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The Role of Stress Response in the Association between Autonomy and Adjustment in Adolescents

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Abstract

Developing autonomy is an important developmental task that has implications for adolescent adjustment and may be impacted by adolescents' response to stress. This study examined whether stress reactivity (i.e., cortisol and heart rate reactivity) to a parent-adolescent conflict interaction moderates the effect of autonomy on adjustment assessed one year later in 100 adolescents (*M* age = 15.09; 68% girls). Multiple group models suggested that youth who evidenced higher stress reactivity when compared to those with lower stress reactivity were more likely to report decreased externalizing problems and internalizing problems when their parents granted more autonomy. In contrast, youth who evidenced higher stress reactivity who experienced undermining of autonomy were more likely to report increased externalizing and internalizing problems than youth who evidenced lower stress reactivity. Results support biological sensitivity to context theory and highlight the importance of considering individual differences in the effect of developmental milestones on adolescents' adjustment.

Keywords

Adolescence; Autonomy; Cortisol Reactivity; Heart Rate Reactivity; Internalizing and Externalizing Problems

Problems negotiating important developmental tasks during adolescence, such as autonomy development, may alter youth's developmental trajectories throughout the life course (Roisman, Masten, Coatsworth, & Tellegen, 2004; Schulenberg, Sameroff, & Cicchetti, 2004). This may be because failure to attain competency in developing autonomy may increase vulnerability for functioning in other important developmental domains, such as maintaining emotional and behavioral competence (e.g., avoiding risk behavior, maintaining positive mental health; Masten & Coatsworth, 1998). Parents are critical in the healthy development of adolescents' autonomy by creating a context where realignment in decision making shifts from parents to youth. Some parents and adolescents find this realignment process difficult, particularly when parents are not supportive or do not fully grant

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adolescents autonomy (Allen, Hauser, Eickholt, Bell, & O'Connor, 1994). Despite the relevance of this developmental task to adolescent outcomes, only a handful of studies have examined whether parental behaviors that promote or restrict autonomy development are associated with increases in emotional and behavioral problems during the adolescent period.

Youth whose parents restrict autonomy and who also are prone to responding to new developmental tasks as stressful may be more vulnerable to the effect that parenting behaviors that restrict autonomy have on developmental outcomes. This basic premise of stress reactivity impacting the effect of the environment on individuals' developmental outcomes is consistent with Boyce's and Ellis' (2005) theory of biological sensitivity to context. This theory proposes that individual differences in stress reactivity increase reactive individuals' susceptibility to both adverse and positive environments, which in turn increases vulnerability for developing negative outcomes under stressful conditions (such as when youth experience problems negotiating new developmental tasks) and positive outcomes under supportive conditions (such as supportive family environments who grant youth autonomy). Recent studies have started to examine this basic premise that stress reactivity may moderate the association between the family environment and adolescent outcomes (Hinnant, Erath, & El-Sheikh, 2015; Steeger, Cook, & Connell, 2017) however to date these studies have not focused specifically on parenting behaviors that promote or restrict autonomy. Identifying the conditions under which developmentally-specific factors, such as autonomy, associate with maladaptive behavior is paramount for informing more developmentally focused prevention programs to reduce problematic outcomes among adolescents (Fraser, Richman, Galinsky, & Day, 2009).

The Relationship between Autonomy and Adolescents' Adjustment

Failures in important developmental task domains have been theorized to have consequences for developmental outcomes concurrently and throughout the life span (Masten et al., 2005). During adolescence, developmental outcomes that are of concern are internalizing problems (Kessler, Avenevoli, Merikangas, 2001) and externalizing problems (Hinshaw & Lee, 2003). One of the chief developmental tasks during adolescence (Allen et al., 1994) that may impact youths' externalizing and internalizing problems is the process of developing autonomy while maintaining emotional connectedness within the parent-adolescent relationship (i.e., autonomy and relatedness; Allen et al., 1994; Steinberg, 1990). Many definitions have been put forth to describe autonomy development, with the recognition that this construct is multifaceted and includes emotional, behavioral, and cognitive components that allow adolescents to feel competent in making decisions and regulating their own actions (Steinberg, 2017). In the current study, we are primarily concerned with examining parenting behaviors that support the development of individuation such that parents encourage adolescents to make decisions on their own, as well as provide input into family decision making. This is consistent with some aspects of emotional autonomy development, which involve the renegotiation of roles so that the parent-adolescent relationship becomes more egalitarian. Difficulties in negotiating autonomy can have negative consequences for adolescents' adjustment, a premise consistent with both a developmental cascade framework and a dynamic systems approach, which postulate that failure in key developmental tasks,

such as autonomy development, may lead to consequences in other developmental domains (Masten & Cicchetti, 2010).

Despite the theoretical attention that autonomy has garnered, few recent studies have examined the direct effect of autonomy on adolescents' internalizing and externalizing problems. In an older study, using multiple measures of autonomy and relatedness, Allen et al. (1994) found that inhibiting of adolescents' autonomy was associated with increased internalizing behaviors, whereas parental rejection, which inhibited relatedness, was associated with higher externalizing behaviors. In a recent meta-analysis that included several studies relying mostly on self-report, autonomy granting was found to have a small association with externalizing behaviors (Pinquart, 2017). Additionally, longitudinal research utilizing observational measures during middle adolescence has indicated that adolescents whose mothers granted them less autonomy during an observed interaction were more likely to increase their degree of hostility toward others during young adulthood (Allen, Hauser, O'Connor & Bell, 2002), suggesting long-term consequences of restricting autonomy on externalizing type behaviors.

Researchers also have examined the effect of psychological control, a related but distinct construct from autonomy granting, on adolescent outcomes. Psychological control involves parents trying to control their adolescents' thoughts and behaviors through intrusive and manipulative methods, which may serve to undermine the individuation process in that it interferes with both autonomy and relatedness (Kunz & Grych, 2013). Research has suggested that higher levels of psychological control have unique associations with increased internalizing problems and externalizing problems longitudinally (Kunz & Grych, 2013; Lansford, Laird, Pettit, Bates, & Dodge, 2014; Pinquart, 2017; Soenens, Park, Vansteenkiste, & Mouratidis, 2012). Taken together, research would suggest that parents' restriction of adolescents' autonomy and relatedness and increased psychological control will be associated with increased internalizing and externalizing problems during adolescence.

The Moderating Role of Adolescents' Stress Response

The direct association between autonomy and adolescent adjustment may be affected by individual difference factors, such as adolescents' processing of stress (Samuolis, Hogue, Dauber, Liddle, 2006). Boyce and Ellis (2005) proposed, and previous research has supported (Boyce & Ellis, 2005; Del Giudice, Hinnant, Ellis, & El-Sheikh, 2012), that individual differences in reactivity, developed as a result of the interaction between genetic and early environmental experiences, increase reactive individuals' susceptibility to both adverse and positive environments (biological sensitivity to context), which in turn increases vulnerability for developing negative outcomes under stressful conditions and positive outcomes under supportive conditions. In the context of the current study, an adverse environment would be one in which parents restrict autonomy and emotional support is low, and a positive environment would be one in which autonomy and relatedness are not restricted and are promoted within the parent-adolescent relationship.

The interactive effect of adolescents' stress response and problems with autonomy granting on functioning during adolescence has not been examined. However, several studies during infancy and childhood suggest that behaviorally or biologically reactive children, as compared to less reactive children, indicate poorer outcomes under conditions of contextual adversity (e.g., low parental warmth) and better outcomes in supportive environments (e.g., high parental support; Boyce et al., 2006; Del Giudice et al., 2012; Ellis, Shirtcliff, Boyce, Dearthorff, & Essex, 2011; El-Sheik & Whitson, 2006; Obradovic, Bush, Stamperdahl, Adler, & Boyce, 2010).

Research during adolescence focusing on the family context has been more scant. A handful of studies have demonstrated that adolescents who are physiologically reactive and experience family adversity (e.g., child maltreatment, marital conflict) are more prone to externalizing and internalizing behaviors and, in contrast, adolescents who are reactive and experience positive family contexts are more prone to positive adjustment or a lack of maladaptive behaviors, thus supporting the premise of biological sensitivity to context theory. (Cook, Chaplin, Sinha, Tebes, & Mayes, 2012; Koss et al., 2014; Steeger et al., 2017). These studies are limited, however, in that none conducted during adolescence explicitly examined parenting. A few recent studies have examined cardiovascular response as a vulnerability factor that influences the impact of parenting on adolescents' adjustment. Hinnant, Erath, and El-Sheikh (2015) examined the interactive effect of RSA suppression, an indicator of stress arousal, and harsh parenting on changes in delinquency and substance use, and found support for their hypothesis that the highest rates of delinquency and other drug use were found among youth who evidenced hyperarousal to stress and also experienced higher rates of harsh parenting. Fletcher, Buehler, Buchanan and Weymouth (2017) also examined the interactive effect of RSA suppression and different indices of negative parenting, with results suggesting that RSA suppression increased the negative effect of psychological control on depressive symptoms for boys only. Hinnant et al.'s and Fletcher et al.'s research, although relevant, did not examine the role that cortisol, an important indicator of stress reactivity, might exert on this relationship.

Hypotheses

Drawing on the existing literature and theoretical premises outlined by developmental cascade theory and biological sensitivity to context theory, we tested a model that examined the effect of parental behavior that promotes or restricts autonomy and relatedness on adolescents' internalizing and externalizing problems, and if this relationship differed as a function of adolescents' stress reactivity. Specifically, we tested two hypotheses. First, we hypothesized that observed maternal restriction of autonomy, less observed maternal promotion of autonomy and relatedness, and self-report of lower maternal autonomy granting and higher psychological control will be associated with increased adolescent externalizing and internalizing problems. Additionally, we examined adolescents' stress response as a moderator of the relationship between factors associated with autonomy development and adolescents' outcomes. Specifically, we hypothesized that a heightened stress response will be a vulnerability that increases adjustment problems for adolescents with autonomy problems such that adolescents who have a heightened stress response and who experience parenting behaviors that restrict autonomy will report the highest

externalizing and internalizing problems. In contrast, adolescents who have a heightened stress response and whose mothers grant autonomy and give support will report the least externalizing and internalizing problems. Results from this study could be used to target adolescents who may be most vulnerable to increases in maladjustment when their mothers do not encourage healthy emotional autonomy development.

Methods

Participants

At the beginning of the study, participants were 100 adolescents and their mothers (91% biological mother) living in or within close proximity to an urban area in the Northeastern part of the United States. Mothers and adolescents were recruited through several methods including community postings, a commercial mailing list (American Student List), community outreach, and school partnerships. Eligible families met the criteria of (a) living at home with a female parent/caregiver, (b) adolescent in grades 9th-11th, and (c) English as the primary language. Adolescents were excluded from participation if their mother indicated that they had an intellectual disability. At the beginning of the study (Wave 1, W1), adolescents were in grades 9th-11th ($M = 15.09$ years, $SD = .98$) and primarily self-identified as European American (78%). The adolescents were predominately female (68%). Seventy-four percent of the mothers reported being married, with 64% reporting that this was their first marriage. The median household income for the family was reported as falling between \$80,000-\$89,999 which is similar to married-couple families within the state (\$88,243; U.S. Census, Table S1901). Mothers also reported that their median level of education was a college degree (41%), considerably higher than state norms (27.1%; U.S. Census, Table S1501).

Adolescents were invited to participate in a follow-up survey one year from their previous data collection to assess changes in adolescents' adjustment. Sixty eight percent of adolescents ($N=68$) participated in this follow-up survey and attrition analyses indicated that participants who completed the follow-up survey were similar to participants who did not complete the survey at Wave 2 (W2) on all study variables with the exception that those adolescents who stayed in the study reported that their mothers had a higher level of education than those who left the study suggesting minimal attrition bias.

Procedures

Data at W1 of the study was collected through home visits. The home visit was approximately 2 and a half hours long and generally started at 3:30 ($M = 3:27$, $SD = .30$) to minimize the amount of cortisol variation due to time of day. For adolescents, the first part of the visit involved a relaxation period, which lasted 30 minutes. To relax, adolescents either watched a G-rated cartoon (21%) or a nature DVD (79%); choice of video was unrelated to measures of stress response. The purpose of this relaxation period was to obtain baseline levels of stress (heart rate and cortisol) following the relaxation video so that any changes in stress response could be attributed to the parent-adolescent interaction that was used as a stressor in this study.

Following the relaxation period, adolescents engaged in two 8-minute counter-balanced interactions that involved mothers and adolescents discussing an issue of conflict (a) within the home and (b) outside of the home. These interactions were used as a means to induce a possible stress response in adolescents that would mirror what might occur in conflict with parents in their day to day lives (Allen, Chango, Szwed, Schad, & Marston, 2012; Chaplin et al., 2012). Interactions also provided a means in which to observe autonomy granting and relatedness in the parent-adolescent relationship. The issue of conflict within the home was identified through a Family Issues Checklist (Robin & Foster, 1989) that asked mothers and adolescents about topics of conflict that occurred within the last month (e.g., fighting with siblings, cleaning up room). Mothers and adolescents separately marked the topics and then rated their feelings while discussing that topic on a scale from 1 (*calm*) to 5 (*angry*). The overall highest rated conflict for mothers and adolescents was chosen. For purposes of the current study, only the parent-adolescent conflict task was coded for autonomy and relatedness. To obtain peak measures of stress response, heart rate was taken every 30 seconds during the parent-adolescent conflict interaction and cortisol was taken 15 minutes following both the tasks. Adolescents also completed a survey at both wave 1 and wave 2 of data collection (details below). These surveys were generally identical but the wave 2 survey was shorter in length. Mothers and adolescents were compensated \$40 each for wave 1 and adolescents were compensated \$15 for the wave 2 survey. All participants gave consent and assent to participate and all procedures were approved by the IRB.

Measures

Autonomy and relatedness—In the current study, we were interested in measuring parenting behaviors that undermine or promote adolescents' emotional autonomy development within the family context, particularly in regards to behaviors that mothers engage in that promote a context where adolescents feel that they are encouraged to contribute to decision making within the family, as well as to feel competent in making their own life decisions. The measures that we have chosen to use specifically focus on behaviors of mothers that are associated with healthy adolescent individuation as opposed to measures that assess adolescents' actual decision making (i.e., behavioral autonomy). The Autonomy and Relatedness Coding System (ARCS; Allen et al., 2000) was used to assess undermining autonomy and promoting autonomy and relatedness in the parent-adolescent relationship. Video-tapes of the 8-minute parent-adolescent interaction were observed and coded by trained coders using the ARCS. For purposes of the current study, we used two observational scales: undermining autonomy and autonomy and relatedness. Undermining autonomy during the interaction theoretically reflects behaviors that the mother would use to restrict autonomy in adolescents' daily lives. Undermining autonomy was measured by observation of mothers' undermining of adolescent autonomy, which reflects pressuring and over-personalizing behaviors that make it difficult or impossible to discuss disagreements; thus, creating a context where adolescents' autonomy development is not encouraged or supported. Examples of undermining autonomy within the interaction include the mother invoking guilt to try and make her point, making degrading statements to force the adolescent to take a position, and the mother using self as a reason the adolescent should not do something (e.g., "I am this way, so you should be."). Scores on the undermining autonomy scale range from 0-4 with higher scores indicative of more restricting on

autonomy and limiting of the discussion by the mother within the task. We also created a combined scale for autonomy and relatedness (AR) utilizing scores from the promoting autonomy and promoting relatedness scales to represent a balancing of behaviors that promote independence of thought and interest and engagement in another person's thoughts and feelings. Possible behaviors displayed during the interaction that reflect AR include expressing and discussing reasons behind disagreements, confidence in stating one's positions, validation (e.g., agreeing with the others position), attending to the other person's statements by being engaged (verbally or non-verbally, e.g., "I would like you to help me understand your point."). The AR scale is a summative scale and can range from 0-16 with higher scores indicative of mothers promoting more autonomy and relatedness during the interaction. When examining autonomy, past research has shown that it is important to not only assess the individual effects of undermining autonomy (McElhaney & Allen, 2001) but also to examine the impact that experiencing promotion of autonomy in the context of relatedness may have on adjustment (Allen et al., 1994). Thirty percent of tasks were coded by an independent coder to assess interrater reliability by calculating intra-class correlation coefficients (ICCs) which ranged from .73-.88 (avg = .78).

In addition to assessing observed autonomy, we also examined adolescents' report of autonomy granting on the Parent Behavior Inventory (CRPBI, Schludermann & Schludermann, 1970). Autonomy granting involves mothers encouraging their adolescents to make decisions and develop independence in their daily lives, primarily in the context of parent-adolescent relationships. This measure includes 8 items that assess adolescents' perception of how much their mother grants them autonomy in their daily lives on a scale of 1 (*not like me*) to 3 (*a lot like me*), with sample items including "likes me to choose my own way of doing things and "tries to understand why I do things." Higher scores indicated more autonomy granting. Internal consistency for this sample was adequate ($\alpha = .81$). We also examined adolescents' report of psychological control, a parenting practice that is associated with undermining autonomy and relatedness as it involves parental control attempts regarding adolescents' emotional and cognitive development (Barber, 1996; Soenens, Vansteenkiste, & Sierens, 2009). Parental psychological control is a distinct construct from autonomy granting and should not be construed as simply representing the opposite side of the continuum (Pinquart, 2017). Eight items were used from Barber's psychological control scale that asks adolescents to respond on a scale of 1 (*not like me*) to 3 (*a lot like me*) to items such as "tries to change how I think about or feel things." Higher scores indicated more psychologically controlling behaviors ($\alpha = .77$).

Stress response—To assess the cardiovascular stress response, a pulse-oximeter (Contec 08C Auto Inflate Blood Pressure Monitor with Pulse Oximeter Probe) was used to measure heart rate continuously throughout the parent-adolescent conflict stressor, as well as during a baseline period (40 minutes into the session after relaxation). Changes in heart rate have been used in other studies with adolescents to reliably assess reactivity to stress in the autonomic nervous system (Cook et al., 2012). Salivary cortisol was assessed to obtain an indicator of HPA axis response. Salivary cortisol is a well-established and non-invasive measure of HPA axis functioning that is highly correlated with plasma cortisol (Adam & Kumari, 2009). Salivary samples were obtained using a cotton strip that adolescents were

asked to place between their back molars and the inside of their cheek (Salimetrics Laboratories, State College, PA). Saliva was collected at several time points, which included baseline following the relaxation period (40 minutes into the session), directly following the parent-adolescent interaction (peak - 65 minutes into the visit), and at two points spaced 20 minutes apart toward the end of data collection (80 minutes into the visit and 100 minutes into the visit). Prior to analyses, samples were stored at -40C. Saliva was assayed in duplicate for cortisol at the Laboratory for Biological Health Psychology (Brandeis University, Waltham, MA) using a competitive chemiluminescence immunoassay (CLIA; IBL-International, Toronto, ON, Canada). The intra-assay coefficients of variation for the assay kits ranged from 3.9% to 6.6% and the inter-assay coefficients of variation ranged from 2.6%-5.5%. Winsoring was used on the raw data scores for the stress reactivity measures that were three standard deviations from the mean (Kertes & Gunnar, 2004).

For the current study, a peak-baseline score was created for each of the stress response variables (i.e., peak-baseline cortisol and peak-baseline heart rate). On average, youth did not show an increase in cortisol to the conflict interaction ($M = -.92$, $SD = 4.22$) but there was great variability in cortisol response (range = -8.96 - 24), with many youth increasing in cortisol. Participants showed a significant increase in heart rate ($t(95) = 10.59$, $p = .00$, $M = 10.64$, $SD = 9.62$). For analyses purposes, we computed a dichotomous moderator for heart rate and a dichotomous moderator for cortisol that reflected (a) those youth scoring in the top 25% of the sample in stress reactivity for a given physiological variable and (b) those scoring in the bottom 75% in stress reactivity for a given physiological variable. This approach has been used by researchers examining the premise put forth by biological sensitivity to context theory that some youth display a heightened reactivity that may be reflected in their physiological reactivity to an acute stressor (Ellis, Essex, & Boyce, 2005).

Adolescents' Adjustment—Indicators of adolescents' adjustment were measured at W2 of data collection and baseline measures at W1 of data collection were used to control for changes in adjustment over time. Indicators included internalizing problems and externalizing problems.

Adolescent internalizing and externalizing were measured with the Child Behavior Checklist Scale (YSR; Achenbach & Rescorla, 2001) from the adolescent's survey at W2. Statements measuring internalizing symptoms included “*I feel confused or in a fog*” and “*I am overtired*.” Statements measuring externalizing symptoms included “*I physically attack people*” and “*I have a hot temper*.” Responses range from 0 (*Not true*) to 2 (*Very/Often true*) with higher scores indicating a higher level of internalizing and externalizing problems. Internal consistency at both waves of data collection for both scales were good (internalizing W1 = .92 & W2 = .95; externalizing W1 = .85 & W2 = .85).

Control variables—Several covariates (gender, age, ethnicity, family income, and puberty) for which past research has shown associations with parenting variables and outcomes were examined in preliminary analyses for their bivariate relationships with autonomy and adolescent outcomes (Dimler & Natsuaki, 2015; Nolen-Hoeksema, 2001; Pinquart, 2016; Pinquart, 2017; Rothbaum & Weisz, 1994; Yap & Jorm, 2015). Of these covariates, basic correlations suggested that gender was the only covariate examined that

was significantly associated with outcomes or predictors, and as such this variable was controlled for in models examining the impact of autonomy variables on externalizing and internalizing problems (Twenge, & Nolen-Hoeksema, 2002).

Analytic Approach

To examine study hypotheses the AMOS 23.0 structural equation-modeling program (SEM) was used to estimate path models. Hypothesis 1 was examined by estimating the direct effect of youth report of autonomy granting, youth report of psychological control, observation of undermining autonomy, and observation of autonomy and relatedness (AR) on internalizing and externalizing. Given the large amount of already estimated parameters we examined each outcome in separate path models resulting in two separate path models. In each of these path models we also controlled for the Wave 1 outcome for that model (e.g., for externalizing at W2 we controlled for externalizing at W1).

To examine the moderating hypothesis (hypothesis 2), a multiple group model (MGM) approach was used to examine differences in structural pathways between youth higher in stress reactivity and youth lower in stress reactivity. Specifically, to reflect heightened reactivity each peak minus baseline score was recoded, such that participants scoring in the top 25% for each physiological measure (cortisol and heart rate coded separately) received a score of one which reflected heightened reactivity and every other participant below 75% received a score of zero (Ellis et al., 2005). This approach of using the top 25% of youth to reflect heightened reactivity is consistent with previous research on biological reactivity that shows that highly reactive individuals typically make up 20% of a sample of individuals and to best capture this reactivity a typological approach may be needed (Boyce et al., 1995; Ellis et al., 2005). These variables were entered as a grouping variable in a multiple group model in AMOS. Multiple group models allow researchers to test if the regression pathways differed across groups. This was accomplished by comparing a model that was fully constrained to a model that allows the regression pathways to vary across the groups (e.g., autonomy granting to externalizing). To evaluate if moderation was present for the entire model, chi square difference tests were examined. In the context of multiple group models, chi square difference test compares a model where pathways are assumed to be equal across groups and a model where pathways are assumed to be different across groups, with a significant p-value indicating that the model where paths are allowed to vary across groups is the better fitting model. Critical ratios were also examined for other evidence of moderation with critical ratios above 1.96 indicating a significant difference in specific regression pathways across models (Byrne, 2013). Full information maximum likelihood estimation procedure (FIML) was used in this study to account for the missing data from wave 1 to wave 2 on the outcome variables.

Results

Correlations for the sample are presented in Table 1, along with means and standard deviations for study variables. Correlations between W1 and W2 outcomes were generally very high ($r = .63-.82$) suggesting stability in externalizing problems and internalizing problems over the course of one year. Gender was significantly correlated with externalizing

problems ($r = -.26, p < .05$) and internalizing problems ($r = -.47, p < .05$) such that being female was associated with increased externalizing and internalizing problems in this sample and as such was controlled for in analyses examining the effects of autonomy variables on these outcomes. Correlations between independent variables suggested distinct constructs with correlations ranging from $r = -.49$ -.13. Relationships between predictors and outcome variables were generally in the expected direction and suggested that youth report of less autonomy granting and more psychological control were both associated significantly with increased risk of internalizing and externalizing problems at W1 and W2. In most cases, these associations were moderate in size suggesting that autonomy granting and psychological control are associated with externalizing and internalizing problems one-year later when no wave 1 behaviors are controlled.

Hypothesis 1: Direct Associations between Autonomy Variables and Adolescent Outcomes

Although basic correlations suggested some associations between predictors and adolescent outcomes, when all predictors were considered in the same model along with relevant study controls there were no direct associations (Figure 1). Few significant direct associations suggest that moderation may be present and as such we tested several models to examine the moderating effects of cortisol reactivity and heart rate reactivity on all pathways.

Hypotheses 2: Stress Reactivity as a Moderator

Comparison of the chi-squares across the freed and constrained models, which indicates that the overall model was moderated by a given stress reactivity variable, are presented in Table 2. Because we were interested in specific pathways that were moderated within the models, we also examined critical ratio difference tests of significance (above 1.96) for the pathways of interest (Kline, 2005). These models are presented in Figures 2 and 3.

Heart rate reactivity models—Three moderating models were estimated, one for each outcome, to assess the impact that heart rate reactivity has on the relationship between autonomy and relatedness variables and adolescent outcomes. Four critical ratios exceeded the value of 1.96, suggesting significant differences across groups in these structural pathways. Specifically, the pathway from psychological control to externalizing problems was significant and positive for those higher in heart rate reactivity, $\beta = .56, p < .05$, but not for youth lower in heart rate reactivity, $\beta = .05, p = ns$, suggesting that youth higher in stress reactivity were more sensitive to the effects of a negative context on the development of externalizing behaviors.

For youth higher in heart rate reactivity, decreased autonomy granting ($\beta = -.40, p < .05$) and undermining of autonomy ($\beta = .25, p < .05$) were significantly associated with increased internalizing problems, but this association was not significant for youth lower in heart rate reactivity, $\beta = .16, p = ns$ and $\beta = -.16, p = ns$, respectively. Furthermore, the pathway from AR to internalizing problems for youth high in heart rate reactivity was significant and positive, $\beta = .38, p < .05$ and for youth lower in heart rate reactivity was significant and negative, $\beta = -.31, p < .05$, suggesting that youth whose mothers expressed autonomy and relatedness in the interaction task and who experienced a more marked increase in heart rate to that task were more likely to report internalizing problems one year later. These findings

are contrary to what we hypothesized and other findings within this study and deserve further attention.

Cortisol reactivity models—Two moderating models were estimated, one for each outcome, to assess the impact that cortisol reactivity has on the relationship between autonomy and relatedness variables and adolescent outcomes. Critical ratios indicated that two of the structural pathways differed for those lower and higher in cortisol reactivity. The pathway from autonomy and relatedness to externalizing problems was significant and negative for youth higher in cortisol reactivity, $\beta = -.40$, $p < .05$, but was non-significant for youth lower in cortisol reactivity, $\beta = -.12$, $p = \text{ns}$. The pathway from psychological control to externalizing problems was also significant for those higher in cortisol reactivity, $\beta = .49$, $p < .05$, but not for youth lower in cortisol reactivity, $\beta = -.03$, $p = \text{ns}$. These results suggest some indication of biological sensitivity to context as youth who were higher in reactivity and experienced a positive environment (i.e., AR) reported fewer externalizing problems and those youth who were higher in reactivity and experienced a negative environment (e.g., psychological control) reported increased externalizing problems when compared to youth lower in reactivity.

Discussion

Understanding individual differences in the effect of key developmental tasks on adjustment during adolescence is a critical area of research that may help identify which youth are at risk for developing adjustment problems due to difficult developmental transitions within the family. The current study contributes to our understanding of individual differences by examining the conditions under which an important developmental task, developing autonomy, is associated with negative adjustment. Results indicated that individual differences in stress reactivity moderated the effect of different parenting behaviors associated with autonomy on externalizing and internalizing problems. Specifically, youth evidencing heightened reactivity, particularly in regard to heart rate reactivity, were more likely to report externalizing and internalizing problems in response to psychological control and undermining autonomy. In contrast, when youth high in reactivity were granted autonomy, they reported less internalizing and externalizing problems. Taken together, these results support the theory of biological sensitivity to context.

Direct Associations among Autonomy and Adolescent Outcomes

Contrary to expectations and past research, there were no significant associations between wave 1 measures of autonomy and adjustment outcomes at wave 2 when controlling for wave 1 behaviors and gender. It is important to note that there were several significant associations between indicators of autonomy and adolescent adjustment when basic correlations were examined cross-sectionally and one-year later. Additionally, many of the effect sizes that we found in our path models were consistent with previous meta-analyses research that has found small associations between autonomy granting and externalizing (Pinquart, 2017) and autonomy granting and anxiety (Yap & Jorm, 2015). Past research generally has not examined autonomy and associated indicators (e.g., psychological control) in the same study and instead has focused attention on a specific measure of autonomy (e.g.,

observed inhibiting autonomy and relatedness, Allen et al., 2002; psychological control, Lansford et al., 2014). Examining all indicators within the same model may make it difficult to find unique associations. Furthermore, the time lag between when wave 1 and wave 2 measures are collected may have impacted findings with past research suggesting that time lags longer than a year may be needed for the effect of certain parenting behaviors to transpire (Rueter & Conger, 1998). Several of the studies that have examined the effect of autonomy or psychological control on outcomes have done so either cross-sectionally (Noom, Dekovic, & Meeus, 1999; Soenens et al., 2012) or over a longer time frame than one-year (e.g., Allen et al., 2012; Lansford et al., 2014). Thus, to more fully evaluate the effects that indicators of autonomy may have on adjustment research needs to evaluate relationships over more than a one-year period.

Stress Reactivity as a Moderator of Associations

Evidence of BSC—Although we did not see evidence of direct associations between predictors and outcomes, results did indicate individual differences in the effect of autonomy on adolescent adjustment. These results generally supported our hypothesis and the premise put forth by biological sensitivity to context theory that a heightened stress response is a vulnerability that increases adjustment problems for adolescents who experience a negative developmental context. However, for adolescents who have a heightened stress response and experience a positive developmental context, externalizing and internalizing problems are lower. Specifically, psychological control and undermining autonomy, two variables that are indicative of a negative family context, were associated more strongly with adjustment problems among youth who were higher in stress reactivity than youth who were lower in reactivity. When indicators of promoting autonomy were examined (i.e., autonomy granting and autonomy and relatedness), results generally indicated that promoting autonomy was associated with less adjustment problems for youth higher in reactivity. Although this is not the first study to find evidence of BSC during adolescence (e.g., Cook et al., 2012; Obradovic et al., 2010), it is the first study to indicate that the effect of autonomy, an important developmental task, on adolescent adjustment may depend on stress reactivity. This is an important contribution to the literature given adolescence is a time when we observe both physiological changes associated with how youth process stress, as well as changes in expectations as to how parent-adolescent relationships function.

Differential effects of predictors—Results generally did not support the contention made in previous research that the combined effect of autonomy and relatedness has more of an impact on adjustment outcomes when compared to examining the granting of autonomy or undermining of autonomy not in the context of relatedness. Although several studies have found relatedness to be an important component in autonomy interactions (Allen et al., 1994), other studies have suggested that these variables are not related and do not have a stronger effect on outcomes than autonomy alone (Inguglia, Ingoglia, Liga, Lo Coco, Lo Cricchio, 2015; Noom et al., 1999). This finding deserves further consideration, particularly in regard to understanding individual differences in the impact of autonomy and relatedness on adolescent adjustment. Interestingly, in our models psychological control had the strongest effect on adolescent outcomes for those who evidenced heightened reactivity. Past research has suggested stronger relationships between psychological control and

externalizing behavior than autonomy granting in direct models (Pinquart, 2017), but individual difference factors such as reactivity have not been examined as moderators of these associations. Psychological control is a parenting practice that interferes with autonomy development and also may affect relatedness, which may make this a particularly detrimental parenting practice to use when adolescents are trying to assert autonomy (Cook, Buehler, and Fletcher, 2012). This negative attempt to thwart adolescents' autonomy development may be particularly problematic for youth who are biologically reactive to stress, a finding that supports previous research documenting that harsh and negative parenting during adolescence is particularly detrimental to externalizing behaviors for adolescents high in reactivity (Hinnant et al., 2015).

Differential findings for heart rate and cortisol—The moderation of individual pathways was stronger when examining heart rate reactivity models as compared to cortisol reactivity models. The only individual pathways that were significantly moderated by cortisol response were those predicting externalizing behaviors. Past research has found that ANS and HPA activation may reflect different responses to stressful stimuli that take on different meanings. ANS response is a rapid response system that has generally been associated with both approach and withdraw systems and the effort or challenge component of stress, whereas HPA stress response has been associated with distress, negative affect, and a withdraw response (Laurent, Powers, and Granger, 2013). Past research also has generally found that cortisol response may not be as sensitive to interpersonal stress and may be more sensitive to how we cope with performance based stressors (Stroud et al., 2009). In the current study, we were interested in autonomy development, which by its very nature involves both approach and withdraw as adolescents and parents negotiate the give and take of autonomy. Furthermore, the development of autonomy within the parent-adolescent relationship is inherently interpersonal. Thus, it is not surprising that heart rate reactivity to the stressor, as an indicator of ANS response, more consistently moderated the effect that autonomy had on adolescent outcomes. As sample size was small, it will be important to replicate these findings with larger samples, as well as other indicators of ANS activity such as alpha amylase.

The combined effect of AR on internalizing problems—Although findings generally supported the moderating hypothesis, there was one finding that was contrary to expectations. Results indicated that youth whose mothers expressed both promotion of autonomy and relatedness in the interaction task and who experienced higher reactivity as measured by heart rate to that task were more likely to report internalizing problems one year later. It is possible that for the group evidencing higher heart rate reactivity, that the autonomy and relatedness promoting behaviors that the mother displayed within the task are not a good fit for the teenager's needs. This basic premise fits with theories of goodness of fit that suggest that a child's temperament should fit well with the demands, expectations, and opportunities provided by the environment in order for that child to succeed (Chess & Thomas, 1989). In the conflict task, mothers who scored high in promoting autonomy and relatedness were mothers who encouraged youth to provide reasons to validate the points that youth were giving when disagreeing with their mothers. Although this was observed in a context of support, it is possible that for youth who are highly sensitive that this pressure and

expectation to act autonomously when discussing issues of conflict may not be a good fit for these teenagers' developmental needs, thus resulting in increased internalizing. One possibility that our data suggests some support for is that adolescents who evidenced higher heart rate reactivity were already showing signs of internalizing problems at wave 1 (*note*, examination of means suggested those in the heart rate reactivity group were higher, although not statistically significant, in internalizing problems at wave 1), and thus expectations for autonomy that mothers created during the task may have exasperated internalizing problems over time. This basic premise has been supported by previous research which has found that involved parenting (more responsiveness, knowledge) has been shown to exasperate already existing internalizing behaviors during adolescence (Reitz, Dekovi, & Meijer, 2006). Furthermore, theories of expressed emotions suggest that high levels of parental emotional expression that could include over-concern and involvement may worsen a child's already existing problems, such as anxiety disorders (Stubbe, Zahner, Goldstein, & Leckman, 1993). In the current study, we did not measure expressed emotion in regard to parental involvement but the construct of observed autonomy and relatedness as measured during the observation task shares similarities with involved parenting as it has been assessed in previous studies. This finding deserves future attention and replication.

It is also important to note that in a handful of previous studies promoting of autonomy and relatedness have been associated with negative adjustment for subsets of youth. Specifically, Allen and colleagues (2002) found that for youth who were classified as insecurely attached (preoccupied style) observed autonomy granting was associated with lower social skills. More recently, Niolon, Kuperminc, and Allen (2015) found that observed maternal autonomy and relatedness were associated with increased perpetration and victimization of violence for girls. Taken together with our findings, research suggests that promotion of autonomy and relatedness may be complex and potentially moderated by different factors, including initial levels of internalizing problems. Understanding these moderators is an important future direction for research so as to better identify individual differences.

Limitations

The current study examined changes over a one year period in important developmental outcomes, which marks an improvement on only estimating relationships at one point in time. However, following youth over a one year-period resulted in attrition with 32% of youth not completing surveys at follow-up. Attrition analyses indicated only one significant difference between those youth who remained in the study and those who left suggesting minimal attrition bias. Furthermore, we utilized FIML to reduce concerns of power when modeling, a technique that is generally thought to be an appropriate way to handle missing data and provides robust estimates using panel data that have significant amounts of attrition (up to 75%; Newman, 2003). Despite the fact that we used FIML to account for missing data overtime, our sample size was still small for testing the path models, which may have resulted in not having enough power to find significant effects in the direct or moderating models. Future studies should examine the combined effects of autonomy and stress response on developmental outcomes over multiple data points in larger samples with a focus on retaining those samples over time.

We made the decision to estimate multiple-group models using a dichotomous moderator that grouped youth into two groups with those evidencing stress reactivity being the youth who scored in the top 25% of the sample on a given stress difference score. We made this decision because we were interested in examining moderation of several different predictors of autonomy on adolescent outcomes and were interested if the entire structural model differed for youth high and low in reactivity. Furthermore, we were concerned with our ability to detect interaction effects if we added several parameters to the model as moderation can be difficult to detect with small samples and continuous variables (Champoux & Peters, 1987; Fan, Thompson, & Wang, 1999). Nevertheless, dichotomizing continuous data to estimate moderation has been criticized by past researchers because of misestimating effect sizes and arbitrary decisions about where to split the data (MacCullum, Zhang, Preacher, & Rucker, 2002). Our decision of where to split the data was based on previous research by the developers of the BSC theory (Ellis et al., 2005) but this limitation is still one to note for future research.

The current study focused on predominately European American youth who were middle to upper income and that our sample was more heavily comprised of female adolescents. Past research has suggested that the effect of autonomy granting may differ for youth in lower income families located in urban environments (Avenevoli, Sessa, & Steinberg, 1999; McElhaney & Allen, 2001) and that both stress reactivity and processes of autonomy may differ for girls and boys (Bumpus, Crouter, & McHale, 2001; Stroud, Salovey, & Epel, 2002). We were unable to test gender differences in the current study due to the unbalanced sample (68% female) and the power needed to adequately test for three-way interactions. Future research should examine the relationship among autonomy, stress reactivity, and adolescent outcomes in larger more diverse samples with a focus on gender, SES, and ethnic differences on these associations.

Conclusion

Despite limitations, the current study contributed to our understanding of individual differences in the impact of autonomy development on adolescent externalizing and internalizing problems. The findings suggest that heightened stress reactivity influences the impact that developing autonomy within the family context has on adolescents' externalizing and internalizing problems such that heightened reactivity may only be a vulnerability factor in families that restrict autonomy and relatedness. However, in families where autonomy is promoted adolescents who evidence heightened reactivity are least at risk of displaying internalizing and externalizing problems. These findings represent an important first step in characterizing the role of stress response in the relationship between a developmental task and adolescent adjustment and can help illuminate the conditions under which autonomy contributes to maladaptive and adaptive functioning during adolescence. Identifying the conditions under which developmentally-specific factors predict adjustment problems is paramount for informing more developmentally focused prevention programs to reduce internalizing and externalizing among youth.

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References

- Achenbach, TM., Rescorla, L. Manual for the Achenbach system of empirically based assessment school-age forms & profiles. Burlington, VT: 2001.
- Adam EK, Kumari M. Assessing salivary cortisol in large-scale, epidemiological research. *Psychoneuroendocrinology*. 2009; 34(10):1423–1436. DOI: 10.1016/j.psychneuen.2009.06.011 [PubMed: 19647372]
- Allen JP, Chango J, Szewedo D, Schad M, Marston E. Predictors of susceptibility to peer influence regarding substance use in adolescence. *Child Development*. 2012; 83(1):337–350. DOI: 10.1111/j.1467-8624.2011.01682.x [PubMed: 22188526]
- Allen JP, Hauser ST, Eickholt C, Bell KL, O'Connor TG. Autonomy and relatedness in family interactions as predictors of expressions of negative adolescent affect. *Journal of Research on Adolescence*. 1994; 4(4):535–552.
- Allen, JP., Hauser, ST., Bell, KL., McElhaney, KB., Tate, DC., Insabella, GM., Schlatter, AKW. The autonomy and relatedness coding system. University of Virginia; Charlottesville: 2000. Unpublished manuscript
- Allen JP, Hauser ST, O'Connor TG, Bell KL. Prediction of peer-rated adult hostility from autonomy struggles in adolescent–family interactions. *Development and Psychopathology*. 2002; 14(1):123–137. [PubMed: 11893089]
- Allen JP, Marsh P, McFarland C, McElhaney KB, Land DJ, Jodl KM, Peck S. Attachment and autonomy as predictors of the development of social skills and delinquency during midadolescence. *Journal of Consulting and Clinical Psychology*. 2002; 70(1):56–66. [PubMed: 11860056]
- Avenevoli, S., Sessa, FM., Steinberg, L. Family structure, parenting practices, and adolescent adjustment: An ecological examination. In: Hetherington, ME., editor. *Coping with divorce, single parenting, and remarriage: A risk and resiliency perspective*. Mahwah, NJ: Lawrence Erlbaum Publishers; 1999. p. 65-90.
- Barber BK. Parental psychological control: Revisiting a neglected construct. *Child Development*. 1996; 67(6):3296–3319. DOI: 10.1111/j.1467-8624.1996.tb01915.x [PubMed: 9071782]
- Boyce WT, Alkon A, Tschann JM, Chesney MA, Alpert BS. Dimensions of psychobiologic reactivity: Cardiovascular responses to laboratory stressors in preschool children. *Annals of Behavioral Medicine*. 1995; 17(4):315–323. [PubMed: 24203598]
- Boyce WT, Ellis BJ. Biological sensitivity to context: I. An evolutionary– developmental theory of the origins and functions of stress reactivity. *Development and Psychopathology*. 2005; 17(2):271–301. DOI: 10.1017/S0954579405050145 [PubMed: 16761546]
- Boyce WT, Essex MJ, Alkon A, Goldsmith HH, Kraemer HC, Kupfer DJ. Early father involvement moderates biobehavioral susceptibility to mental health problems in middle childhood. *Journal of the American Academy of Child & Adolescent Psychiatry*. 2006; 45(12):1510–1520. DOI: 10.1097/01.chi.0000237706.50884.8b [PubMed: 17135997]
- Bumpus MF, Crouter AC, McHale SM. Parental autonomy granting during adolescence: exploring gender differences in context. *Developmental Psychology*. 2001; 37(2):163–173. [PubMed: 11269385]
- Byrne, BM. *Structural equation modeling with LISREL, PRELIS, and SIMPLIS: Basic concepts, applications, and programming*. Mahwah, NJ: Lawrence Erlbaum Associates, Inc.; 2013.
- Champoux JE, Peters WS. Form, effect size and power in moderated regression analysis. *Journal of Occupational Psychology*. 1987; 60(3):243–255.

- Chaplin TM, Sinha R, Simmons JA, Healy SM, Mayes LC, Hommer RE, Crowley MJ. Parent–adolescent conflict interactions and adolescent alcohol use. *Addictive Behaviors*. 2012; 37(5):605–612. [PubMed: 22341765]
- Chess, S., Thomas, A. Goodness of fit: Clinical applications from infancy through adult life. Psychology Press; 1999.
- Cook EC, Buehler C, Fletcher AC. A process model of parenting and adolescents' friendship competence. *Social Development*. 2012; 21(3):461–481. DOI: 10.1111/j.1467-9507.2011.00642.x [PubMed: 24882948]
- Cook EC, Chaplin TM, Sinha R, Tebes JK, Mayes LC. The stress response and adolescents' adjustment: The impact of child maltreatment. *Journal of Youth and Adolescence*. 2012; 41(8): 1067–1077. DOI: 10.1007/s10964-012-9746-y [PubMed: 22359225]
- Del Giudice M, Hinnant JB, Ellis BJ, El-Sheikh M. Adaptive patterns of stress responsivity: A preliminary investigation. *Developmental Psychology*. 2012; 48(3):775–790. DOI: 10.1037/a0026519 [PubMed: 22148947]
- Dimler LM, Natsuaki MN. The effects of pubertal timing on externalizing behaviors in adolescence and early adulthood: A meta-analytic review. *Journal of Adolescence*. 2015; 45:160–170. [PubMed: 26439868]
- El-Sheikh M, Whitson SA. Longitudinal relations between marital conflict and child adjustment: Vagal regulation as a protective factor. *Journal of Family Psychology*. 2006; 20(1):30–39. DOI: 10.1037/0893-3200.20.1.30 [PubMed: 16569087]
- Ellis BJ, Essex MJ, Boyce WT. Biological sensitivity to context: II. Empirical explorations of an evolutionary–developmental theory. *Development and Psychopathology*. 2005; 17(2):303–328. DOI: 10.1017/S0954579405050157. [PubMed: 16761547]
- Ellis BJ, Shirtcliff EA, Boyce WT, Deardorff J, Essex MJ. Quality of early family relationships and the timing and tempo of puberty: Effects depend on biological sensitivity to context. *Development and Psychopathology*. 2011; 23(1):85–99. DOI: 10.1017/S0954579410000660 [PubMed: 21262041]
- Fan X, Thompson B, Wang L. Effects of sample size, estimation methods, and model specification on structural equation modeling fit indexes. *Structural Equation Modeling*. 1999; 6(1):56–83.
- Fletcher AC, Buehler C, Buchanan CM, Weymouth BB. Parenting stressors and young adolescents' depressive symptoms: Does high vagal suppression offer protection? *Physiology & Behavior*. 2017; 170:78–87. DOI: 10.1016/j.physbeh.2016.11.036 [PubMed: 27979628]
- Fraser, MW., Richman, JM., Galinsky, MJ., Day, SH. Intervention research: Developing social programs. New York, NY: Oxford University Press; 2009.
- Hinnant JB, Erath SA, El-Sheikh M. Harsh parenting, parasympathetic activity, and development of delinquency and substance use. *Journal of Abnormal Psychology*. 2015; 124(1):137–151. DOI: 10.1037/abn0000026 [PubMed: 25688440]
- Hinshaw, SP., Lee, SS. Conduct and oppositional defiant disorders. In: Mash, EJ., Barkley, RA., editors. *Child Psychopathology: 2nd Edition*. New York, NY: The Guilford Press; 2003. p. 145-199.
- Inguglia C, Inguglia S, Liga F, Coco AL, Cricchio MGL. Autonomy and relatedness in adolescence and emerging adulthood: Relationships with parental support and psychological distress. *Journal of Adult Development*. 2015; 22(1):1–13. DOI: 10.1007/s10804-014-9196-8
- Kertes DA, Gunnar MR. Evening activities as a potential confound in research on the adrenocortical system in children. *Child Development*. 2004; 75(1):193–204. DOI: 10.1111/j.1467-8624.2004.00663.x [PubMed: 15015684]
- Kessler RC, Avenevoli S, Merikangas KR. Mood disorders in children and adolescents: An epidemiologic perspective. *Biological Psychiatry*. 2001; 49(12):1002–1014. DOI: 10.1016/S0006-3223(01)01129-5 [PubMed: 11430842]
- Kline, RB. *Structural equation modeling*. New York: Guilford; 1998.
- Koss KJ, George MR, Cummings EM, Davies PT, El-Sheikh M, Cicchetti D. Asymmetry in children's salivary cortisol and alpha-amylase in the context of marital conflict: Links to children's emotional security and adjustment. *Developmental Psychobiology*. 2014; 56(4):836–849. DOI: 10.1002/dev.21156 [PubMed: 24037991]

- Kunz J, Grych JH. Parental psychological control and autonomy granting: Distinctions and associations with child and family functioning. *Parenting*. 2013; 13(2):77–94. DOI: 10.1080/15295192.2012.709147 [PubMed: 23418403]
- Lansford JE, Laird RD, Pettit GS, Bates JE, Dodge KA. Mothers' and fathers' autonomy-relevant parenting: Longitudinal links with adolescents' externalizing and internalizing behavior. *Journal of Youth and Adolescence*. 2014; 43(11):1877–1889. DOI: 10.1007/s10964-013-0079-2 [PubMed: 24337705]
- Laurent HK, Powers SI, Granger DA. Refining the multisystem view of the stress response: Coordination among cortisol, alpha-amylase, and subjective stress in response to relationship conflict. *Physiology & Behavior*. 2013; 119:52–60. DOI: 10.1016/j.physbeh.2013.05.019 [PubMed: 23684904]
- MacCallum RC, Zhang S, Preacher KJ, Rucker DD. On the practice of dichotomization of quantitative variables. *Psychological Methods*. 2002; 7(1):19–40. [PubMed: 11928888]
- Masten AS, Coatsworth JD. The development of competence in favorable and unfavorable environments: Lessons from research on successful children. *American Psychologist*. 1998; 53(2): 205–220. DOI: 10.1037/0003-006X.53.2.205 [PubMed: 9491748]
- Masten AS, Cicchetti D. Developmental cascades. *Development and Psychopathology*. 2010; 22(3): 491–495. DOI: 10.1017/S0954579410000222 [PubMed: 20576173]
- Masten AS, Roisman GI, Long JD, Burt KB, Obradovi J, Riley JR, Boelcke-Stennes K, Tellegen A. Developmental cascades: linking academic achievement and externalizing and internalizing symptoms over 20 years. *Developmental Psychology*. 2005; 41(5):733–746. [PubMed: 16173871]
- McElhaney K, Allen JP. Autonomy and adolescent social functioning: The moderating effect of risk. *Child Development*. 2001; 72(1):220–235. DOI: 10.1111/1467-8624.00275 [PubMed: 11280481]
- Newman DA. Longitudinal modeling with randomly and systematically missing data: A simulation of ad hoc, maximum likelihood, and multiple imputation techniques. *Organizational Research Methods*. 2003; 6(3):328–362. DOI: 10.1177/1094428103254673
- Niolon PH, Kuperminc GP, Allen JP. Autonomy and relatedness in mother–teen interactions as predictors of involvement in adolescent dating aggression. *Psychology of Violence*. 2015; 5(2): 133–143. [PubMed: 25914852]
- Nolen-Hoeksema S. Gender differences in depression. *Current Directions in Psychological Science*. 2001; 10:173–176. DOI: 10.1111/1467-8721.00142.
- Noom MJ, Dekovi M, Meeus WH. Autonomy, attachment and psychosocial adjustment during adolescence: A double-edged sword? *Journal of Adolescence*. 1999; 22(6):771–783. DOI: 10.1006/jado.1999.0269 [PubMed: 10579889]
- Obradovi J, Bush NR, Stamperdahl J, Adler NE, Boyce WT. Biological sensitivity to context: The interactive effects of stress reactivity and family adversity on socioemotional behavior and school readiness. *Child Development*. 2010; 81(1):270–289. DOI: 10.1111/j.1467-8624.2009.01394.x [PubMed: 20331667]
- Pinquart M. Associations of parenting styles and dimensions with academic achievement in children and adolescents: A meta-analysis. *Educational Psychology Review*. 2016; 28(3):475–493.
- Pinquart M. Associations of parenting dimensions and styles with externalizing problems of children and adolescents: An updated meta-analysis. *Developmental Psychology*. 2017; 53:873–892. [PubMed: 28459276]
- Reitz E, Dekovi M, Meijer AM. Relations between parenting and externalizing and internalizing problem behaviour in early adolescence: Child behaviour as moderator and predictor. *Journal of Adolescence*. 2006; 29(3):419–436. [PubMed: 16168474]
- Robin, AL., Foster, SL. *Negotiating Parent-Adolescent Conflict: A Behavioral-Family Systems Approach*. New York, NY: Guilford Press; 1989.
- Roisman GI, Masten AS, Coatsworth JD, Tellegen A. Salient and emerging developmental tasks in the transition to adulthood. *Child Development*. 2004; 75(1):123–133. DOI: 10.1111/j.1467-8624.2004.00658.x [PubMed: 15015679]
- Rothbaum F, Weisz JR. Parental caregiving and child externalizing behavior in nonclinical samples: A meta-analysis. *Psychological Bulletin*. 1994; 116:55–74. <http://dx.doi.org/10.1037/0033-2909.116.1.55>. [PubMed: 8078975]

- Rueter MA, Conger RD. Reciprocal influences between parenting and adolescent problem-solving behavior. *Developmental Psychology*. 1998; 34(6):1470–1482. DOI: 10.1037/0012-1649.34.6.1470 [PubMed: 9823526]
- Samuolis J, Hogue A, Dauber S, Liddle HA. Autonomy and relatedness in inner-city families of substance abusing adolescents. *Journal of Child & Adolescent Substance Abuse*. 2006; 15(2):53–86. DOI: 10.1037/0893-3200.20.4.535 [PubMed: 20376203]
- Schludermann E, Schludermann S. Replicability of factors in children's report of parent behavior (CRPBI). *The Journal of Psychology*. 1970; 76(2):239–249. DOI: 10.1080/00223980.1970.9916845
- Schulenberg JE, Sameroff AJ, Cicchetti D. The transition to adulthood as a critical juncture in the course of psychopathology and mental health. *Development and Psychopathology*. 2004; 16(4): 799–806. DOI: 10.1017/S0954579404040015 [PubMed: 15704815]
- Soenens B, Park SY, Vansteenkiste M, Mouratidis A. Perceived parental psychological control and adolescent depressive experiences: A cross-cultural study with Belgian and South-Korean adolescents. *Journal of Adolescence*. 2012; 35(2):261–272. DOI: 10.1016/j.adolescence.2011.05.001 [PubMed: 21620464]
- Soenens B, Vansteenkiste M, Sierens E. How are parental psychological control and autonomy-support related? A cluster-analytic approach. *Journal of Marriage and Family*. 2009; 71(1):187–202. DOI: 10.1111/j.1741-3737.2008.00589.x
- Steeger CM, Cook EC, Connell CM. The interactive effects of stressful family life events and cortisol reactivity on adolescent externalizing and internalizing behaviors. *Child Psychiatry & Human Development*. 2017; 48(2):225–234. DOI: 10.1007/s10578-016-0635-6 [PubMed: 26961703]
- Steinberg, L. Autonomy, conflict, and harmony in the family relationship. In: Feldman, SS., Elliot, GR., editors. *At the threshold: The developing adolescent*. Cambridge, MA: Harvard University Press; 1990. p. 255–276.
- Steinberg, L. *Adolescence*. New York, NY: McGraw Hill; 2017.
- Stroud LR, Foster E, Papandonatos GD, Handwerger K, Granger DA, Kivlighan KT, Niaura R. Stress response and the adolescent transition: Performance versus peer rejection stressors. *Development and Psychopathology*. 2009; 21(1):47–68. [PubMed: 19144222]
- Stroud LR, Salovey P, Epel ES. Sex differences in stress responses: social rejection versus achievement stress. *Biological Psychiatry*. 2002; 52(4):318–327. [PubMed: 12208639]
- Stubbe DE, Zahner GE, Goldstein MJ, Leckman JF. Diagnostic specificity of a brief measure of expressed emotion: A community study of children. *Journal of Child Psychology and Psychiatry*. 1993; 34(2):139–154. [PubMed: 8444989]
- Twenge JM, Nolen-Hoeksema S. Age, gender, race, socioeconomic status, and birth cohort difference on the children's depression inventory: A meta-analysis. *Journal of Abnormal Psychology*. 2002; 111(4):578–588. DOI: 10.1037/0021-843X.111.4.578 [PubMed: 12428771]
- Yap MBH, Jorm AF. Parental factors associated with childhood anxiety, depression, and internalizing problems: A systematic review and meta-analysis. *Journal of Affective Disorders*. 2015; 175:424–440. [PubMed: 25679197]

Highlights

- Youth evidencing heightened reactivity, particularly in regards to heart rate reactivity, were more likely to report externalizing and internalizing problems in response to psychological control and undermining autonomy.
- Youth who evidenced higher stress reactivity and who experienced autonomy and relatedness were more likely to report decreased externalizing problems than youth who evidenced lower stress reactivity.
- Results support biological sensitivity to context theory and highlight the importance of considering individual differences in the effect of developmental milestones on adolescents' adjustment.

Figure 1. The Effect of Autonomy and Relatedness on Adolescents' Adjustment

The Effect of Autonomy on Adolescents' Adjustment. Although represented here in the same figure, separate models were estimated for the two outcomes of adolescents' adjustment given the high overlap. YR represents youth report and OBS represents observation. Standardized betas are presented. All analyses controlled for W1 youth outcomes.

Figure 2. Heart Rate Reactivity as a Moderator of Autonomy and Relatedness on Adolescents' Adjustment

The Effect of Heart Rate Reactivity on the Relationship between Autonomy and Relatedness and Adolescents' Internalizing and Externalizing Problems. Standardized betas are presented and * indicates significance at $p < .05$ level. ^a indicates that the critical ratio difference test was above 1.96 indicating significant differences across groups in the structural pathway. Those low in heart rate reactivity are to the left and youth high in heart rate reactivity are to the right of the diagonal. Analyses controlled for gender and W1 youth outcomes. Although represented here in the same figure, separate models were estimated for internalizing and externalizing problems.

Figure 3. Cortisol Reactivity as a Moderator of Autonomy and Relatedness on Adolescents' Adjustment

The Effect of Cortisol Reactivity on the Relationship between Autonomy and Relatedness and Adolescents' Externalizing Problems and Internalizing Problems. Standardized betas are presented and * indicates significance at $p < .05$ level. ^a indicates that the critical ratio difference test was above 1.96 indicating significant differences across groups in the structural pathway. Those low in cortisol reactivity are to the left and youth high in cortisol reactivity are to the right of the diagonal. Analyses controlled for gender and W1 youth outcomes. Although represented here in the same figure, separate models were estimated for externalizing problems and internalizing problems.

Table 1
Means, Standard Deviations and Correlations between Study Variables

Variables	M(SD)	1	2	3	4	5	6	7	8	9
1. W1 Autonomy Granting YR	2.39(.48)	—								
2. W1 Psychological Control YR	1.63(0.42)	-.49**	—							
3. W1 Undermining Autonomy - OBS	2.48(0.41)	-.10	.13	—						
4. W1 Autonomy and Relatedness - OBS	10.87(2.13)	.12	.07	-.34**	—					
5. W1 Externalizing	10.31(6.72)	-.27*	.27**	.05	-.11	—				
6. W1 Internalizing	13.15(9.6)	-.22*	.45**	-.02	.06	.54**	—			
7. W2 Externalizing	8.59(6.10)	-.23*	.27*	.03	-.22	.63**	.46**	—		
8. W2 Internalizing	14.47(11.85)	-.26*	.43**	.04	-.19	.43**	.82**	.53**	—	
9. Gender	—	.13	-.25*	-.08	.13	-.14	-.25	-.26*	-.47*	—

Table 2
Chi-Square Difference Tests for Moderating Models

Outcome	Cortisol Reactivity Models	Heart Rate Reactivity Models
Internalizing Problems	$\chi^2 = 7.56, df = 6, p = ns$	$\chi^2 = 20.04, df = 6, p < .01$
Externalizing Problems	$\chi^2 = 12.19, df = 6, p = ns$	$\chi^2 = 6.92, df = 6, p = ns$