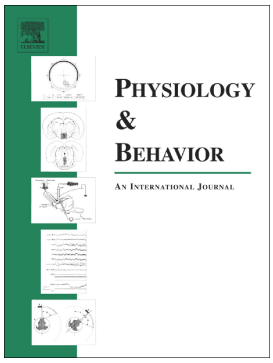

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Parenting Stressors and Young Adolescents' Depressive Symptoms: Does High Vagal Suppression Offer Protection?

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Abstract

Grounded in a dual-risk, biosocial perspective of developmental psychopathology, this study examined the role of higher vagal suppression in providing young adolescents protection from four parenting stressors. It was expected that lower vagal suppression would increase youth vulnerability to the deleterious effects of these parenting stressors. Depressive symptoms were examined as a central marker of socioemotional difficulties during early adolescence. The four parenting stressors examined were interparental hostility, maternal use of harsh discipline, maternal inconsistent discipline, and maternal psychological control. Participants were 68 young adolescents (Grade 6) and their mothers. Greater vagal suppression provided protection (i.e., lower depressive symptoms) from interparental hostility, harsh discipline, and maternal psychological control for boys but not for girls.

adolescents; depression; vagal suppression; vagal withdrawal; gender; parenting

Parenting Stressors and Young Adolescents' Depressive Symptoms: Does High Vagal Suppression Offer Protection?

There is extensive evidence linking parenting stressors with adolescents' depressive symptoms (Barber, Stolz, & Olsen, 2005; Cummings, Cheung, Koss, & Davies, 2014; Yap, Pilkington, Ryan, & Jorm, 2014). Yet in a meta-analysis, Yap et al. (2014) documented variability across adolescents in the extent to which such stressors are associated with depressive symptoms or depression diagnoses. One of the factors that might help explain these individual differences is vagal suppression (Diamond, Fagundes, & Cribbet, 2012). Vagal suppression is a central physiological marker indicative of adaptive responses to environmental challenges and stressors (Graziano & Derefinko, 2013). The purpose of the current study was to examine the interactive effects of parenting stressors and adolescents' vagal suppression during a simulated challenge task in predicting youth depressive symptoms. We focused on early adolescence because of the transitional salience of this developmental period, considered youth gender as a moderator of effects, and examined four parenting stressors: interparental hostility, maternal harsh discipline, maternal inconsistent discipline, and maternal psychological control.

Early adolescence is an important developmental period for studying stress reactivity (McCormick, Mathews, Thomas, & Waters, 2010). It is a time of accelerated growth across many social, psychological, and biological domains, as well as a period of increased vulnerability (Dahl, 2004; Steinberg et al., 2006). Some research suggests that stress is more likely to have emotional consequences in the early years of adolescence than prior to that time (Larson & Ham, 1993; McLaughlin, Rith-Najarian, Dirks, & Sheridan, 2015), perhaps due to better cognitive understanding of stressful events (Larson & Ham, 1993; McLaughlin et al., 2015) or perhaps because of the co-occurrence of many transitional changes (Simmons & Blyth, 1987). Stress reactivity appears to be heightened during times of pubertal development (Romeo, 2010; Spear, 2009). Animal research has shown that juvenile rats have greater stress-

induced hormone levels than do adult rats and that the recovery period is longer for juveniles (Romeo, 2010). Less research has been conducted with humans than with non-human animals, but scholars have suggested that adolescence is a critical time for the examination of physiological stress responses because of their associations with concurrent and future well-being (Dahl & Gunnar, 2009; Lopez-Duran, Kovacs, & George, 2009).

Within the current study, we focus on depressive symptoms as an important aspect of psychosocial adjustment (McLaughlin & King, 2015). Although rates of major depressive disorders are relatively low during early adolescence (Costello, Erkanli, & Angold, 2006), depressive symptoms are prevalent, with between 20 and 50 percent of children and adolescents experiencing heightened levels of depressive symptoms (Kessler, Avenevoli, & Merikangas, 2001). Epidemiological studies have found that the rates of symptomatic, sub-clinical levels of depression exceed the prevalence rates of clinical depression among adolescents (Kessler & Walters, 1998). Furthermore, symptomatic levels of depression during adolescence have enduring influences on psychosocial functioning (Kessler & Wang, 2009), being a predictor of subsequent depressive disorders (Klein et al., 2009). Additionally, studies have found that depressive symptoms during early adolescence predict later sleep problems (Shanahan, Copeland, Angold, Bondy, & Costello, 2014), behavior problems (Reinke, Eddy, Dishion, & Reid, 2012), and decreased peer acceptance (Kochel, Ladd, & Rudolph, 2012). As such, during early adolescence, depressive symptoms represent a prevalent and an important marker for later adjustment and well-being.

Parenting Stressors

Certain characteristics of parental behavior raise the risk for depressive symptoms during adolescence, and as such represent environmental stressors. We examined four parenting risk factors for adolescent depressive symptoms. The first of these, interparental hostility, addresses the nature of interactions between parents (Yap et al., 2014). A long history of research links higher marital conflict or interparental hostility with a variety of internalizing

problems including depression (Grych & Fincham, 1990). In support of the premise that interparental hostility might be causally related to adolescent depressive symptoms, the association has been documented in several longitudinal studies (Barton et al., 2015; Cui, Conger, & Lorenz, 2005; Cui, Donnellan, & Conger, 2007; Cummings et al., 2014; Lee, Wickrama, & Simons, 2013). The association also exists across diverse ethnic groups (e.g., Barton et al., 2015; Krishnakumar, Buehler, & Barber, 2003) and controlling for other problems linked with internalizing problems, such as externalizing difficulties (Buehler, Benson, & Gerard, 2006; Benson, Buehler, & Gerard, 2008). Two meta-analyses published almost two decades apart have indicated that the link between interparental conflict or hostility and adolescents' internalizing problems (especially depressive symptoms) is well-supported across studies (Buehler et al., 1997; Yap et al., 2014). With some exceptions, research suggests that the link is similar for boys and girls (Buehler et al., 1997), at least through early adolescence (Crawford, Cohen, Midlarsky, & Brook, 2001).

Three other parental risk factors for adolescent depressive symptoms have to do with the nature of parents' interactions with children: parental psychological control (also called intrusiveness or overcontrol), use of harsh discipline, and parental inconsistent discipline. A long line of research documents that higher use of psychological control by parents increases the risk of depressive symptoms among adolescents (Barber, Stolz, & Olsen, 2005). Higher psychological control has been linked with more adolescent depressive symptoms in longitudinal studies spanning different lengths of time across adolescence, regardless of child or parent gender (although there is some suggestion that maternal psychological control might be an especially strong predictor), across multiple countries and cultures, and controlling for other central aspects of parenting (e.g., parental support, parental behavioral control). Parental overinvolvement, which includes psychological control, was identified in an extensive meta-analysis as a parenting characteristic linked to depression in adolescents (Yap et al., 2014). These pervasive findings have been interpreted to indicate that one's developing sense of self –

and the emotional health that accompanies this development – is damaged when parents do not respect the adolescent child's individuality and instead attempt to change the adolescent, particularly through manipulative and intrusive means (Barber et al., 2005).

Harsh discipline -- whether verbal (Wang & Kenny, 2014) or physical (Wang, Chan, Lin, & Li, 2015) -- also predicts more adolescent internalizing problems. This association holds in studies based on one-time correlational data (Bender et al., 2007) and in longitudinal designs (Wang & Kenny, 2014). Yap et al.'s (2014) meta-analysis indicated that there is a sound base of evidence supporting a link between parental "aversiveness" -- which includes criticism, punishment, and conflict -- and depression among adolescents. Parental harshness is thought to increase the risk of depressive symptoms through a variety of possible mechanisms, including development of a negative self-concept or self-criticism (Sachs-Ericsson, Verona, Joiner, & Preacher, 2006), cognitive reactivity (Cole et al., 2014), emotional dysregulation (Yap, Schwartz, Byrne, Simmons, & Allen, 2010), or difficulty developing positive social relationships (parental and non-parental).

Inconsistent parental discipline is another parenting practice that has been linked to internalizing problems among adolescents. Theoretically, the unpredictability of parents' responses results in psychological distress for the adolescent (Dwairy, 2010). Although there appears to be no longitudinal evidence for this association at present, a meta-analysis of cross-sectional research suggests that more inconsistent discipline is associated with higher levels of adolescent depression (Yap et al., 2014).

These parenting stressors all uniquely predict higher adolescent internalizing among young adolescents (Benson et al., 2008; Buehler et al., 2006). Yet effects are small-to-medium in size (Buehler et al., 1997; Yap et al., 2014), and there is unexplained individual variability in associations. Thus, it becomes important to identify potential moderators of associations between parenting stressors and adolescent depressive symptoms so as to understand which

adolescents are especially vulnerable to the impact of such environmental stressors, or especially resilient in the face of them.

Vagal Suppression

Recent theory has suggested that various aspects of physiological functioning explain individual differences in vulnerability to environmental stressors (Brotman, Gouley, Klein, Castellanos, & Pine, 2003). A “dual-risk” model (Brotman et al., 2003) is derived from a diathesis-stress perspective and predicts that environmental stressors have particularly negative effects on youth who have physiological markers that suggest debilitating stress responses. The dual-risk model was used to generate hypotheses and interpret findings for the current study.

Vagal suppression is an important physiological process that might interact with parenting stressors to affect adolescent depressive symptoms. Vagal suppression is an indicator of parasympathetic nervous system (PNS) activity in response to challenge. The PNS contributes to flexible control of cardiac functioning through employment or inhibition of the vagal brake (Bernston, Quigley, & Lozano, 2007). Under perceptions of a safe environment, the PNS employs the vagal brake which contributes to inhibitory control of cardiac functioning, appropriate environmental and social engagement, and calm states (e.g., keeping heart rate low and steady; Porges, 2007). In response to environmental stress, the PNS helps individuals respond quickly and with some flexibility by reducing inhibitory control of cardiac functioning (i.e., removing the vagal break; Porges, 2007). This reduction in the inhibitory control often is referred to as vagal withdrawal or vagal suppression (El-Sheikh & Whitson, 2006). Vagal suppression functions to allow the sympathetic nervous system to mobilize needed resources in order to quickly attend to the environmental challenge (Diamond & Otter-Henderson, 2007; Porges, 1995). Although there have been some inconsistent findings, accumulating evidence has suggested that higher vagal suppression is associated with greater adaptive functioning, as well as lower maladjustment in children and adolescents (Diamond et al., 2012; El-Sheikh & Whitson, 2006; Graziano & Derefinko, 2013; Morgan, Shaw, & Forbes, 2013).

Interaction between Parenting Stressors and Vagal Suppression

There has been much more research on the main effects of parenting stressors or vagal regulation on various markers of youth maladjustment than on the interaction between these two factors. However, the developing literature suggests that higher vagal suppression during a simulated stressor might buffer the deleterious effects of parenting stressors on young adolescents' depressive symptoms. An extensive set of biosocial studies conducted by El-Sheikh and her colleagues includes three studies that have examined the moderating role of vagal suppression in the association between interparental conflict and child/adolescent internalizing problems or depressive symptoms. In a sample of 8-12 year olds, El-Sheikh, Harger, and Whitson (2001) did not find a significant interaction between marital conflict and vagal suppression in the prediction of youth internalizing problems (although significant interaction effects were found for outcomes of boys' health and externalizing problems). In a subsample of 9 to11 year olds, Whitson and El-Sheikh (2003) found that higher vagal suppression played a protective role such that mother-reported physical marital conflict and youth internalizing problems were positively associated only among youth with lower vagal suppression during a simulated parental argument. In a sample of elementary-school aged children (mean age 9.7 years), El-Sheikh and Whitson (2006) replicated the finding that higher vagal suppression buffered the positive association between marital conflict and youth internalizing problems. They extended this research by reporting that the protective moderating role of higher vagal suppression continued to predict lower internalizing problems two years later, but only for daughters. Thus, there is accumulating evidence that the positive association between interparental conflict and youth internalizing problems might characterize only youth who also have the lowest levels of vagal suppression when exposed to familial stressors.

Although scant, there have been a few investigations of the moderating role of vagal suppression in studies of additional parenting stressors and youth internalizing problems or depressive symptoms. In a study of adolescents aged 13 to 17, McLaughlin, Alves, and

Sheridan (2014) found that abuse from parents during childhood (reported by youth retrospectively) was associated with higher youth internalizing problems, but only for youth with lower vagal suppression. There was no significant association between abuse and internalizing problems for youth with higher vagal suppression. Whitson and El-Sheikh (2003) examined parent-child conflict (psychological and physical) and found no significant interaction effects between parent-child conflict and vagal suppression in the prediction of youth internalizing problems.

In a sample of adolescents aged 11 to 16, Hastings, Klimes-Gougan, Kendziora, Brand, and Zahn-Waxler (2014) found that vagal regulation during a challenge task that involved watching sadness-inducing video clips interacted with mothers' supportive emotion socialization behaviors, but only for daughters. Higher depressive symptoms were reported by girls when mothers were less supportive emotionally and when girls had *lower* vagal suppression during sadness film clips. Hastings et al. found no interactions in the prediction of depressive symptoms when examining vagal suppression during fearful film clips. We were unable to find research that has examined interactions between vagal regulation and parental inconsistent discipline or psychological control. Thus, although scholars have suggested that vagal regulation might moderate some of the deleterious effects of familial stressors on adolescents' depressive symptoms, few studies have been conducted that have focused on specific parenting stressors.

Gender Differences in Associations between Vagal Suppression and Internalizing Behavior

It is noteworthy that several of these studies of interactions between parenting stressors and vagal regulation in relation to indicators of youth maladjustment have indicated that interaction effects differ for boys versus girls – although not always and not consistently. For example, El-Sheikh and Whitson's (2006) findings that higher vagal suppression served a protective function in terms of the relation between marital conflict and youth internalizing

problems two years later were evident only among girls. In contrast, Hastings et al. (2014) found that lower levels of maternal support were linked with more depressive symptoms when girls, but not boys, had *lower* vagal suppression when viewing film clips intended to induce sadness.

Additional work focused on understanding relations between indicators of PNS activity and symptoms of internalized distress has also indicated gender differences. Hinnant and El-Sheik (2011) examined gender, baseline respiratory sinus arrhythmia (RSA), and RSA during a social stressor task as predictors of membership in internalizing and externalizing behaviors profiles during early adolescence. For adolescent boys, lower vagal suppression predicted membership in both high internalizing and high externalizing profiles. For girls, higher vagal suppression predicted membership in these same profiles.

McLaughlin, Rith-Najarian, Dirks, and Sheridan (2015) examined both vagal tone (RSA) and a variety of contextual stressors (e.g., community violence, victimization, traumatic events) in relation to internalizing and externalizing symptoms in adolescence. For internalizing symptoms only, the researchers reported significant interactions between low vagal tone and a number of contextual stressors such that stressors were associated with more internalizing symptoms (anxiety and depression) among adolescents with lower vagal tone, but not higher vagal tone. Most interestingly, these effects were more prevalent among male adolescents than among female adolescents.

The Current Study

The current study examines the interaction between four parenting stressors and youth vagal regulation during a simulated challenge in the prediction of young adolescents' depressive symptoms. Based on a dual-risk, biosocial perspective and existing research, we hypothesized positive associations between specific parenting stressors and adolescent depressive symptoms for youth with lower vagal suppression. We hypothesized a protective function for higher vagal suppression, such that the association between a given parenting stressor and adolescent depressive symptoms would be nonsignificant in the presence of higher vagal

suppression. We also predicted that patterns would differ for boys versus girls, but we were unable to provide specific moderating hypotheses given current theory and empirical findings. This study was designed to make two important contributions to the existing literature. First, rather than focusing on main effects of either parenting stressors or youth vagal regulation, it examined the interaction between these two important biosocial factors. Second, two parenting stressors were included in this study that have not been examined in prior work on the interaction between familial stressors and young adolescents' vagal regulation – maternal inconsistent discipline and psychological control. Given both are important socialization features that might shape youths' self-regulation, the inclusion of these two parenting stressors constitutes an important contribution to the existing literature on environmental stressors and youth's physiological regulation.

Method

Participants

Participants in this study were 68 mother-young adolescent dyads who participated in the study when children were in the 6th grade. Youth were 56% female (*n* = 38) and 44% male (*n* = 30). Children identified themselves as European American (*n* = 37; 54%) and African American (*n* = 28; 41%), with one child each self-identifying as Hispanic, Native American, and Asian (not Hmong). Forty-three mothers (63%) indicated that they were married, 25 (37%) indicated that they were single. Participants represented a variety of social class backgrounds as indicated by mean scores on the Economic Pressure Scale (which yields scores ranging from 1 to 5; Conger & Elder, 1994) ranging from 1.38 to 5 with a mean of 3.49 (SD = .85).

Procedure

Mothers and youth participated in data collection sessions at a university-based research laboratory. Separately, each participated in an Institutional Review Board approved consent (assent for youth) interview and signed forms consenting (or assenting) to their own participation. Youth wore heart rate monitors and completed questionnaires for ten minutes

while they acclimated to the monitors and research lab. Youth then completed a baseline task during which they stood and read aloud for two minutes from a below grade-level script. Next, youth participated in a modified version of the Trier Social Stress Test for Children, TSST-C; (Buske-Kirschbaum, Jobst, Wustmans, Kirschbaum, Rauh, & Hellhammer, 1997), which involved preparing and presenting a five-minute speech (witnessed by two expressionless research assistants and the mother who was cautioned to maintain an expressionless face as well) about a "time that you were left out, excluded, or rejected by another kid (or kids)." Heart rate monitor output was marked to designate three distinct segments of the task: *speech preparation* (3 minutes), *speech* (5 minutes), and a *math task* during which they were asked to count backwards from 758 by sevens (4 minutes). Heart rate monitors were removed and both mothers and youth completed more questionnaires.

Measures

Potential control variables. Youth self-reported their gender (0 = female; 1 = male) and ethnicity (0 = European American; 1 = ethnic minority). As a proxy for socioeconomic status, mothers completed the Economic Pressure Scale (Conger & Elder, 1994). Mothers were asked to respond on a scale ranging from (1) *strongly disagree* to (5) *strongly agree* the extent to which they believed their families had enough money to afford seven types of expenses (e.g., "food we should have," "leisure and recreational activities we want to participate in"), as well as to rate agreement with the general statement "our income never seems to catch up with our expenses." Responses were averaged to yield a summary score for which lower scores indicated greater perceptions of economic pressure (α = .89). Youth completed the Pubertal Development Scale (PDS: Petersen, Crockett, Richards, & Boxer, 1988), which involved providing self-reports of five aspects of pubertal development (with some different questions for boys versus girls) with responses averaged across items to yield summary scores ranging from 1 (*has not started to develop*) to 5 (*development seems completed*). Youth responded to the question "Did you have any caffeine today?" with responses coded as 0 = no; 1 = yes. Youth

responded to the question “How would you rate your overall physical health?” with response options ranging from 1 (*very poor*) to 5 (*excellent*).

Parenting stressors. Youth completed the 5-item Interparental Hostility Scale (Buehler et al.,1998). This scale assessed the extent to which youth perceived parents as engaging in overtly hostile behaviors toward each other during disagreements. For each item, youth indicated on a four-point scale ranging from (1) *never* to (4) *very often* how frequently parents engaged in behaviors such as “yell at each other.” Items were averaged to yield summary scores for which higher scores indicated more interparental hostility (α = .86).

Youth completed the corporal punishment subscale of the Alabama Parenting Questionnaire (Shelton, Frick, & Wooten, 1996) which was scored as an index (count variable). This index consisted of three items assessing the extent to which mothers engaged in behaviors such as “your mother spanks you with her hand when you have done something wrong.” Scores on this index ranged from 0 to 3, indicating how many of the three corporal punishment behaviors were engaged in by mothers (0 being none and 3 being all three).

Mothers completed the six-item inconsistent discipline subscale of the Alabama Parenting Questionnaire (Shelton et al., 1996). This measure assessed the extent to which mothers engaged in inconsistent disciplinary practices such as “you let your child out of a punishment early.” Frequencies of inconsistent behaviors were rated on a scale ranging from (1) *never happens* to (5) *almost always happens*, and items were averaged to yield a summary score for which higher scores were indicative of more maternal use of inconsistent discipline (α = .74).

Youth completed eight items from the Psychological Control Scale (Barber, 1996). Youth indicated how similar each item was to their mother with responses on a three-point scale ranging from (1) *not like her* to (3) *a lot like her*. A sample item from this scale was “says if I loved her, I would do what she asks.” Items were averaged to yield a summary score for which higher scores were indicative of higher levels of psychological control (α = .83).

Youth depressive symptoms. Youth completed the ten-item Children's Depression Inventory (Kovacs, 1992), designed to assess cognitive, affective, and behavioral symptoms of depression in children and adolescents. Youth selected among three response options for each item, choosing the response that was most like them. For example, youth chose one item from (1) *Sad once in a while*, (2) *Sad many times*, (3) *Sad all the time*. Responses were averaged to yield a summary score with higher scores indicative of more symptoms of depression (α = .82).

Stress reactivity. Electrocardiogram (ECG) data were collected at a sampling rate of 1 kHz using the 3991x-GPP General Purpose Psychophysiological BioLog by UFI --DPS v1.1. A key fob was programmed to interface with the biolog and was used by research assistants to mark the division of task segments within the data stream. Disposable electrodes were attached to the biologs via a Fetrode Input Assembly. One fetrode/electrode was placed directly under the last rib on the left side and the other directly under the right collarbone. The reference electrode was placed directly under the last rib on the right side. ECG data were downloaded from monitors to a desktop computer, then parsed and cleaned to yield heart rate (HR) and interbeat interval (IBI; time between R-waves) data files for each task segment with IBI files being of interest for the current study. Data were visually examined and CardioEdit software (Brain Body Center, University of Illinois at Chicago; version 1.4) was used to identify segments that needed to be edited to correct artifacts (abnormally large or small IBIs reflected in extra or missing data points as a result of individual variation or external events) and to make such corrections.

RSA was estimated based on the high-frequency spectrum of heart rate variability using Porges' filtered variance method (1985) and CardioEdit (Brain Body Center, University of Illinois at Chicago). We applied a sequential algorithm to IBI data and RSA estimates were calculated by averaging 30 second sequential epochs with variance of HP data extracted using 500 msec sampling and a bandpass filter with a frequency band of spontaneous respiration of .121.0 Hz. Due to concerns that standing and speaking might have biased RSA estimates, we compared

RSA estimates for our baseline episode (standing and reading aloud) with RSA estimates for the period of time participants sat and completed questionnaires. The two sets of estimates were strongly correlated, $r(67) = .58$, $p < .001$, but a paired samples t-test comparing the mean RSA estimates in these two episodes was statistically significant, $t(65) = -9.33$, $p < .001$., These findings indicated that although these two estimates were related, mean RSA was lower when adolescents stood and read than when they were sitting in a relaxed state. Then, mean values of these epoch RSA means were calculated across each episode (baseline standing/reading, instructions, preparation, speech, math task) with these means becoming the data of interest for analyses. Stress reactivity was measured in terms of change scores – RSA within a given episode of stress or challenge minus baseline RSA (El-Sheikh et al., 2001). These change scores are referred to as delta RSA scores and are indicative of levels of vagal suppression such that higher change scores mean greater vagal suppression.

Analytic Strategy

To determine whether vagal suppression moderated associations between parenting stressors and youth depressive symptoms, we conducted a series of regression analyses (one for each of the three task episodes) that included control variables (Block 1), the parenting stressor of interest and delta RSA (Block 2), and the interaction of the parenting stressor and delta RSA (Block 3). Of primary interest was the interaction term in the third block. A significant interaction terms indicated a moderating effect of delta RSA and was probed using tests of simple slopes. In analyses using the full sample and focusing on focal predictor variables and control variables, we used a probability level of .05 as a cutoff for determining statistical significance. Whisman and McClelland (2005) have documented the increased level of power needed to detect interaction effects in non-experimental research and have recommend that research involving such interaction effects use higher probability levels so that potentially important patterns are not missed. Given our relatively small sample size, such an approach

was particularly appropriate. Accordingly, we used a probability value of .10 as a cutoff for determining the statistical significance of interaction effects and when probing the interactions.

Results

Preliminary Analyses

We performed preliminary regressions to determine whether we might eliminate some demographic controls from the analyses, as well as whether we needed to consider gender as a potential moderator. First, we predicted youth-reported depressive symptoms by entering as predictors potential control variables (gender, ethnicity, economic pressure, pubertal development, caffeine consumption, and self-rated physical health), baseline RSA, delta RSA and the parenting stressor of interest (interparental hostility, harsh discipline, inconsistent discipline, or psychological control). We repeated these analyses for RSA change as measured across each of the three episodes of the stress task (preparation, speech, math). Only gender was consistently associated ($p < .05$) with depressive symptoms across multiple parenting stressors and episodes. Therefore, we trimmed all potential control variables except for gender from subsequent analyses.

We then conducted a series of hierarchical regressions to determine whether gender might serve as a moderator within our models. For these analyses, we included gender, baseline RSA, delta RSA, and the parenting stressor of interest in the first block, interaction terms for gender x parenting stressor, gender x delta RSA, and parenting stressor x delta RSA in a second block, and gender x parenting stressor x delta RSA in a third block. Of interest was whether any interactions (two-way or three-way) involving gender were statistically significant (at a $p \leq .10$ level). The intent was to perform focal regression analyses separately for boys and girls if any statistically significant interaction terms indicated that gender served as a moderator of effects of parenting, delta RSA, or the combination of the two. Standardized regression coefficients and associated *p* values for all interaction terms in these analyses are presented in Table 1. One or more interaction terms involving gender was significant at for interparental

hostility, use of harsh discipline, and psychological control. Accordingly, we conducted analyses separately for boys versus girls for these parenting stressors. However, we did not split the sample by youth gender for analyses involving maternal inconsistent discipline.

Table 1

Regression Interaction Terms Testing Gender as a Potential Moderator Variable

	Stress Task Episodes					
	Preparation		Speech		Math Task	
Interaction Term	β	*p*	β	*p*	β	*p*
Interparental hostility						
gender x delta RSA	-.03	.86	.18	.21	.11	.45
gender x parenting	**.29**	**.09**	**.29**	**.07**	.26	.10
gender x parenting x delta RSA	-.06	.70	-.13	.42	-.09	.58
Harsh discipline						
gender x delta RSA	-.08	.66	-.11	.43	.07	.62
gender x parenting	-.04	.78	-.02	.86	.01	.93
gender x parenting x delta RSA	**-.42**	**.03**	-.13	.33	-.16	.29
Inconsistent discipline						
gender x delta RSA	-.05	.79	.08	.52	.09	.53
gender x parenting	.03	.88	-.04	.78	-.08	.63
gender x parenting x delta RSA	-.03	.90	-.02	.87	.00	.97
Psychological control						
gender x delta RSA	-.12	.52	.13	.35	.07	.64
gender x parenting	-.03	.82	-.01	.93	-.12	.43
gender x parenting x delta RSA	-.26	.12	**-.31**	**.04**	**-.33**	**.02**

Intercorrelations among Model Variables and Gender Differences

Descriptive statistics and bivariate correlation coefficients for all model variables are presented in Table 2 separately by gender. For both boys and girls, delta RSA scores across the three task episodes demonstrated strong positive correlations. Few other significant correlations were observed for boys or for girls. Exceptions included a strong positive correlation between psychological control and interparental hostility for boys, $r(28) = .76$, $p < .01$, and a significant negative correlation for girls between interparental hostility and delta RSA during preparation, $r(36) = -.38$, $p < .01$.

Table 2

Descriptive Statistics and Intercorrelations among Model Variables

Variable		1	2	3	4	5	6	7	8
1. Δ RSA Preparation		-	.38*	.44*	-.38*	.11	.09	-.24	.24
2. Δ RSA Speech		.56*	-	.87*	-.21	-.10	-.08	-.16	.18
3. Δ RSA Math		.66*	.75*	-	-.26	.04	-.06	-.29^{t}	.12
4. Interparental Hostility		.03	-.26	-.05	-	.02	.11	.20	-.24
5. Harsh Discipline		-.05	-.10	-.13	.21	-	.12	-.22	-.04
6. Inconsistent discipline		.28	-.18	.16	.03	.02	-	.09	-.11
7. Psychological Control		.00	-.11	.21	.76*	.28	.10	-	.09
8. Youth Depressive Symptoms		.26	.35^{t}	.23	.22	-.07	-.31†	.11	-
Mean:	Girls	.22	.34	.44	1.65	.37	2.03	1.34	1.34
	Boys	.68	.30	.25	1.52	.40	1.99	1.24	1.16
SD:	Girls	.77	1.1	1.15	.66	.49	.57	.38	.35
	Boys	.89	.61	.67	.63	.49	.64	.33	.23
N:	Girls	35	38	37	36	37	38	37	38
	Boys	25	27	27	30	30	30	30	30

Note: Correlations for girls are above the diagonal; Correlations for boys are below the diagonal
$^{\dagger}p \leq .10$. $^{*}p \leq .05$.

We conducted *t*-tests to determine if mean levels of all model variables differed for boys versus girls. Results indicated that girls reported higher levels of depressive symptoms than did boys, $t(64.60) = 2.50$, $p = .02$, Cohen's $d = .60$. Also, boys experienced lower vagal suppression than did girls during the preparation episode of the stress task, $t(58) = -2.10$, $p = .04$, Cohen's $d = .54$.

Associations among Parenting Stressors, Vagal Suppression, and Youth Depressive Symptoms

Maternal inconsistent discipline. In regression analyses focused on maternal use of inconsistent discipline, we predicted youth depressive symptoms from baseline RSA and gender (Block 1), maternal inconsistent discipline and delta RSA (Block 2), and the interaction between inconsistent discipline and delta RSA (Block 3). Regressions were repeated three times, once each for delta RSA measured for each of the three stress task episodes (preparation, speech, math). Results of these analyses are presented in Table 3.

Table 3

Regression Analyses Predicting Youth Depressive Symptoms from Maternal Inconsistent Discipline, delta RSA, and Interaction Terms

		Stress Task Episodes								
		Preparation			Speech Task			Math Task		
Step	Predictor	β	*p*	ΔR^2	β	*p*	ΔR^2	β	*p*	ΔR^2
1	Baseline RSA	-.01	.92		-.03	.78		-.03	.78	
	Gender	-.27*	.03	.07	.29*	.02	.08†	-.29*	.02	.08†
2	Delta RSA	.28*	.03		.21	.11		.16	.25	
	Maternal Inconsistent discipline	-.21†	.09	.10*	-.14	.23	.06	-.17	.15	.05
3	Delta RSA x Inconsistent discipline	-.13	.30	.01	-.17	.15	.02	-.21	.10	.03

†$p \leq .10$. *$p \leq .05$.

The main effect of maternal inconsistent discipline did not reach statistical significance. Although it was not the primary focus of the study, there was a main effect of vagal suppression in the preparation episode such that higher levels of vagal suppression were associated with

more depressive symptoms, b = .11, β = .28, t(59) = 2.19, p = .03. There were no statistically significant interaction effects between delta RSA and inconsistent discipline,

Interparental hostility. For interparental hostility (as well as use of harsh discipline and psychological control), we conducted regression analyses separately for boys and girls. In these analyses, we predicted youth depressive symptoms from baseline RSA (Block 1), the parenting stressor of interest and delta RSA (Block 2), and the interaction between the parenting stressor of interest and delta RSA (Block 3). All regressions were conducted three times, once each for delta RSA measured during each of the three stress task episodes. Results of these analyses are presented in Tables 4 and 5, separately for boys and girls.

Table 4

Regression Analyses Predicting Girls' Depressive Symptoms from Parenting Stressors, delta RSA, and Interaction Terms

		Stress Task Episodes								
		Preparation			Speech Task			Math Task		
Step	Predictor	β	*p*	ΔR^2	β	*p*	ΔR^2	β	*p*	ΔR^2
1	Baseline RSA	.10	.54	.01	.05	.74	.00	.05	.73	.00
2	Delta RSA	.17	.35		.23	.23		.14	.46	
	Interparental Hostility	-.19	.32	.09	-.23	.18	.10	-.23	.20	.08
3	Delta RSA x Interparental Hostility	-.22	.36	.02	-.06	.71	.00	-.14	.48	.01
1	Baseline RSA	.08	.65	.00	.03	.83	.00	.03	.83	.00
2	Delta RSA	.26	.14		.27	.17		.22	.28	
	Harsh Discipline	-.06	.70	.07	-.03	.85	.05	-.06	.71	.03
3	Delta RSA x Harsh Discipline	.28	.13	.07	.19	.26	.03	.18	.29	.03
1	Baseline RSA	.08	.63	.00	.03	.83	.00	.03	.83	.00
2	Delta RSA	.30	.10		.28	.15		.23	.24	

	Psychological Control	.18	.31	.09	.12	.46	.06	.15	.41	.05
3	Delta RSA x Psych. Control	.10	.64	.00	.28	.11	.06	.32†	.08	.08†

†$p \leq .10$. *$p \leq .05$.

Table 5

Regression Analyses Predicting Boys' Depressive Symptoms from Parenting Stressors, delta RSA, and Interaction Terms

		Stress Task Episodes								
		Preparation			Speech Task			Math Task		
Step	Predictor	β	*p*	ΔR^2	β	*p*	ΔR^2	β	*p*	ΔR^2
1	Baseline RSA	-.16	.43	.02	-.16	.40	.02	-.16	.40	.02
2	Delta RSA	.23	.30		.47†	.05		.24	.36	
	Interparental Hostility	.14	.50	.06	.26	.19	.15	.15	.46	.05
3	Delta RSA x Interparental Hostility	-.37†	.07	.13†	-.33	.14	.07	-.35	.10	.10†
1	Baseline RSA	-.16	.43	.02	-.16	.40	.02	-.16	.40	.02
2	Delta RSA	.08	.70		.34	.14		.19	.47	
	Harsh Discipline	.22	.32	.08	-.10	.58	.10	-.12	.56	.04
3	Delta RSA x Harsh Discipline	-.37	.10	.11	-.09	.67	.00	-.13	.60	.01
1	Baseline RSA	-.16	.43	.02	-.16	.40	.02	-.16	.40	.02
2	Delta RSA	.23	.31		.40	.11		.22	.40	
	Psychological Control	.01	.96	.04	.09	.67	.10	-.03	.86	.03
3	Delta RSA x Psych. Control	-.40†	.05	.15†	-.47*	.04	.15*	-.45*	.03	.17*

†$p \leq .10$. *$p \leq .05$.

For girls, there were no significant main effects of either delta RSA or interparental hostility. Nor was the interaction between delta RSA and interparental hostility statistically significant

For boys, there were no significant main effects of either delta RSA or interparental hostility. The interactions of delta RSA and interparental hostility were significant in both the preparation and the math tasks ($t(24) = -1.86$, $p = .07$; $t(26) = -1.71$, $p = .10$. Both of these interactions effects were in the same direction, so for the sake of brevity we probed only the larger of the two (preparation episode). This interaction was probed using tests of simple slopes as recommended by Aiken and West (1991). Figure 1 shows the simple slopes graphed one standard deviation above and below the mean of delta RSA. As hypothesized, boys with lower vagal suppression, greater interparental hostility was associated with higher levels of depressive symptoms, $b = .19$, $\beta = .43$, $t(24) = 1.72$, $p = .10$. For boys with higher vagal suppression, interparental hostility was not associated with levels of depressive symptoms, $b = -.15$, $\beta = -.35$, $t(24) = -1.06$, $p = .30$.

Harsh discipline. For girls, there were no significant main effects of either delta RSA or harsh discipline. Nor were there any significant interactions between delta RSA and harsh discipline.

For boys, there were no significant main effects of either delta RSA or harsh discipline. The interaction between delta RSA and harsh discipline was significant in the preparation episode, $t(24) = -1.70$, $p = .10$. Figure 1 shows simple slopes graphed one standard deviation above and below the mean of delta RSA. Tests of simple slopes suggested that for boys with lower vagal suppression, maternal use of harsh discipline was not related to levels of depressive symptoms, $b = .09$, $\beta = .18$, $t(24) = .64$, $p = .52$. For boys with higher vagal

suppression, maternal use of harsh discipline was associated with lower levels of depressive symptoms, b = -.29, β = -.57, $t(24)$ = 1.72-1.88, p = .07.

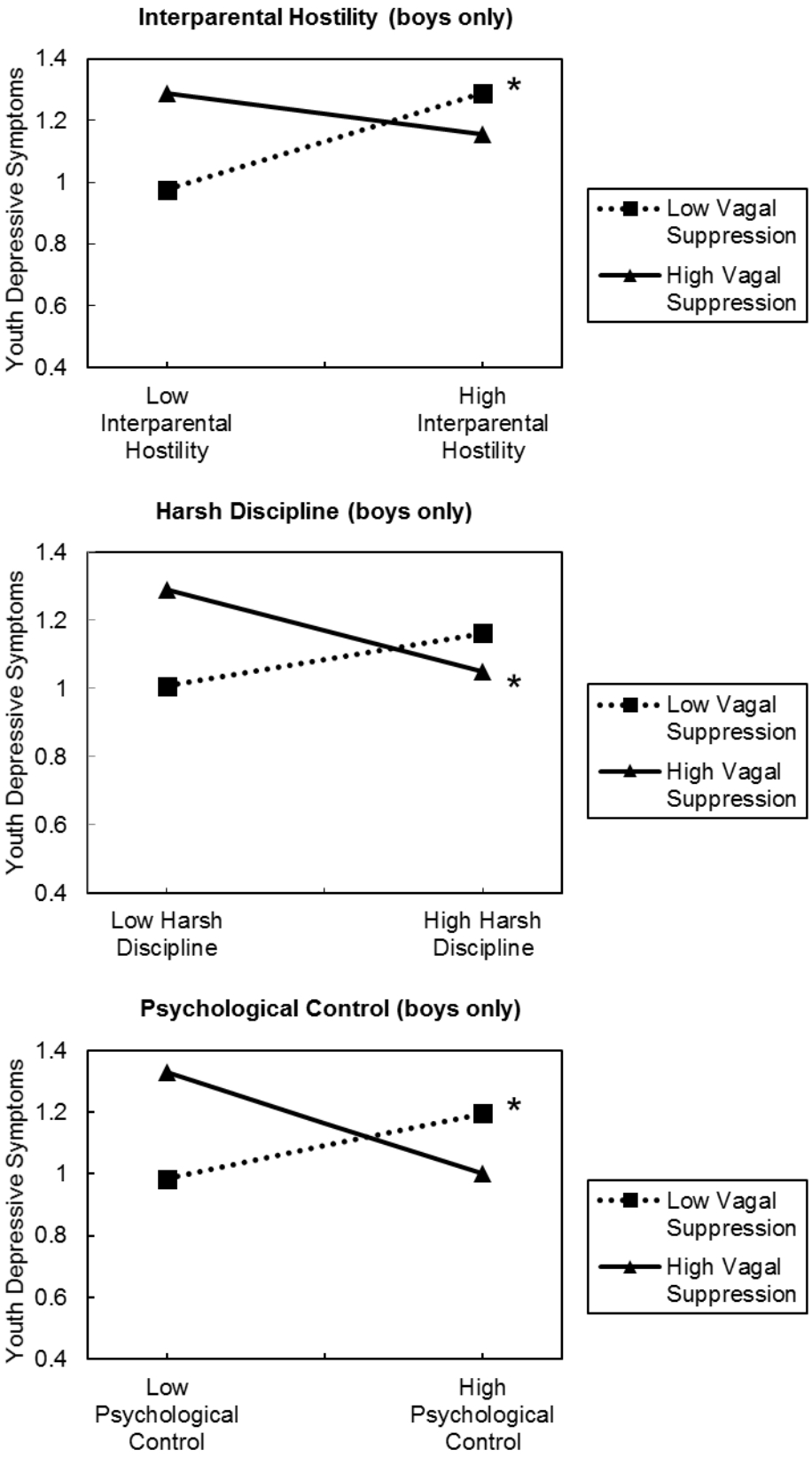

Figure 1. Associations between parenting stressors and boys' depressive symptoms.
*slope significantly different from 0; $p \leq .10$

Psychological control. For girls, there were no significant main effects of either delta RSA or psychological control. The interaction between delta RSA and psychological control was significant in the math episode, $t(35) = 1.77$, $p = .08$. Figure 2 shows simple slopes graphed one standard deviation above and below the mean of delta RSA. For girls with lower vagal suppression, maternal psychological control was unassociated with depressive symptoms, $b = .09$, $\beta = .10$, $t(35) = .58$, $p = .56$. Contrary to our hypotheses, for girls with higher vagal suppression, higher levels of psychological control was associated with higher levels of daughters' depressive symptoms, $b = .44$, $\beta = .48$, $t(35) = 1.89$, $p = .06$.

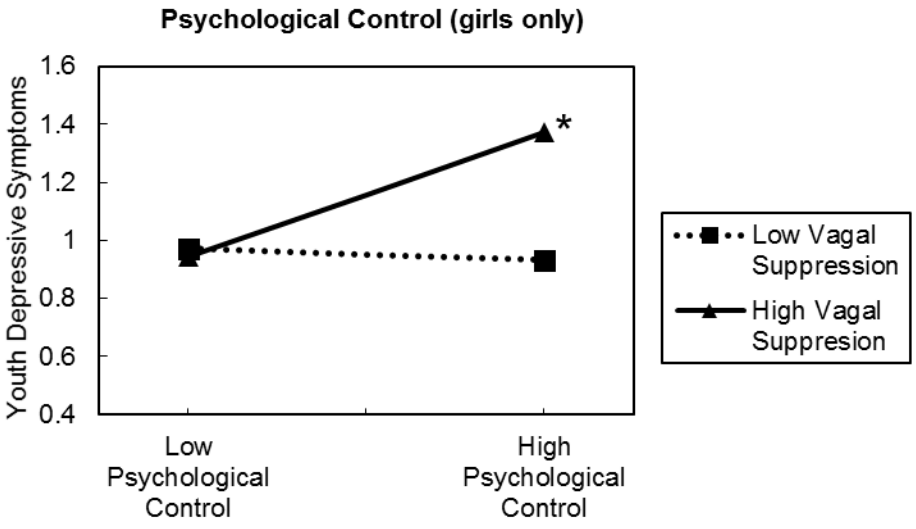

Figure 2. Associations between parenting stressors and girls' depressive symptoms.
*slope significantly different from 0; $p \leq .10$

For boys as well, there were no significant main effects of either delta RSA or harsh discipline. The interaction between delta RSA and psychological control was significant in all

three episodes, $t(35) = 1.77$, $p = .08$; $t(35) = 1.77$, $p = .08$; $t(35) = 1.77$, $p = .08$ for preparation, speech, and math, respectively. We probed the largest interaction (speech). Figure 1 shows simple slopes graphed one standard deviation above and below the mean of delta RSA. As hypothesized, for boys with lower vagal suppression, greater maternal psychological control was associated with higher levels of depressive symptoms, $b = .35$, $\beta = .43$, $t(26) = 1.69$, $p = .10$. For boys with higher vagal suppression, psychological control was not significantly associated with levels of depressive symptoms, $b = -.44$, $\beta = -.54$, $t(26) = -1.46$, $p = .15$.

Discussion

The purpose of this study was to examine whether an indicator of PNS activity in response to challenge (vagal suppression) might moderate associations between a select set of parenting stressors and depressive symptoms among young adolescents. Findings indicated that this was the case for three of the four parenting stressors of interest. Although preliminary and based on a small sample size, our findings suggested that for boys with lower levels of vagal suppression, higher levels of interparental hostility were associated with more depressive symptoms. For boys with lower vagal suppression, more maternal use of psychological control was linked with more depressive symptoms. Interestingly, for boys with higher levels of vagal suppression, higher levels of harsh discipline were associated with lower levels of depressive symptoms. This last finding is complementary to what we had hypothesized – that low levels of vagal suppression would result in significant positive associations between parental use of harsh discipline and depressive symptoms. This pattern of moderated associations was consistent in direction across stress task episodes and parenting stressors, indicating that lower vagal suppression constituted a risk factor that made young male adolescents more susceptible to the potentially negative effects of poor parenting or, alternatively, higher vagal suppression was adaptive in terms of protecting youth from the potentially harmful effects of stressful parenting contexts. For adolescent girls, vagal suppression generally did not interact with

parenting stressors in the prediction of depressive symptoms. In the one case in which such an interactive effect was observed, it was the combination of high vagal suppression and high maternal psychological control that predicted more depressive symptoms.

For boys, our findings are consistent with a dual-risk model (Brotmanet al., 2003) perspective on the etiology of depressive symptoms in early adolescence. Specifically, environmental (parenting) stressors are more likely to be associated with depressive symptomatology among youth who have debilitating physiological responses to stress. The results of our study help to explain documented variability across adolescents in the extent to which exposure to suboptimal parenting is associated with increased levels of depressive symptoms or depression diagnoses (Yap et al., 2014). Considerable research (Barber et al., 2005; Cummings et al., 2014; Yap et al, 2014) has indicated that the parenting variables of focus in our study (maternal inconsistent discipline, interparental hostility, maternal psychological control, and maternal use of harsh discipline) are concurrently associated with, and in many cases longitudinally predictive of, higher levels of depressive symptoms. Yet such effects have been small-to-medium in size (Buehler et al., 1997; Yap et al., 2014). Our results suggest that this variability is due in part to individual differences in physiological reactivity to these parenting stressors.

Our findings indicate that the risk created by problematic parenting is particularly great among a clearly defined subset of young adolescents – boys who are characterized by lower levels of vagal suppression in the context of a stressful laboratory task. Low vagal suppression is defined in terms of the inability of the PNS to react quickly to perceived stressful conditions, potentially limiting the ability of individuals to summon physiological resources to help them negotiate a challenging situation (Diamond & Otter-Henderson, 2007; Porges, 2007). Our findings add to a growing literature (Diamond et al., 2012; El-Sheikh & Whitson, 2006; Graziano & Derefinko, 2013; Morgan et al., 2013) indicating that youth with low vagal suppression are at risk for a variety of indicators of psychological and behavior maladjustment. Furthermore, our

findings extend existing knowledge by demonstrating that vagal suppression moderates associations between depressive symptoms in early adolescence and a set of parenting stressors that have heretofore not been studied with respect to the moderating role of vagal suppression.

Interestingly, our findings indicate that low vagal suppression constitutes more of a risk factor for young adolescent boys than for young adolescent girls. Low vagal suppression constituted a risk in terms of associations between interparental hostility, use of harsh discipline, and psychological control, and depressive symptomsamong boys. Our consideration of gender as a potential moderator variable was exploratory in nature. We did not offer specific hypotheses with respect to how such moderation might be expressed, as existing theory and research have not been clear in suggesting how the role of vagal suppression in relation to associations between parenting stressors and indicators of child maladjustment might vary for boys versus girls. However, our findings in this study that boys were more vulnerable than were girls is consistent with an extensive literature indicating that boys experience risk disproportional to girls in terms of indicators of well-being that include school failure (Wach et al.,2015) as well as aggression and antisocial behavior (Loeber et al., 2013). Boys are also at risk in terms of depressive symptoms during late childhood and early adolescence, as gender differences in this area do not begin emerging until early adolescence (Hankin et al., 2015). There is also evidence indicating that boys might be more vulnerable than are girls to parenting stressors such as marital conflict (O'Leary & Vidair, 2005). Given the greater vulnerability of boys overall, in conjunction with their greater risk in the context of parenting stressors, it was not surprising that our findings indicated them to be at particular risk when they experienced the combination of low vagal suppression and stressful parenting environments.

Finally, it is important to emphasize that our findings did not indicate consistent main effects of either vagal suppression or parenting stressors in relation to levels of depressive symptoms in early adolescence. Although this lack of main effects might not seem intuitively

obvious, it makes sense in the context of the manner in which we defined our key research questions. It was our premise that it would be the interactive effects of low vagal suppression and high exposure to parenting stressors that would place young adolescents at risk in terms of depressive symptoms. In fact, it was the somewhat small effect sizes and variable nature of associations between parenting stressors and maladjustment in early adolescence that constituted the inspiration for this study. The same can be said for the role of low vagal suppression. It is not surprising (especially in the context of our small sample size – see below) that we were unable to detect consistent main effect associations between vagal suppression or parenting stressors, and levels of depressive symptoms. Rather, it appears that it is the *combination* of both experiencing physiological risk (defined in terms of low vagal suppression) and suboptimal parenting that is associated with higher levels of depressive symptoms.

Despite the compelling nature of our findings, our research design is not without limitations. Foremost among these are the small sample size, characteristics of the sample, and reliance on an artificial (laboratory-based) stress inducer. Given the labor-intensive nature of physiological data collection, it is not unusual for researchers studying biomarkers such as vagal suppression to utilize relatively small samples (El-Sheikh et al., 2001). Yet there is no question that a sample size of 68 limited the statistical power needed to detect main effects of parenting and vagal suppression, and particularly interactive effects of the two. Despite our limited sample size, however, we were still able to detect significant two-way and three-way interactions in the prediction of depressive symptoms in early adolescence. That we obtained the pattern of significant results that we did speaks to the magnitude of the effect sizes and suggests that the moderating role of vagal suppression might be quite powerful in relation to associations between parenting stressors and depressive symptoms during early adolescence. However, we suspect that these findings would have been even more compelling had a larger sample afforded increased statistical power. This increased power would potentially have allowed us

detect significant effects of vagal suppression as a moderator for girls as well as boys and to present a clearer pattern of findings in terms of patterns of significance in tests of simple slopes.

The current investigation relied on a sample of young adolescents who represented predominantly two ethnic groups: African American and European American. It is possible that findings reported here might have differed had we focused efforts on either younger children or older adolescents, or on children from a more diverse set of ethnic backgrounds. Our decision to focus on early adolescence was deliberate. As a critical period for social, psychological, and biological change, early adolescence represents a time of particular vulnerability (Dahl, 2004; Steinberg et al., 2006). By focusing on reactivity to stress during early adolescence, we increased our ability to detect effects of such reactivity, either alone or in conjunction with parenting stressors (Dahl & Gunnar, 2009; Lopez-Duran et al.,2009). We did not make a deliberate decision to focus on young adolescents from any particular ethnic group. Rather, African American and European American youth represented the predominant ethnic backgrounds at the schools from which we recruited participants – and in fact are the two most prevalent ethnic groups in the county within which these schools were located. Still, further research on this topic should include attention to whether the patterns we have described here hold across samples diverse with respect to both child age and ethnicity.

The laboratory-based stressor task to which we exposed youth was by definition artificial. It is certainly an unusual experience for young adolescents to visit a research laboratory, be connected to heart rate monitors, and be asked to present a speech in front of two strangers. Yet despite the artificial nature of this stressor task, we believe it was successful in inducing a moderate level of stress in youth. Public speaking is widely recognized as a stressful experience for individuals of all ages. Engaging in this activity in a strange environment might actually be more stress-inducing than engaging in a similar task in a more familiar setting (such as school). Also, given the nature of the biologs and accompanying electrodes used to collect heartrate data, it would have been virtually impossible to collect such data from youth as

they experienced stress within less controlled settings. For all of these reasons, use of the Trier Stress Task (Buske-Kirschbaum et al., 1997) is widely accepted as appropriate for inducing moderate levels of stress for the purposes of examining individuals' physiological reactivity to such experiences. We also note that the use of the Trier Stress Task presented challenges with respect to the definition of an appropriate baseline task. We elected to use a baseline that involved youth standing and speaking to minimize the validity threat that might have been invoked by shifting from sitting to standing on respiratory and cardiac functioning. However, we note that RSA scores during this baseline differed from those obtained while adolescents were seated and relaxing. Use of a standing/speaking baseline task potentially introduced a confound into the study and raises questions as to what constitutes an appropriate baseline activity for stressor tasks that are more physically active.

Despite these limitations, the results of this study have yielded important knowledge concerning ways in which exposure to the type of parenting young adolescents receive has implications for the likelihood that they will experience symptoms of depression. Our analyses suggest that a particular subset of adolescents – boys with limited ability to respond in a physiologically beneficial manner to stressful experiences – are at greatest risk when exposed to parenting stressors that include interparental hostility, use of harsh discipline, and psychological control. It is such youth for whom parenting interventions are likely to be of the greatest benefit. We suggest that vagal suppression can potentially be identified as a risk factor that interacts with parenting stressors to impact psychological adjustment in early adolescence. Targeting youth who are at physiological risk with respect to their ability to respond to stress might be the next frontier in the application of parenting interventions.

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Parenting Stressors and Young Adolescents' Depressive Symptoms: Does High Vagal Suppression Offer Protection?

Highlights

- Vagal suppression and parenting stressors jointly affect youth depressive symptoms.
- Evident for harsh discipline, coparents' hostility, psychological control.
- Effects are more consistently observed for boys than for girls.