THESIS

AUTONOMIC NERVOUS SYSTEM COORDINATION MODERATES LINKS OF INTERPARENTAL CONFLICT WITH ADOLESCENT EXTERNALIZING BEHAVIORS

Submitted by

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ABSTRACT

AUTONOMIC NERVOUS SYSTEM COORDINATION MODERATES LINKS OF INTERPARENTAL CONFLICT WITH ADOLESCENT EXTERNALIZING BEHAVIORS

Although negative interparental conflict predicts elevated externalizing problems for children, there are individual differences in this association. Theoretically, children's abilities to coordinate physiological stress across response systems moderate the effects of interparental conflict on outcomes. Past research has demonstrated that poor coordination of sympathetic (SNS) and parasympathetic (PNS) nervous systems puts children at a greater risk for externalizing behaviors in the context of interparental conflict. The goal of this study was to whether this same pattern is evident in adolescents. Participants were families with an adolescent (10-17 years) from diverse ethnic and socioeconomic backgrounds. Parents reported conflict, were observed during a conflict discussion, and reported adolescent externalizing behaviors. Adolescents experienced a stressor while skin conductance (SC; SNS) and respiratory sinus arrhythmia (RSA; PNS) were measured. Similar to past research with children, there were three-way interactions between negative, threatening interparental conflict, SC-R, and RSA-R in relation to adolescent externalizing behaviors. Adolescents who displayed poorly coordinated responding displayed a *positive* association between interparental conflict and externalizing behaviors, whereas adolescents who showed well-coordinated responding displayed a *negative* association between conflict dimensions and externalizing behaviors. Results indicate that SNS and PNS coordination may protect adolescents from experiencing increased externalizing behaviors in the context of interparental conflict.

TABLE OF CONTENTS

INTRODUCTION

Externalizing behaviors embody numerous behavior patterns such as impulsivity, hyperactivity, oppositionality, defiance, aggression, and antisocial behaviors (Buodo, Moscardino, Scrimin, Altoè, & Palomba, 2013; El-Sheikh, 2005). Children who show continuing externalizing behaviors through adolescence are at risk for negative outcomes later in life, including poorer academic performance (Masten et al., 2005), juvenile delinquency (Buodo et al., 2013), and antisocial adult psychopathology (Reef, Diamantopoulou, van Meurs, Verhulst, & van der Ende, 2011). Extensive literature has linked the development of externalizing behaviors to exposure to frequent, intense, and/or poorly resolved interparental conflict (Cummings & Davies, 2002; El-Sheikh, 2005; Pendry, Carr, Papp, & Antles, 2013; Rhoades, 2008), but less is known about the various factors that moderate the impact of interparental conflict on youth's externalizing behaviors. Physiological functioning is an important characteristic to consider. Physiological responses have been linked to behavior across various domains (see Granger et al., 2012, for an overview) and environmental stress has been shown to be related to dysregulated physiological responding in youth (Gordis, Granger, Susman, & Trickett, 2007).

There is evidence that when the two sub-systems of the autonomic nervous system – which governs part of our physiological response to stress – are poorly coordinated, interparental conflict increases the risk of child externalizing behaviors (El-Sheikh et al., 2009). The current study is an important extension on this past work by examining coordination of physiological stress responses across response systems in relation to interparental conflict and externalizing behaviors during adolescence, a critical period for the development and maintenance of mental health and adjustment (Andersen, 2003). In the current study, we aimed to add to the growing

literature emphasizing the importance of examining bio-physiological markers across systems and risk factors underlying the development of externalizing behaviors in adolescents.

Interparental Conflict and Adjustment Outcomes

Although interparental conflict has also been associated with a range of negative developmental outcomes for children and adolescents, the present analysis focuses largely on externalizing outcomes in order to expand upon the theoretical understandings about individual differences in the impact of interparental conflict on adolescents. A meta-analysis conducted by Rhoades (2008) concluded that effect sizes for the association between interparental conflict and adjustment were larger for internalizing behaviors than externalizing behaviors, indicating that the connection between interparental conflict and internalizing behavior in children is stronger and/or more consistent than externalizing behavior. Thus, individual differences may be more important to understand in terms of the effect of interparental conflict on externalizing behaviors, with physiological stress responding coordination as one potential moderator of this relationship.

There are two different dominant theoretical models to explain why interparental conflict leads to declines in child functioning, including increases in externalizing behaviors. Indirect effects models posit that interparental conflict erodes the parenting relationship to the point that children are no longer receiving consistent discipline, autonomy, and warmth, which then increases children's risk for experiencing externalizing behaviors (Stroud, Meyers, Wilson, & Durbin, 2014). In support of this conceptualization, sometimes referred to as the spillover effect, research suggests that interparental conflict is associated with parental emotional unavailability (Sturge-Apple, Davies, & Cummings, 2006), ineffective parenting (Buehler & Gerard, 2002), and lack of parental acceptance of children (Erel & Burman, 1995; Krishnakumar & Buehler, 2004). Further, studies that examine parenting as a mediator find that interparental conflict

predicts parenting problems, which, in turn, predicts negative child outcomes, such as externalizing behaviors (Buehler & Gerard, 2002; Harrist & Ainslie, 1998).

Alternatively, direct effects models posit that children are affected by interparental conflict because of the emotional and cognitive strains of conflict exposure. The emotional security hypothesis proposes that children's responses to interparental conflict are guided by appraisal and meaning-making of the conflict and that a child's sense of emotional security within the family then shapes his or her behavior (Davies & Cummings, 1994). Through this lens, marital stress directly causes feelings of insecurity, distress, and anxiety about the future in children, all of which may lead to externalizing behavior patterns. Additionally, the cognitive-contextual model emphasizes the importance of a child's cognitive and developmental abilities, as well as the context of the interparental conflict (Grych & Fincham, 1990). In this framework, the context of the conflict (intensity, content, duration, and resolution) is thought to directly influence the child's processing of and coping in response to conflict (Grych & Fincham, 1990). The ways children appraise interparental conflict are then important predictors of mental health and adjustment.

Unified theories support an integration of both the indirect and direct effects models, in which interparental conflict simultaneously disrupts parenting practices as well as children's emotional security and conflict appraisals (Cummings & Davies, 2002). Grych and Fincham (1990) explain that interparental conflict may directly increase aggressive and undesirable behavior in children through modeling of unhealthy conflict strategies and exposure to stress, while also indirectly damaging the parent-child relationship. Research in late adolescence also supports that cognitive appraisals and emotional security are both important mediators of health following interparental conflict (Mann & Gilliom, 2002). In their integration of the cognitive-

contextual and emotional security hypotheses, Mann and Gilliom (2002) explain that negative cognitive appraisals may intensify the impact of interparental conflict on emotional security, or decreased emotional security may lead to more negative appraisals of interparental conflict, or both of these processes may occur simultaneously. Without attentive parenting and without the emotional and cognitive capacities to manage stress caused by marital conflict, children become more vulnerable to externalizing behaviors.

Although these theories offer support for how interparental conflict has negative effects on children, they do not fully address why or to what extent interparental conflict impacts children differently. Despite robust research on the connection between interparental conflict and externalizing behavior patterns, not all children who are exposed to high levels of conflict develop maladaptive behaviors (El-Sheikh et al., 2009) and studying moderators of this association can help inform interventions (Cummings & Davies, 2002). Although severity and chronicity of conflict exposure certainly play a role in the impact of conflict on adjustment, other risk and protective factors may also moderate a child's reaction to interparental conflict.

Interparental Conflict and Physiological Reactivity

Differential physiological responding is one of the primary theoretical factors that has been proposed to better understand interparental conflict's negative impacts on child development (Bauer, Quas, & Boyce, 2002; El-Sheikh et al., 2011; Lucas-Thompson, 2012). Exposure to interparental conflict is stressful for children (Flinn & England, 1995; Grych & Fincham, 1990; Luecken & Lemery, 2004) and because interparental conflict is likely to be a continuous stressor, it may disrupt the ways that children respond to future stress. The allostatic load hypothesis suggests that chronic overactivation of stress response systems wears down physiological systems over time, increasing stress susceptibility (Juster, McEwen, & Lupien,

2010). Chronic exposure to interparental conflict may make children more susceptible to physiological dysregulation, which likely leads to damage in both short-term and long-term health and behavioral outcomes.

There are two competing arguments about the ways that repeated exposure to stressors affect functioning of stress response systems: the hyper-reactivity and the hypo-reactivity hypotheses. The hyper-reactivity hypothesis advances that children from home environments with high levels of negative interparental conflict display heightened levels of stress reactivity and physiological arousal as a product of sensitization to repeated stress exposure (Lucas-Thompson, 2012). As children experience continued and prolonged stress, their response systems become more easily triggered and they experience physiological activations more frequently and more strongly. Conversely, the hypo-reactivity hypothesis posits that repeated exposure to interparental conflict desensitizes a person's stress response system over time (Kudielka, Hellhammer, & Wust, 2009; Lucas-Thompson, 2012). This theory suggests that continuous exposure to stress makes it more difficult to respond appropriately to future stressors because the body's responses have been worn down due to chronic, continuous activation. Most research linking interparental conflict to stress reactivity has focused on children, and there is evidence for both the hyper-reactivity hypothesis (Cummings, Goeke-Morey, & Papp, 2003; El-Sheikh & Cummings, 1992; O'Brien, Margolin, John, Krueger, 1991), and the hypo-reactivity hypothesis (Flinn & England, 1995; Granger et al., 1998). Indeed, both are problematic forms of physiological dysregulation and are associated with child behavioral problems (Cummings et al., 2003; El-Sheikh & Cummings, 1992; Flinn & England, 1995; Granger et al., 1998).

Interparental Conflict and Physiological Reactivity in Adolescence

Individual differences in physiological responding may regulate the intensity of youth responses to interparental conflict (Lucas-Thompson & Granger, 2014; El-Sheikh, 2009). As exposure to interparental conflict persists across childhood and into adolescence, these effects may become more acute. Most studies that have examined links between interparental conflict, stress physiology, and behavioral outcomes have focused on children rather than adolescents, meaning the strength of these associations are unknown in this developmental period.

A transitional stage characterized by physical, emotional, cognitive, physiological, and behavioral changes, adolescence is a critical developmental stage. Adolescents experience dramatic changes in neuroendocrine physiology (Andersen, 2003), potentially making them vulnerable in different ways than children to the physiological effects of interparental conflict. Experiences during childhood influence the development of stress response systems in the brain due to the plasticity of the pre-pubertal brain (Andersen, 2003), and stress physiology may also change over time. The maturation of brain processes continues well into emerging adulthood and the adolescent brain undergoes continuous change, affecting regulation of arousal, motivation, and risk-taking behaviors (Steinberg, 2005). For example, most evidence with samples of children indicates that high levels of parental conflict predict hyper-reactive physiological stress responses (Ballard, Cummings, & Larkin, 1993; Buodo et al., 2013; El-Sheikh, Cummings, & Goetsch, 1989). In contrast, older adolescents from high conflict homes show hypo-reactive physiological stress responses to a social stressor (Lucas-Thompson, 2012). Although interparental conflict may initially create increased physiological sensitivity and hyper-reactivity, the prolonged nature of parental conflict exposure over time may result in hypo-reactive stress physiology during adolescence (Lucas-Thompson, 2012).

Despite the evidence that adolescents may be predisposed to hypo-reactive stress responses because of prolonged exposure to stress, both children and adolescents tend to show *emotional* responses to stress that are hyper-reactive (Cummings, Goeke-Morey, & Papp, 2003; El-Sheikh & Cummings, 1992). Across domains, adolescents are demonstrating both over- and under- physiological dysregulation to stressful situations, indicating that adolescents may be more likely than children to have trouble coordinating their physiological stress response across different systems (Lucas-Thompson, 2012; Lucas-Thompson & Granger, 2014).

Autonomic Nervous System

One of the primary systems of stress response is the autonomic nervous system. The autonomic nervous system is responsible for regulating automatic bodily functions, such as breathing, digesting, and keeping the heart beating. The autonomic nervous system is made up of the sympathetic nervous system (SNS) and the parasympathetic nervous system (PNS) that constantly regulate and manage the body's normal internal functioning. When the SNS is activated, it readies the body's fight-or-flight response and increases physiological arousal, including increasing heart rate and sweat production. Skin conductance level reactivity (SCL-R) measures the activity change in a person's sweat glands. Therefore, measuring changes in electrodermal activity (i.e., skin conductance) can provide an indication of SNS activity.

When the PNS is activated, physiological arousal is reduced, and the result is that the body is calmed down, conserving energy by slowing respiratory processes and heart rate. Respiratory sinus arrhythmia (RSA) can provide an indication of PNS activation (El-Sheikh et al., 2009). RSA is a measurement of heart rate during inhalation and exhalation (Beauchaine, 2001), and is controlled by the vagus nerve. Vagal tone acts as a brake on the sinoatrial node, causing heart rate deceleration (when the brake is applied) or acceleration (when the brake is

lifted) and serves as a key component of autonomic nervous system regulation (Beauchaine, 2001; Hinnant, Erath, & El-Sheikh, 2015). Because vagal tone cannot be directly measured (Beauchaine, 2001), RSA measurements are often used to estimate vagal tone (Calkins, Graziano, & Keane, 2007; El-Sheikh et al., 2009; El-Sheikh & Whitson, 2006). Research suggests high RSA is indicative of PNS activation (i.e., applying the brake), whereas low RSA indicates PNS inhibition (i.e., lifting the brake) (El-Sheikh & Whitson, 2006). Evidence suggests that small changes in RSA reactivity in response to stress (i.e., the vagal brake is not lifted) is associated with child behavioral problems (Calkins et al., 2007; El-Sheikh & Whitson, 2006) and indicates a failure to access the PNS and other helpful physiological resources that would otherwise moderate the strength of stress such as interparental conflict on behavior (El-Sheikh et al., 2009). Because vagal withdrawal, resulting in accelerated heart rate, aids in stress coping and adaptation (El-Sheikh et al., 2009; El-Sheikh & Whitson, 2006), it seems that children who do not engage in vagal withdrawal during stress have difficulties in coping and responding appropriately to stress.

Under ideal circumstances, the SNS and PNS coordinate to maintain the body's homeostasis: when the SNS is activated, the PNS is inhibited, and vice versa. Coordination of these systems is paramount to healthy stress responding. Children with biological predispositions for SNS and PNS disruptions may be at greater risk for developing maladaptive behaviors when in consistently stressful environments, such as a home with high levels of interparental conflict (El-Sheikh et al., 2009). Under abnormally chronically stressful circumstances, these systems may become dysregulated such that both the SNS and PNS are engaged (coactivation) or withdrawn (coinhibition), leaving the child unable to adjust to stress and therefore more vulnerable to behavioral problems (El- Sheikh et al., 2009). In chronically stressful

environments, children are unable to develop key skills required to manage the negative emotions produced by interparental conflict (Cummings & Davies, 2002). Further, compared to reciprocal responding, coactivation or coinhibition of the SNS and PNS have been found to be associated with higher rates of delinquency, ADHD, and other externalizing behavior in children exposed to martial conflict (El-Sheikh et al., 2009). Rather than studying either system individually, a multi-systemic approach helps elucidate the complex interactions among environment, physiology, and behavior (Bauer et al., 2002). The SNS and PNS are key components in the body's stress response system and the ways that they work together may represent an important individual difference variable in terms of individuals' susceptibility to environmental factors (El-Sheikh & Whitson, 2006). However, there is as of yet no evidence about the role of SNS and PNS coordination in the association between interparental conflict and externalizing behaviors in adolescence.

The Current Study

El-Sheikh and colleagues (2009) performed a series of cross-sectional studies to examine children's SNS and PNS coordination as moderators of externalizing behavior in the context of interparental conflict. They found that opposing action of the SNS and PNS through coinhibition or coactivation acted as a risk factor for children. Specifically, high SCL-R paired with high RSA (reflecting coactivation of the SNS and PNS) and/or low SCL-R paired with low RSA (reflecting coinhibition of the SNS and PNS) were associated with more externalizing behaviors in children from homes with interparental conflict (El-Sheikh et al., 2009). Conversely, reciprocal SNS and PNS activation, measured as high SCL-R paired with low RSA (reciprocal sympathetic activation) and/or low SCL-R paired with high RSA (reciprocal parasympathetic activation), appeared to be a protective factor against externalizing behavior, even in the context

of interparental conflict. Because adolescence may be a particularly vulnerable developmental period for physiological dysregulation and coordination (e.g., Lucas-Thompson, 2012), these interactions should be studied in adolescents. A replication of these findings in adolescents would also elucidate if SNS and PNS interaction play a larger role in some developmental periods in comparison to others.

Given what we know about stress responsivity and in an attempt to replicate the findings of El-Sheikh and colleagues, I predict that the interaction between SNS and PNS is related to externalizing behaviors in the context of negative reported, observed, or appraised interparental conflict (i.e., three-way interactions between conflict dimensions, SNS activation, and PNS activation). More specifically, that when these systems are either coactivated or coinhibited in response to stressful stimuli and when martial conflict is negative, externalizing behaviors are elevated in adolescents. In contrast, when the SNS and PNS action is reciprocal (where one is activated, the other is inhibited), adolescents are protected from negative interparental conflict and show lower levels of externalizing behaviors. Finally, I hypothesize that this three-way interaction will be evident whether considering parent-reported, observed, or adolescent appraised interparental conflict.

METHODS

Participants

Two-parent families with at least one child between the ages of 10 and 17 participated, for a total of 153 youth from 98 families (M = 12.92, SD = 2.16). The sample was approximately equal in terms of female and male participants (52% female). Seventy-eight percent of families were intact at time of study, but stepparent families were also included if the adults had been married or cohabitating for at least two years at time of study (length of relationship M = 15.64, SD = 5.86). Participants were recruited from a moderately-sized community in the United States using a variety of recruitment techniques to ensure a diverse sample in terms of ethnicity, socioeconomic status, and neighborhood conditions. Advertisements were placed in local newspapers, parenting magazines, and church bulletins. Adolescents were 49% non-Hispanic Caucasian, 26% other or mixed ethnicities, 17% African American, 6% Asian American, 1% American Indian and 1% Hispanic; 6% did not report ethnicity. Yearly family income ranged from $3375 to $450,000 (*Median* = $67,750, SD = $63,879.39). On average, both mothers and fathers had an Associate's Degree, or additional vocational training beyond high school.

Procedure

Adolescents and both parents visited the laboratory in the afternoon. After providing informed consent and assent, parents and youth were brought to separate rooms where they completed questionnaires using Audio Computer Assisted Self Interview Software (ACASI) and engaged in other tasks. ACASI software can read questions and answers out-loud to the participants, allowing sensitive information to be collected confidentially. This system also adjusts for various reading levels, making collection more accessible to adults and children of

varying degrees of literacy. Data were collected as part of a larger study, so only procedures relevant to the current study will be discussed below.

Procedure: Youth. First, a research assistant attached the necessary materials to record skin conductance (sensors on the first two fingers of the left hand), and respiratory sinus arrhythmia (via an electrocardiogram from sensors on the right wrist and left ankle, as well as a respiration belt around the chest to measure breathing); these measures were collected throughout the remainder of the visit. Then, participants completed a shortened version of the Positive and Negative Affect Schedule (PANAS; Laurent et al., 1999) and then sat quietly for ten minutes while watching a nature documentary (the baseline period). Next, participants experienced a version of the Trier Social Stress Test (TSST; Kirschbaum, Pirke, & Hellhammer, 1993; Yim, Quas, Cahill, & Hayakawa, 2010) modified for children and adolescents, which has been shown to effectively induce mild to moderate stress and accompanying physiological responses. In the modified TSST, after a preparation period (5 minutes), adolescents gave a speech about themselves, pretending that they are introducing themselves to a new classroom (5 minutes). Then, the participants were asked to conduct difficult arithmetic out-loud (4 minutes). Both tasks were observed by a female research assistant who maintained neutral affect and who participants were told would analyze their behavior, speech, and body language. The task was also viceo-recorded, and adolescents were told that the recording would be later reviewed by experts. Immediately following the TSST, participants completed the shortened version of the PANAS, and then a battery of other questionnaires unlikely to affect physiological recovery.

Procedure: Parents. Parents completed the original PANAS (Watson, Clark, & Tellegen, 1988), a 20-item scale measuring emotional reactivity, and then engaged in a standardized marital interaction tasks. Generated to produce a conflictual problem solving

interaction (Heffner, Kiecolt-Glaser, Loving, Glaser & Malarky, 2004), parents individually rated common areas of conflict and then were asked to discuss the most conflict-producing topics. Couples were then instructed to work towards a resolution on the chosen topics for 15-miutes, and encouraged to talk as they would in a normal disagreement. The discussions were recorded, and later coded for conflict behaviors. Following the interaction tasks, parents completed additional questionnaires using the ACASI program.

Measures

Parent-reported interparental conflict. Parents reported on the frequency, intensity, and resolution of their interparental conflict on two questionnaires. Frequency and intensity of conflict was assessed using the Conflict subscale from the Braiker-Kelley Partnership Questionnaire (Braiker & Kelley, 1979). The 5-item subscale included questions such as "How often do you and your partner argue with one another," "When you and your partner argue, how serious are the problems or arguments," and "How often do you feel angry or resentful toward your partner." Responses were appraised using a Likert scale of 1 to 9, with 1 representing "not at all" and 9 representing "very much." This scale (both in its entirety and subscales) has been used to measure interparental conflict in previous research. Lucas-Thompson (2009) reported the subscale was internally consistent for both mothers (Cronbach's alpha=.75) and fathers (Cronbach's alpha=.85). In addition, Gryl, Stitch, and Bird (1991) reported a Cronbach's alpha of .81 for the Conflict subscale. Belsky, Lang, and Rovine (1985) reported adequate test-retest reliability across three time points, further demonstrating reliability.

Conflict resolution was assessed using the 13-item Resolution subscale from the Kerig Conflicts and Problem-solving Scales (Kerig, 1996). Parents rated each statement according to how well it described the outcome of their disagreements. Answer possibilities were "Never,"

"Rarely, "Sometimes," and "Usually." The resolution subscale measured a person's resolution quality from highly negative to highly positive. After weighting the score for each parent, Lucas-Thompson (2009) reported the subscale is internally consistent (mothers: Cronbach's alpha=0.86; fathers: Cronbach's alpha=0.89), and that mother's and father's scores were significantly correlated (r=0.45, p<.01), suggesting convergent validity. Kerig (1996) also demonstrated high correlations between mother's and father's scores (r=0.29, p<.001) and adequate test-retest reliability using the full scale. Further bolstering the use of the CPS Resolution subscale, Kerig (1996) found significant convergent validity between overlapping the CPS and other measures of interparental conflict, and significant divergent validity between dissimilar measures. The weighted score from the resolution subscale was added to the frequency and intensity mean (there was a large correlation between the two self-report measures, r=0.56, p<.001; Cronbach's alpha: mothers=0.79, fathers=0.78). Total conflict scores were created by averaging both parent's overall scores, and mother and father's total conflict scores were significantly correlated, r=0.53, p<.001; M=-1.06, SD=5.90.

Observed interparental conflict. Interparental conflict was further assessed by observer ratings of specific behaviors during the parents' conflict discussion. Behaviors were rated on the degree to which they were present, ranging from absent to very strongly displayed, using a coding scheme developed by Cummings and Davies (2002). Inter-rater reliability for this system has been established in past research (i.e., Lucas-Thompson & Granger, 2014) and raters achieved at least 70% reliability prior to coding the interactions. Negative conflict behavior scores were created by summing ratings of verbal and nonverbal anger, defensiveness, withdrawal, distress, physical aggression, threat, pursuit, and insult, with a maximum score of 18 (Cronbach's alpha: mothers=0.65, fathers=0.66; maternal and paternal scores were significantly

correlated, r=0.46, p<.001). Total conflict scores were created by averaging mothers' and fathers' negative conflict behaviors, M=3.14, SD=2.66, for use in this study.

Adolescent physiological response. A BioPac ambulatory measuring system (MP150) was used to continuously measure physiological indicators that were used to calculate SCL and RSA. Acq*Knowledge* software was used to calculate SCL (average during baseline), SCL-R (TSST values minus baseline values), RSA (average during baseline), and RSA-R (residualized chance scores by regressing TSST values on baseline values). SCL and SCL-R were calculated using the parameters established in Dawson, Schell, and Filion (2000). The RSA index was then computed using the peak-valley method (Grossman, Van Beek, & Wientjes, 1990).

Externalizing behaviors. Externalizing behaviors were measured through maternal report using the Child Behavior Checklist (CBCL), a widely used, well-validated, reliable, and internally consistent parent-report of behavioral problems (Achenbach, 1999; Davies et al. 2007). Parents rated a series of statements in terms of how well they describe their adolescent on a Likert scale ranging from 0 to 2, with 0 representing "not true," 1 representing "somewhat true or sometimes true," and 2 representing "very true or often true." An externalizing score was created based on the externalizing scale of the CBCL for both mothers and fathers by summing responses to the attention problems (e.g., "can't concentrate or pay attention for long"), delinquency (e.g., "Lying or cheating", and aggression (e.g., "gets in many fights") subscales. Higher scores reflect higher levels of externalizing behaviors. Maternal and paternal scores were internally consistent (Cronbach's alpha: mothers=0.90, fathers=0.92) and significantly correlated, r=0.73, p<.001. Further, Nakamura and colleagues (2008) found strong evidence that the CBCL demonstrates both convergent and divergent validity, as well as reliability.

Control variables. Age, sex, ethnicity (White vs. non-White), family SES, and height were included as controls because of previous associations with one or more of the primary study variables. Factors that may affect stress physiology (e.g., coffee consumption, hours slept, alcohol or nicotine consumption, weight, and height) were included in a participant screening and were controlled for when significantly related to the physiological outcomes.

Data Analytic Plan

Because adolescents from the same families could participate, generalized estimating equation (GEE) models (regression-based, non-parametric) were conducted in order to adjust for clustering of youth within families (e.g., Ballinger, 2004). Main effects of interparental conflict on externalizing behaviors were tested first, then hierarchical testing proceeded to test higher-order (two-way, multiplicative interactions, calculated after centering on the mean) and finally three-way interactions (controlling for lower-order terms), following the procedures in Aiken and West (1991). Separate tests were conducted for interactions with each reactivity (SCL-R, RSA-R) value and each interparental conflict indicator. In addition to age, sex, ethnicity, SES, and height, caffeine consumption in the hour before the visit was included as a control variable because it was associated in bivariate analyses with the physiological variables.

RESULTS

Bivariate Correlations

Means, *SD*s, and bivariate correlations are shown in Table 1. Parent-reported conflict was significantly correlated with observed negative conflict behavior and mother-reported externalizing behavior. Parent-reported interparental conflict was significantly related to adolescent externalizing behaviors, such that more conflict predicted more externalizing behaviors. In terms of SNS and PNS levels, baseline RSA and SCL were significantly and negatively associated; there were no other significant correlations between interparental conflict dimensions, externalizing behaviors, RSA, or SCL.

In terms of correlations between control variables and primary variables, ethnicity and SES were significantly related to parent-reported interparental conflict and observed negative conflict behavior, such that non-White participants and those with lower SES reported more interparental conflict and displayed more negative conflict behaviors. SES was also significantly related to adolescent SCL during the stressor, such that participants with higher income had higher levels of skin conductance. Finally, participant age was significantly, negatively related to parent-reported conflict and observed negative behavior. There were no other significant correlations between control and primary variables.

Table 1

Descriptive Statistics for and Correlations between Marital Conflict Dimensions, Physiological Measurements, and Externalizing Behaviors

	1	2	3	4	5	6	7	8	9	10	11
1. Parent-reported conflict	X										
2. Neg. conflict behavior[a,c]	.43**	X									
3. Baseline RSA[c]	-.15	-.14	X								
4. Baseline SCL[c]	.02	-.11	-.24**	X							
5. RSA-R[c]	.06	.04	-.10	-.03	X						
6. SCL-R	-.10	-.01	-.05	.10	-.05	X					
7. Externalizing behavior[c]	.17*	.12	-.07	.15	.04	.04	X				
8. SES	-.24**	-.19*	-.04	.05	-.07	.18*	-.12	X			
9. White[b]	-.23**	-.20*	-.08	.12	-.12	-.01	-.12	.14	X		
10. Sex[a]	.01	.07	.12	-.22	-.13	-.10	-.90	.05	.02	X	
11. Age	-.17*	-.25**	.08	-.11	<.01	.04	-.06	.07	.09	-.01	X
M	-.82	.40	1.94	.83	2.07	<.01	8.01[d]	-.01	.46	1.52	12.92
SD	5.99	.34	.26	.31	.21	2.27	8.04[d]	.88	.50	.50	2.16

* $p < .05$ ** $p < .01$ *** $p < .0001$ Note: [a]1=male, 2=female [b]1=White; 0= other [c]Variable log-transformed to ameliorate the effects of significant skew; [d] Raw means and SDs presented.

Interactions Among Interparental conflict, SCL-R, and RSA-R in relation to Externalizing Behaviors

Before turning to the analyses that tested the key hypotheses about interactions, the main effects of interparental conflict on adolescent adjustment was tested, revealing a trend-level and positive main effect of parent-reported interparental conflict on mother-reported externalizing behaviors, but no other main effects were evident (see Table 2). No other main effects were significant.

Next, I examined interactions between interparental conflict (parent-reported and observer-rated), SCL, and RSA in relation to adjustment. Results from these GEE models revealed a significant three-way interaction between negative conflict behavior, RSA-R, and SCL-R in relation to mother-reported externalizing behaviors (Est. = 19.13, *SE* = 9.31, $p = .04$). Figure 1 displays the nature of this interaction. For adolescents who had reciprocal sympathetic activation (i.e., high SCL-R / SNS activation and low RSA-R / PNS inhibition), there was a negative (although non-significant) association between conflict behavior during the discussion task and externalizing behavior. The same pattern, although it appeared weaker, was evident for adolescents with reciprocal parasympathetic activation (i.e., low SCL-R / SNS inhibition and high RSA-R / PNS activation). For adolescents whose systems either coactivated (i.e., low SCL-R and RSA-R / SNS and PNS activation) or coinhibited (i.e., high SCL-R and RSA-R / SNS and PNS coinhibition), there were marginally significant positive associations between negative conflict and externalizing behaviors.

Table 2
Associations between Interparental conflict Dimensions and Mother Reported Externalizing Behaviors[a]

	Concurrent externalizing behaviors		Prospective externalizing behaviors	
	b	*SE*	*b*	*SE*
Reported interparental conflict	.215+	.128	-.012	.058
Negative Conflict Behaviors	2.274	2.271	-.414	1.297
Baseline RSA	3.095	3.120	.224	1.383
Baseline SCL	3.765	2.384	2.191+	1.205
RSA-R	.820	3.110	1.248	2.277
SCL-R	.068	.299	-.042	.175
Externalizing Behaviors time 1	--	--	.149*	.058
SES	-.721	.783	.207	.457
Sex[b]	-.1.723	1.387	-.219	-.219
Adolescent age	.366	.333	-.139	-.139
White (1) vs. non-White (0)	-1.832	1.440	.327	.327

+ $p < .10$ * $p < .05$ ** $p < .01$ ** $p < .001$. [a] Analsyses also controlled for participant height and caffiene consumption in the hour before the visit [b]1=male, 2=female.

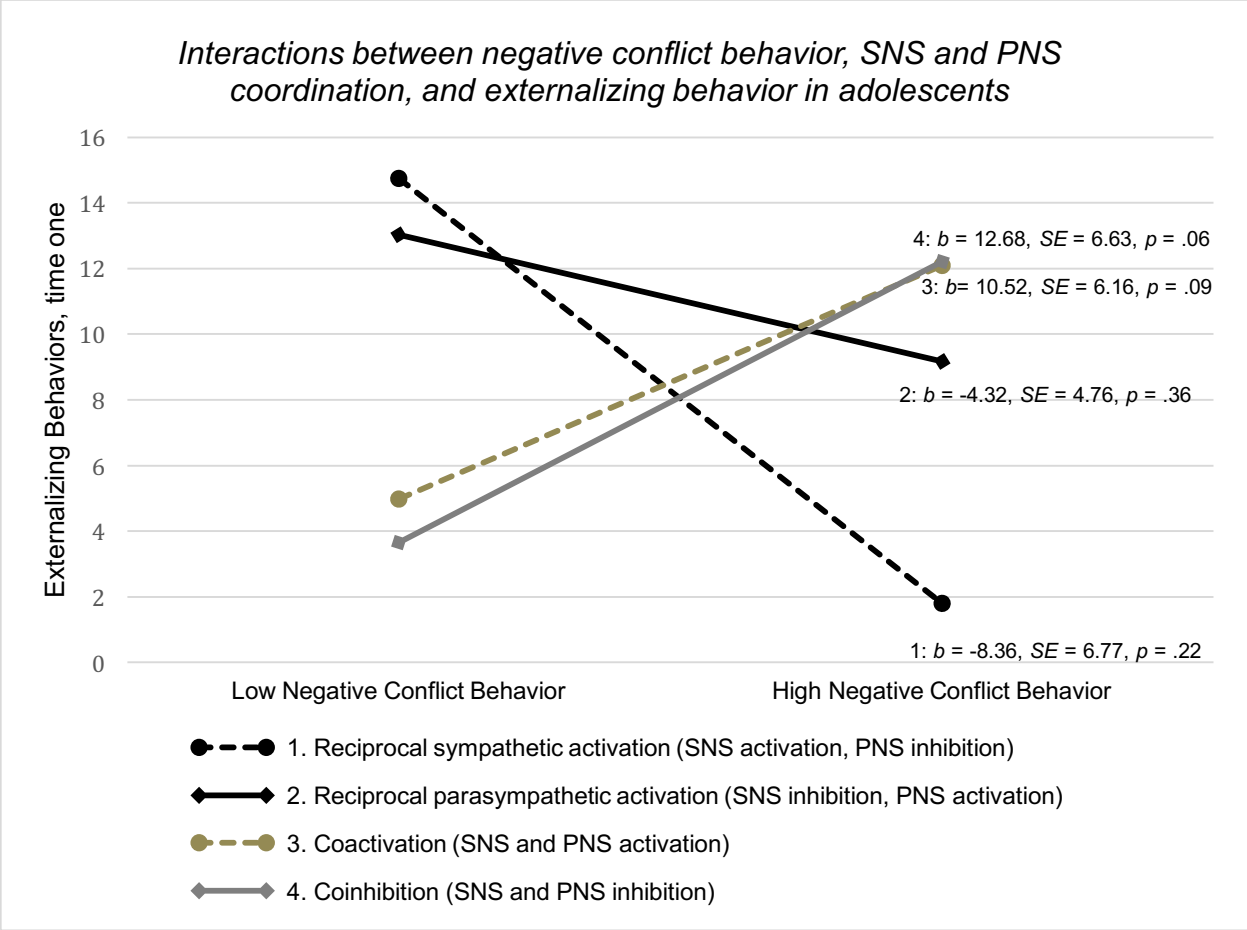

Figure 1. Links between negative conflict behavior and externalizing behaviors at time 1 are moderated by SNS and PNS coordination. *b*s, *SE*s, and *p*s represent the simple slope of the association between negative conflict behavior and externalizing behaviors. Line 3 is marginally significantly different from both lines 1 and 2; line 1 is marginally significantly different from line 4; and lines 2 and 4 are marginally significant from each other. No other lines are significantly different from each other.

DISCUSSION

The goal of the present study was to examine whether coordination of the SNS and PNS moderates the association between interparental conflict dimensions and adolescent externalizing behaviors in order to replicate and expand upon the work of El-Sheikh and collaborators. Results from these analyses found patterns consistent with those found in children (El-Sheikh et al., 2009) but also provide new and important information that these patterns continue to be evident in adolescence.

Overall, it appeared that interparental conflict and the subsystems of the autonomic nervous system work together to predict how much and in what ways interparental conflict is related to externalizing behaviors in adolescence. Evidence suggested that SNS and PNS coordination moderated the association between negative and threatening interparental conflict and externalizing behaviors in adolescents. Specifically, when adolescents displayed coinhibition and coactivation (i.e., poorly coordinated SNS and PNS stress responding) in response to the stressor, externalizing behaviors were elevated in the context of negative interparental conflict. In contrast, adolescents with reciprocal activation (particularly SNS activation) displayed lower levels of externalizing behaviors in the context of negative interparental conflict. Past work has tended to examine activity of only one system at a time in response to stress, rather than how well that system works together with other relevant systems to prepare the body for stressful stimuli. One reason that literature indicates discrepancies in the nature of the association between interparental conflict and stress responding (i.e., hypo- vs. hyper- responses to stressors) may be due in part to a greater focus on isolated systems. The results of the current study are in keeping with a multi-system perspective (see Beauchaine, 2001; Granger et al., 2012) and underscore the importance of examining functioning across systems.

In the context of high levels of negative conflict behavior, adolescents who showed coactivation or coinhibition of the SNS and PNS were especially at risk for externalizing behavior. First addressing coactivation, this may be because coactivation represents physiological over-arousal wherein the sympathetic "fight or flight" response is competing with the parasympathetic "rest and digest" response (El Sheikh et al., 2009). Adolescents with this profile of responding may experience interparental conflict as especially stressful, making its impact all the more salient. One explanation for this pattern draws upon Davies and Cummings' (1994) proposal that enhanced sensitization to interparental conflict threatens emotional security in children and increases children's involvement in parents' conflict, which may increase both the stress of the event as well as its impact on the child. Through an emotional security lens, adolescents with SNS and PNS coactivation may experience enhanced sensitization to interparental conflict across systems.

In contrast, coinhibition of the SNS and PNS may represent an ambivalent response to interparental conflict. El-Sheikh and colleagues (2009) propose that this response reflects the parasympathetic system equipping the child for response by withdrawing its inhibitory influence, yet the sympathetic system fails to produce the necessary output for appropriate emotional and behavioral response. This pattern may be indicative of hypo-reactivity (Flinn & England, 1995; Granger et al., 1998), wherein repeated stress desensitizes a person's stress response system, making it difficult for them to process the emotional burden of conflict. Lack of stress processing could result in more callous responses (Fung et al., 2005), resulting in impulsive, oppositional, and hyperactive behaviors (Frick et al., 2003). Because interparental conflict is likely to begin in childhood and continue into adolescence, adolescents may be especially vulnerable to this type of response (Lucas-Thompson, 2012). Previous research shows that older adolescents from high

conflict homes are more likely to show hypo-reactive physiological stress responses to social stressors than are children (Lucas-Thompson, 2012), suggesting that coinhibition and ambivalence to stress may develop over time. Future research would benefit from analyzing the evolution of response profiles over time.

Alternatively, it is also possible that having a under or over reactive adolescent with high levels of externalizing behaviors contributes to parental stress, contributing to more parental conflict. Having an adolescent who frequently acts out and who responds very strongly to stressors such as interparental conflict may exacerbate and worsen interparental conflict; in contrast, the callous-unemotional personality traits that have been linked with hypo-reactivity (Fung et al., 2005) may be stressful for parents in a way that worsens family conflict, particularly when adolescents are also engaging in high levels of risky behavior.

These results also indicate that reciprocal responding may protect adolescents from externalizing behaviors in the context of negative interparental conflict, in line with theory and past cross-sectional results with children (El-Sheikh et al., 2009). Reciprocal sympathetic activation, during which the PNS withdraws and the SNS engages, reflects the most appropriate response to stressors broadly and to interparental conflict specifically. Adolescents with this profile may actively engage with helpful authority figures in order to manage distress, or may make attempts to reduce their exposure to interparental conflict overall (El-Sheikh et al., 2009); whatever the mechanism, they may be managing their responses to stressors well enough to prevent the development of behavior problems. Similarly, adolescents who showed reciprocal parasympathetic activation may be better equipped to engage in self-soothing and emotional regulation techniques that limit the use of externalizing behaviors (Hill, Degnan, Calkins, & Keane, 2006). Even in the face of highly negative behaviors in parental conflicts, reciprocal

responding seems to protect adolescents from aggressive, hyperactive, and delinquent behaviors. This model of risk and protection is similar to that proposed by El-Sheikh and colleagues (2009), which found similar patterns in children exposed to different levels of interparental conflict. Although speculative, it is also possible that adolescents whose systems are well-regulated may reduce acting out behaviors in order to compensate for parental conflict that feels threatening. Appropriate stress responses may make it easier for adolescents to understand their effects on the family systems and this interaction may demonstrate that they can effectively reduce their externalizing behaviors in order to stabilize that system.

Interestingly, ANS coordination was a significant moderator of the effects of observed negative conflict but not parental reports of conflict. The negative behaviors prevalent in interparental conflict reinforce aggressive and other disruptive behaviors in adolescents by modelling inappropriate ways of interaction (Cummings, Goeke-Morey, & Papp, 2004). Higher levels of negative behavior in interparental conflict may increase the likelihood that adolescents will model negative behavior in other contexts, such that parents who engage in more conflict in the house will have children who reproduce negative conflict and aggression outside of the home. In this way, negative behaviors during conflict discussions may be more important for behavioral regulation by modelling inappropriate or ineffective ways of managing conflict and stress (Cummings, Goeke-Morey, & Papp, 2004) in ways that frequency or intensity of conflict do not.

Limitations and Conclusion

Although this study represents an important advance in understanding how different profiles of ANS responding interact with interparental conflict in relation to adjustment, there are limitations that need to be mentioned. Assessments of adolescent adjustment behaviors were

measured through parent questionnaires. Parents may under- or over- report adolescent internalizing and externalizing behaviors. However, the Child Behavior Checklist has been found to elicit highly correlated parent and child responses for internalizing and externalizing behaviors (Stranger & Lewis, 2010). An additional limitation is that this study was cross-sectional in design, which limits our ability to make cause and effect conclusions. Future research should observe adolescents over time in order to make stronger conclusions about directionality of effects and to further understand patterns of risk over time. Finally, because data were drawn from a community sample with less representation of the most serious forms of interparental conflict and adjustment problems, results may not fully reflect the nature of these interactions or generalize to clinical samples.

Despite these limitations, the current study has important strengths. These include sophisticated data analytic procedures that account for sibling clusters within families, physiological measurements that assess stress responding across systems, and an observed interparental conflict task that allowed direct measurement of negative conflict behaviors. Findings advance theory and research by suggesting that autonomic nervous system subsystem coordination is an important factor for why some adolescents exposed to interparental conflict are at a greater risk for adjustment problems. The coordination between the subsystems of the autonomic nervous system appears to create different profiles of responding across the context of negative interparental conflict. This work furthers our understanding about how and in what ways interparental conflict affects adolescents and helps to inform interventions for improving adolescent adjustment. By considering multiple, unique risk mechanisms and processes for externalizing behaviors, it may be possible to identify specific ways to address various combinations of risk profiles and lessen the impact of interparental conflict on adolescents and

children. Future research should consider ways to stabilize stress responding in adolescents to encourage reciprocal sympathetic responding, which may protect adolescents from developing externalizing behavior, and continue to investigate ways to encourage positive coping in adolescents exposed to interparental conflict.

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APPENDIX A: PARENT-REPORTED MARITAL CONFLICT

The following questions ask about certain aspects of your relationship with your partner. Please answer these questions for the present time in your relationship by circling the number that best describes your relations with your partner.

	Not at all								Very much
1. How often do you and your partner argue with one another?	1	2	3	4	5	6	7	8	9
2. To what extent do you try to change things about your partner that bother you (e.g., behaviors, attitudes, etc.)?	1	2	3	4	5	6	7	8	9
3. How often do you feel angry or resentful toward your partner?	1	2	3	4	5	6	7	8	9
4. When you and your partner argue, how serious are the problems or arguments?	1	2	3	4	5	6	7	8	9
5. To what extent do you communicate negative feelings toward your partner (e.g., anger, dissatisfaction, frustration, etc.)?	1	2	3	4	5	6	7	8	9

All couples have conflicts from time to time, and there are many ways that partners can try to handle disagreements when they arise. Please tell us about yours during the last year. Circle the number that corresponds to what is true for you.

	Once a year or less	Every 4-6 months	Every 2-3 months	Once or twice a month	Once or twice a week	Just about every day
6. How often do you and your partner have **minor** disagreements (e.g., "spats", getting on each other's nerves)?	1	2	3	4	5	6
7. How often do you and your partner have **major** disagreements (e.g., big fights, "blow-ups")?	1	2	3	4	5	6

For each statement, please circle the rating that best describes the outcomes of your disagreements.

	Never	Rarely	Sometimes	Usually
8. We feel that we've resolved it, or come to an understanding.	1	2	3	4
9. We feel closer to one another than before the fight.	1	2	3	4
10. We each give in a little bit to the other.	1	2	3	4
11. We feel worse about one another than before the fight.	1	2	3	4
12. We don't resolve the issue; we continue to hold grudges.	1	2	3	4
13. We end up feeling angry and annoyed with one another**.**	1	2	3	4
14. We stay mad at one another for a long time.	1	2	3	4
15. We don't speak to one another for a while.	1	2	3	4

For each statement, please circle the rating that best describes the outcomes of your disagreements.

	Extremely dissatisfied	Mostly dissatisfied	Works sometimes but could be better	Works OK most of the time	Very satisfied
16. How satisfied are you with the strategies that you have for resolving your conflicts?	1	2	3	4	5
17. Overall, how happy are you with this relationship?	1	2	3	4	5

Length of exposure to marital conflict
THE HISTORY OF OUR MARRIAGE

Now we would like you to think about your marriage from the beginning (if you are not married, but living together, think about from when you started living together).

How many years have you been married or living together? (Answer choices will range from 2-35)

For those who have been married for less than 10 years (skip logic will be used so that participants only provide information for the relevant number of years):

The following questions will be asked about these prompts: 1) *Think about your marriage for the **first 2 years . . .*** 2) *Think about your marriage for **years 3-4 . . .*** 3) *Think about your marriage for **years 5-6*** 4) *Think about your marriage for **years 7-8 . . .***

1. *How would you describe your marriage?*
    a. Very enjoyable
    b. Somewhat enjoyable
    c. Not one of the best periods
    d. Rocky
    e. Divorce considered

2. *How would you rate the level of conflict in your marriage?*
    a. A lot of conflict
    b. A moderate amount of conflict
    c. A little conflict
    d. Almost no conflict

3. *How does your marriage THEN compare to your marriage NOW in terms of how much you fight?*
    a. Much worse than now
    b. A little worse than now
    c. A little better than now
    d. Much better than now

For those who have been married for more 10-20 years:

The same questions outlined above will be asked about these prompts: 1) *Think about your marriage for the **first 4 years . . .*** 2) *Think about your marriage for **years 5-9 . . .*** 3) *Think about your marriage for **years 10-14*** 4) *Think about your marriage for **years 15-19 . . .***

For those who have been married for more than 20 years:

The same questions outlined above will be asked about these prompts: 1) *Think about your marriage for the **first 5 years . . .*** 2) *Think about your marriage for **years 6-11 . . .*** 3) *Think about your marriage for **years 12-17*** 4) *Think about your marriage for **years 18-22*** 5) *Think about your marriage for **years 23-27***