.41$, $p<.01$, T1 externalizing $r=.55$, $p<.01$, T2 externalizing $r=.49$, $p<.01$; mother- and teacher-report: T1 internalizing $r=.24$, $p<.01$, T2 internalizing $r=.10$, ns , T1 externalizing $r=.28$, $p<.01$, T2 externalizing $r=.31$, $p<.01$; father- and teacher-report: T1 internalizing $r=.18$, $p<.05$, T2 internalizing $r=.19$, $p<.05$, T1 externalizing $r=.35$, $p<.01$, T2 externalizing $r=.36$, $p<.01$). The internal reliability coefficients for the current sample ranged from .84–.91 for internalizing problems and .86–.93 for externalizing problems.

Analytic Plan

A growth mixture modeling approach (Muthén, 2004) was utilized to model different patterns of cortisol reactivity. Consistent with hypotheses, it was expected that three distinct patterns would emerge: an adaptive pattern, an elevated pattern, and a low, flat pattern. The adaptive pattern was expected to show a decline in cortisol levels consistent with the diurnal pattern of cortisol functioning (Gunnar & Vazquez, 2006). Consistent with a sensitization hypothesis, it was expected that an elevated pattern would emerge resulting in an increase in cortisol levels in response to the simulated phone anger task. Additionally, a third flat, blunted pattern was expected, reflecting lower initial levels of cortisol reactivity that would remain relatively stable and non-changing across the three collection time points, consistent with an attenuation hypothesis.

A latent basis approach was utilized to capture non-linear change with three time points; this approach frees the second time parameter in a growth model to allow for fitting different shapes to the data which allows for more flexibility in modeling change patterns than a linear growth model (McArdle & Epstein, 1987). Latent basis approaches for constructing change patterns can be integrated into the growth mixture modeling approach (Ram & Grimm, 2009). It was expected that children would show different patterns of change in cortisol levels in response to the simulated phone anger task and phone resolution task.

Results

Descriptive Statistics

Means, standard deviations, and correlations for all study variables are displayed in Table 1. Children's cortisol levels, for the entire sample, were largely uncorrelated with children's emotional security or child adjustment, suggesting the need for a person-centered approach to examine different patterns of cortisol reactivity in relation to children's responses to conflict and adjustment. Children's cortisol levels at all three time points were heavily skewed; thus, consistent with recommendations the data were transformed using the natural log transformation (Tabachnick & Fidell, 2007). The transformed data approximated normally distributed data and were utilized in all subsequent analyses.

Growth Mixture Modeling – Model Selection

Growth mixture modeling analyses were conducted in M-Plus (Version 5; Muthén & Muthén, 2007) to identify the number of classes based on distinct patterns of cortisol reactivity trajectories. Children's classes were determined based on differences in initial levels and change patterns of cortisol in response to the simulated conflict. Exploratory data analysis revealed differences in the change patterns present in children's cortisol responses (e.g., increasing levels that initially started at lower baseline levels, a declining response that had initially higher levels, and non-changing flat patterns at lower levels). Conditional linear growth mixture models, utilizing the latent basis approach, were modeled with conflict-related variables as predictors of children's trajectories. Means of the intercept and slope variables, variances of cortisol measurements, and the second time point were freed to vary across the three groups.

To determine the appropriate number of classes, models were compared using the Lo-Mendell-Rubin Adjusted Likelihood Ratio Test (LMR LRT) and the Bayesian Information Criterion (BIC). The LMR LRT indicates whether a given model fits the data significantly better than a model with ($k-1$) classes. Models with minimized BIC values indicate a good fit when compared across multiple nested models. Two-, three-, and four-class models were examined; results are displayed in Table 2. Both the LMR LRT and BIC results indicate that the three-class model fits the data better than the two- and four-class models, consistent with theoretical notions of cortisol responses in the current study. Individuals' placement in a given class was based on the probability of membership in a class; children were placed in the class in which they had the highest probability. Average probabilities for the class membership for the three-class solution ranged from .93 to .94 (see Table 3); values closer to 1.0 indicate better classification.

Growth Mixture Modeling – Three Class Model of Children's Cortisol Reactivity

The average predicted patterns of reactivity for the three-class model are displayed in Figure 1; these patterns were consistent with study hypotheses. The majority of children displayed a decreasing pattern of reactivity, consistent with either the natural diurnal rhythm of cortisol secretion or a down-regulation of cortisol in response to entering the laboratory setting ($n = 150$, 77.7%; 86 girls, 64 boys). This falling group showed higher initial levels that steadily decreased across the three collections. A second pattern emerged, consistent with an attenuation hypothesis; these children displayed a stable, non-changing pattern of cortisol levels ($n = 21$, 10.9%; 12 girls, 9 boys). This flat pattern had low initial levels of cortisol that remained stable throughout the three collections. Lastly, a third pattern emerged, consistent with a sensitization hypothesis; these children displayed a rising pattern of cortisol levels ($n = 22$, 11.4%; 11 girls, 11 boys). The group of children with rising levels showed levels that increased from lower baseline levels in response to the marital dispute and continued to increase in response to the marital resolution.

A one-way ANOVA was conducted to determine if time of day of the cortisol collection differed across the three patterns of reactivity. Results revealed no significant differences among the three patterns suggesting that time of day did not impact the patterns exhibited ($F(2, 190) = 0.96$, *ns*). Lastly, a chi-square test was conducted to determine differences in gender among the three patterns; results revealed no differences in the proportion of boys and girls among the three patterns of responses ($\chi^2(2) = 0.42$, *ns*).

Analyses were conducted to examine group differences in mothers' and children's perception of the simulated phone anger task. A one-way ANOVA was conducted to examine group differences in similar conflicts that occur in the home; no differences were found in mother's report of frequency of similar marital disputes or resolutions ($F(2,190) = .$

44, *ns*; $F(2,190) = .67$, *ns*, respectively) or mother-report of similarity in children's responses to conflict or resolution ($F(2,189) = 1.13$, *ns*; $F(2,189) = .32$, *ns*, respectively). A one-way ANOVA was conducted to determine group differences in children's perceived levels of distress in response to the simulated phone anger task and resolution. There were no differences in children's emotion intensity to the phone disagreement or resolution for feelings of anger ($F(2,190) = .97$, *ns*; $F(2,189) = .48$, *ns*, respectively), sadness ($F(2,190) = .98$, *ns*; $F(2,190) = .75$, *ns*, respectively), fear ($F(2,190) = .71$, *ns*; $F(2,190) = .40$, *ns*, respectively), or happiness ($F(2,190) = .98$, *ns*; $F(2,189) = .65$, *ns*, respectively). Taken together, these results suggest that the phone disagreement and resolution were equally emotionally-arousing and similar to conflict occurring in the home for all three patterns of cortisol reactivity.

Marital Conflict and Children's Cortisol Reactivity

Multinomial regression analyses indicated that the probability of class membership for children's cortisol response patterns differed depending on concurrent levels of the frequency of child-related conflict, children's perceptions of threat to marital conflict, and overall destructive marital conflict. Odds ratio statistics are displayed in Table 4. Higher levels of children's perceived threat were associated with a higher probability of being in the rising cortisol group compared to the falling group. Similarly, more frequent child-related conflict was associated with a higher probability of being in the rising group compared to both the falling group and the flat group. Children exposed to more destructive marital conflict had a higher probability of being in the flat group compared to the group with falling levels.

Children's Cortisol Reactivity and Child Outcomes

Emotional Security—A one-way multivariate analysis of variance (MANOVA) was conducted to determine if there were differences in children's emotional security about the interparental relationship depending on class membership (e.g., patterns of cortisol reactivity). Parent composite report of children's emotional reactivity, behavioral dysregulation, and involvement in marital conflict were included in these analyses. Results revealed significant differences in children's emotional security among groups of cortisol reactivity ($F(6, 340) = 2.84$, $p < .01$). Means and standard deviations for emotional security variables for each group are displayed in Table 5. Planned pairwise comparisons revealed that children with rising cortisol levels had higher levels of emotional reactivity ($F(1,172) = 9.04$, $p < .01$) and behavioral dysregulation ($F(1,172) = 7.02$, $p < .01$) compared to children with falling cortisol levels. Children with rising cortisol levels also had higher levels of involvement in marital conflict compared to children with low flat response patterns ($F(1,172) = 6.49$, $p < .05$).

Child Adjustment—A one-way MANOVA was also conducted to determine if there were differences in children's concurrent and subsequent levels of problem behaviors; children's first grade (concurrent) and second grade (one year later) levels of internalizing and externalizing behaviors were included in these analyses. Results revealed significant differences in children's problem behaviors among groups of cortisol reactivity for concurrent ($F(4, 324) = 21.98$, $p < .01$) and subsequent functioning ($F(4, 274) = 5.90$, $p < .01$). Means and standard deviations for child adjustment variables for each group are displayed in Table 5. Planned pairwise comparisons revealed that children with a rising pattern had higher levels of concurrent internalizing ($F(1,162) = 73.86$, $p < .01$; $F(1,162) = 62.75$, $p < .01$, respectively) and externalizing behaviors ($F(1,162) = 69.26$, $p < .01$; $F(1,162) = 44.74$, $p < .01$, respectively) and higher levels of internalizing $F(1,137) = 17.92$, $p < .01$; $F(1,137) = 19.54$, $p < .01$, respectively) and externalizing behaviors one year later than children with a falling and flat patterns ($F(1,137) = 11.99$, $p < .01$; $F(1,137) = 15.03$, p

< .01, respectively). There were no differences in child adjustment between children with falling and low flat response patterns.

Discussion

The current study utilized a growth mixture modeling approach to examining individual differences in children's cortisol response patterns to witnessing interparental conflict. For the sample as a whole, cortisol levels were not related to children's emotional security or child adjustment, suggesting that these processes may only be related in a subset of children thus necessitating the use of person-centered approaches. Models supported a three-class solution consistent with the theorized altered patterns of adrenocortical functioning. Patterns emerged reflecting attenuation and sensitization patterns, as well as a normative pattern. Results supported a sensitization hypothesis, that is, rising cortisol levels were related to family risk, child coping processes, and adjustment problems with evidence also linking low unchanging cortisol levels, consistent with an attenuation hypothesis, with risk.

The rising pattern, reflecting the sensitization hypothesis, was associated with histories of child-related conflict, perceived threat, and children's emotional insecurity. Children displaying increasing cortisol in response to the marital dispute were more likely to respond behavioral and emotionally to interparental conflict as well. They also evidenced higher levels of perceived threat and multiple indicators of emotional insecurity including, emotional reactivity, behavioral dysregulation, and involvement in interparental conflicts. These results suggest that multiple levels of children's regulatory functioning are disrupted by exposure to marital conflict. The extensive support for emotional insecurity and perceived threat as processes related to problems in children's functioning highlight the maladaptive nature of these response patterns (Cummings et al., 2006; Grych et al., 2003). Consistent with these conclusions, children in this group also displayed the highest rates of concurrent and subsequent internalizing and externalizing problems. Previous research has also linked elevated cortisol levels and reactivity with higher levels of both internalizing and externalizing problems (e.g., Gunnar & Vazquez, 2001).

While another well-defined pattern, which we posited as reflective of an attenuation pattern, emerged from the data, the present study did not support associations with children's emotional security or child adjustment. However, this flat pattern was associated with exposure to higher levels of destructive marital conflict, which has been identified as a risk factor for adjustment problems (Cummings & Davies, 2010). An intriguing alternative interpretation of diminished responding in children is the notion that suppression of cortisol secretion may be an adaptive response in the face of continued high activation of the LHPA axis which may serve to gradually damage or deteriorate healthy functioning (Fries, Hesse, Hellhammer, & Hellhammer, 2005; Gunnar & Vazquez, 2001). Given this adaptive alternative view of attenuated cortisol responses, it is perhaps not surprising that our flat response pattern was associated with higher risk but not higher insecurity or problem behaviors. Future research should examine the effects of a history of chronic marital conflict exposure on children's down-regulation of cortisol responses.

Cortisol follows a diurnal pattern with levels gradually decreasing throughout the day. Non-decreasing levels, such as the stable, flat pattern, may be an indication of divergence from the diurnal pattern similar to the rising response pattern; however this lack of decrease may not be strong enough to off-set the diurnal pattern and display a rising pattern. Thus, this stable, non-changing pattern may reflect a pattern in between the falling and rising groups. However, without measures of children's diurnal cortisol patterns outside of the research laboratory setting, we cannot conclude whether this stable pattern reflects an inability to respond to the marital dispute, a response not great enough to offset the diurnal rhythm, or a

situation in which children's lack of response is due to no need to regulate back to pre-laboratory levels given no changes in cortisol. Relatedly, a flat response may not necessarily reflect a maladaptive form of functioning. However, research supports diminished cortisol functioning in association with the inability to effectively respond to subsequent stressors and exhibit low baseline levels in non-stressful situations (Granger et al., 1998). While an adaptive view of an attenuation hypothesis is plausible, the muted pattern of reactivity may also be related to other domains of functioning (e.g., social competence, peer relations) not captured in the current study. In fact, previous research has supported an association between lower levels of cortisol and social relationships for adolescent girls (Booth, Granger, & Shirtcliff, 2008). Future research employing a person-centered approach should include multiple domains of stage-salient functioning to better understand the links between children's adrenocortical functioning, marital conflict, and child adjustment.

The decrease displayed by the falling group may found for a variety of reasons. First, falling cortisol levels follow the diurnal cortisol rhythm that decreases throughout the day. Alternatively, this pattern may be reflective of an appropriate down-regulation of the LHPA axis. This group displayed the highest baseline levels which may suggest an increase in cortisol levels in anticipation of arrival into the laboratory setting rating than reflecting the diurnal pattern. Furthermore, failure to anticipate challenge has been associated with problem behavior (Susman, Dorn, & Chrousos, 1991). However, at the time of the study children were familiar with the study setting which was designed to be a comfortable and friendly home-like environment. Thus it may not be reasonable to conclude children's cortisol levels spiked in anticipation of their visit to the laboratory. Regardless, this group represented the majority of the subjects and their decreasing pattern likely reflects adaptive physiological functioning whether in the form of adaptive down-regulation or a normative diurnal pattern.

Despite advances in understanding relations between exposure to marital conflict and children's physiological stress responses, further study of explanatory mechanisms and for whom these different patterns of physiological responses emerge is needed. The present study demonstrates the importance of the saliency of a stressor in impacting children's physiological functioning. More frequent child-related conflict, higher perceived threat, and greater emotional insecurity about marital conflict, were associated with children displaying a rising cortisol pattern. Conflict that is particularly distressing and threatening to children's security may a unique form of conflict that serves as a mechanism through which family stress alters children's physiological reactivity patterns. The differences in the role of conflict found in the current study in between the elevated and low stable patterns may reflect the unique role of specific types of conflict (e.g., child-related) that may be particularly distressing and harmful. Further investigation of these patterns of responses and relations with coping processes, as well as implications on child adjustment are warranted.

A number of limitations were present in the current study; the group sizes of children displaying an elevated or stable response were small, however previous research on children's cortisol responsivity suggest that a smaller percentage of children respond physiologically to a given stressor (Gunnar, Talge, & Herrera, 2009). The current study utilized a community sample of families reflecting a largely well-adjusted sample; research on dampened cortisol functioning often supports relations between low cortisol levels and child adjustment in high-risk samples. Children's cortisol levels were collected in response to a staged-conflict thus may affect the generalizability of the present study's findings. In particular, children's cortisol levels among all groups were consistent with healthy functioning, typical of community samples. Furthermore, the patterns found in this study may be response patterns that are reflective of children's true reactivity to conflict in the home that may produce a large response from the LHPA axis. Given children's behavioral

and emotional responses to the staged-conflict, it is likely that this task provided an ecologically-valid stressor that simulates the implications of interparental conflict in the home. The present study examined relationships between interparental conflict, adrenocortical functioning, emotional security, and child adjustment in the early school years. Future research should examine these relationships throughout development as children's adrenocortical functioning is believed to become more entrenched as children become older.

Nonetheless, the present study furthers our understanding of the interrelatedness of children's multilevel functioning in the context of family stress by examining children's physiological, psychological, emotional, and behavioral responses to interparental conflict. These results provide further support for the link between children's emotional security and altered physiological functioning. Children's insecurity about the family not only motivates their behavioral and emotional responses to restore security, their biopsychological resources may also be deployed to restore a sense of security. The present study further delineates the effects of marital conflict on multiple regulation systems and provides evidence for utilizing a multilevel approach to understanding children's stress and coping in the family.

Acknowledgments

This research was supported by grant R01 MH57318 from the National Institute of Mental Health awarded to Patrick T. Davies and E. Mark Cummings. The authors are grateful to the families who participated in this project. Their gratitude is also expressed to the staff and students who assisted on various stages of the project at the University of Notre Dame and the University of Rochester.

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Figure 1. Predicted cortisol reactivity class trajectories for the 3-class model. Cortisol measured as $\mu\text{g}/\text{dl}$.

Table 1

Correlations and descriptive statistics

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Baseline Cortisol	--												
2. Post Conflict Cortisol	.71**	--											
3. Post Resolution Cortisol	.59**	.90**	--										
4. Child Perceived Threat	-.01	.11	.11	--									
5. Child-Related Conflict	.18*	.21**	.14	.02	--								
6. Destructive Conflict	-.05	.03	.05	.09	.18*	--							
7. Emotional Reactivity	.07	.11	.06	.18*	.13	-.05	--						
8. Behavioral Dysregulation	.05	.00	-.01	.12	.25**	-.03	.46**	--					
9. Involvement	.04	.02	-.05	.14	.26**	-.01	.26**	.37**	--				
10. T1 Internalizing Problems	-.07	-.06	-.10	.21**	.25**	.11	.25**	.25**	.19*	--			
11. T2 Internalizing Problems	-.05	.03	-.03	.18*	.22**	.07	.19*	.17*	.23**	.67**	--		
12. T1 Externalizing Problems	.00	.04	.03	.20**	.26**	.05	.20**	.39**	.09	.53**	.47**	--	
13. T2 Externalizing Problems	.13	.11	.04	.08	.24**	.06	.10	.32**	.07	.36**	.57**	.85**	--
<i>M</i>	.10	.08	.07	2.68	14.53	2.31	14.98	7.11	25.76	6.73	7.22	7.79	7.15
<i>SD</i>	.04	.04	.03	2.16	3.74	1.10	3.05	2.48	6.67	4.70	4.65	5.72	5.14

Note. Emotional security and child adjustment reflect multiple reporter composite variables. T1: first grade assessment, T2: second grade assessment

* $p < 0.05$.

** $p < 0.01$.

Table 2

Model Selection Criteria for Comparison of the 2-, 3-, and 4-class Models

Model	LMR LRT	BIC	Entropy
2 classes	165.03 *	2842.34	.95
3 classes	90.54 *	2818.89	.82
4 classes	60.75	2854.67	.85

Note.

*
p < 0.05.**
p < 0.01.

Table 3

Average Latent Class Probabilities for Most Likely Latent Class Membership by Latent Class

	Falling	Flat	Rising
Falling	.93	.07	.01
Flat	.06	.94	.00
Rising	.05	.02	.93

Multinomial Regression Analyses with Children’s Perceptions of Threat and Frequency of Child-related Disagreements as Predictors of Cortisol Reactivity Classes

Table 4

Class Comparisons	Perceived Threat	Child-Related Conflict	Destructive Conflict
	Odds Ratio	Odds Ratio	Odds Ratio
Falling vs. Flat ^a	1.21	0.89	1.68 [*]
Falling vs. Rising ^a	1.53 ^{**}	1.14 ^{**}	1.00
Flat vs. Rising ^b	0.79	0.78 ^{**}	1.69 ^t

Note.

^aFalling group as the reference category;

^bRising group as the reference category.

^tp < 0.07.

^{*}p < 0.05.

^{**}p < 0.01.

Table 5
Means and Standard Deviations for Child Adjustment and Emotional Security by Children's Cortisol Reactivity Patterns

Variable	Falling Reactivity		Rising Reactivity		Flat Reactivity	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
<i>Emotional Security</i>						
Emotional Reactivity	14.60 ^a	2.84	16.68 ^a	3.50	15.31	2.41
Behavioral Dysregulation	6.86 ^a	2.13	8.38 ^a	3.41	7.14	2.71
Involvement	25.73	6.35	28.43 ^b	6.26	22.97 ^b	8.53
<i>Child Adjustment</i>						
Internalizing Problems - T1	5.95 <i>a</i>	3.67	13.97 ^{ab}	5.50	4.27 <i>b</i>	3.13
Internalizing Problems - T2	6.90 <i>a</i>	4.60	12.14 ^{ab}	3.32	5.08 <i>b</i>	3.26
Externalizing Problems - T1	6.80 <i>a</i>	4.23	16.47 ^{ab}	7.69	6.27 <i>b</i>	4.73
Externalizing Problems - T2	6.89 <i>a</i>	4.79	11.67 ^{ab}	5.89	4.77 <i>b</i>	4.32

Note.

^aSignificant difference in mean differences between falling and rising response groups ($p < .05$).

^bSignificant difference in mean differences between flat and rising response groups ($p < .05$).