

**CAREGIVERS' LABORATORY CORTISOL RESPONSE: LINKS TO
TRAUMA EXPOSURE AND ADOLESCENT ATTACHMENT**

by

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ABSTRACT

Prior studies have pointed to an association between a history of trauma exposure, PTSD symptoms, and cortisol response to lab-based stressors. Further, research has shown that the offspring of caregivers with a trauma history are also at risk for a host of psychosocial problems. In the current study, caregivers' cortisol was measured at five time points during afternoon laboratory visits with a 15-year old adolescent child. We examined cortisol in two ways: first, using area-under-the-curve (AUC) analyses to assess for global cortisol response during the laboratory visit, and second, using hierarchical linear modeling (HLM) to test for cortisol response to a trauma interview. Regression and HLM analyses examined the extent to which caregivers' cortisol response was associated with their own trauma history, perceived nurturance and adolescents' Dismissing and Preoccupied attachment states of mind. Caregivers' trauma exposure and PTSD symptoms were not significantly associated with their cortisol responses over the course of the lab visit. However, AUC analysis indicated that both caregiver nurturance and adolescents' Dismissing states of mind were associated with caregivers' cortisol response. HLM analyses further revealed that higher caregiver nurturance was associated with reduced reactivity to the trauma interview and that caregivers who were accompanied to the lab by more Dismissing adolescents had higher levels of cortisol during the trauma interview, greater cortisol reactivity to the interview, and slower decline in overall cortisol response throughout the laboratory visit. These findings are discussed in terms of potential directions of effects between caregivers' cortisol response and adolescents' Dismissing states of mind.

Chapter 1

INTRODUCTION

Several decades of research have identified links between trauma exposure and dysregulation of the hypothalamic-pituitary-adrenal (HPA) axis, a central component of the stress response system (Van Voorhees & Scarpa, 2004). Further, research has implicated HPA dysregulation in maladaptive psychological and physical health outcomes (Miller et al., 2007), including the development and maintenance of psychopathology (Faravelli et al., 2012; Morris, Compas & Garver, 2012). Further, the intergenerational transmission of traumatization theory (ITT; Bowers & Yehuda, 2016) posits that caregivers' exposure to traumatic events may predispose their offspring to a host of psychosocial problems. However, the extent of transmission and the mechanisms through which such transmission occurs remain unclear. The current study was designed to examine the associations between caregivers' trauma exposure, caregiver cortisol response to during a laboratory and a broad measure of adolescents' psychosocial adjustment.

1.1 Trauma Exposure And Cortisol Reactivity

Past studies have examined the association between adults' trauma history and cortisol response to laboratory-based stressors. These studies have produced mixed results. On the one hand, some studies have shown that that trauma-exposed individuals exhibit increased cortisol activity in response to stressors (Heim et al., 2003). However, the majority of research to date points to a hyporeactivity response to

stress among traumatized individuals (for a recent review, see Bunea et al., 2017). These findings are largely drawn from studies that have employed well-validated lab-based tasks to induce social stress, such as the Trier Social Stress Test (TSST; Kirschbaum, Pirke, & Hellhammer, 1993). For example, studies Carpenter et al. (2007) found that adults with a history of traumatic events showed less cortisol reactivity to the TSST. In addition to reactivity to the TSST, other studies have expanded on these findings by employing other stress-inducing lab-based tasks. These studies have yielded support for the cortisol hypo-reactivity hypothesis. For example, Voellmin et al. (2005) showed that individuals who reported more adverse childhood experiences showed attenuated cortisol response when completing a social-evaluative arithmetic laboratory task. Using an intimacy-induction lab task, another study found that women with a history of sexual trauma less cortisol reactivity as compared to controls (Martinson, Craner, and Sigmon, 2015). Taken together, these findings suggest that individuals with previous trauma exposure may exhibit blunted cortisol response to a range of laboratory-based stressors.

1.2 Cortisol Reactivity To Trauma-Specific Stressors

Although these prior studies of laboratory-based stressors are informative about general stress responses, they have primarily been limited to psychosocial stressors. Therefore, these studies do not inform an understanding of cortisol response to trauma-specific stressors and, to date, only a handful of studies have done so. For instance, Elzinga et al. (2003) reported that women with posttraumatic stress disorder (PTSD) showed greater cortisol levels during and following a personalized trauma script exposure than did women without PTSD. Similarly, Gola et al. (2012) examined cortisol response to a standardized clinical interview among war survivors with and

without a history of rape. Findings indicated that, although basal cortisol levels did not differ between groups, participants with a history of rape showed an increased cortisol response after exposure to trauma-related material compared to participants with no rape history. It should also be noted that one study showed no significant cortisol response to a trauma interview among traumatized male refugees (Kolassa et al., 2007). Thus, the relatively little that is known about cortisol response to trauma-related lab stressors has produced contradictory findings.

1.3 Trauma-Related Symptoms

Some research has assessed the extent that trauma-related symptoms are related to HPA-axis functioning. This literature suggests that PTSD symptoms are more likely to be associated with reduced HPA activity or hypocortisolism (Sherin & Nemeroff, 2011). A recent meta-analysis indicated that individuals with PTSD tend to have lower basal cortisol levels than individuals with no prior trauma exposure (Meewise et al., 2007). Yet, this literature is also comprised of mixed results, as other research has reported higher daily levels of salivary cortisol among women with PTSD than trauma-exposed women without PTSD symptoms (Bremner et al., 2003; Inslicht et al., 2006), while others have reported no overall relationship between trauma exposure, PTSD symptoms, and cortisol levels (Klaassen, Giltay, Cuijpers, van Veen & Zitman, 2012; Morris et al., 2016). Further, relatively little is known about how these trauma-related symptoms may be related to cortisol response to trauma-related stressors.

1.4 Parenting And Offspring Adaptation

Examining caregiver cortisol response during a trauma interview is important to further understanding of how caregivers' trauma history may influence their offspring. Intergenerational transmission is inferred when the offspring of traumatized caregivers evidence negative psychosocial and emotional outcomes (Bowers & Yehuda, 2016). Putative transmission mechanisms may include proximal processes, including maladaptive parenting, and more distal processes, such as caregiver psychopathology (Schwartz, Dohrenwend, & Levav, 1994). The intergenerational transmission of trauma may also be moderated by a safe and nurturing parent-child relationship that buffers the child from negative parenting (Jaffee et al., 2013). Extant research has demonstrated that trauma-related symptoms can hinder parenting behaviors in a way that impacts children across the developmental lifespan (Lang & Gartstein, 2008; Schwerdtfeger et al., 2013).

One general marker of adolescent adaptation is adolescents' Dismissing and Preoccupied states of mind in the Adult Attachment Interview (AAI). A wealth of research suggests that secure states of mind in adolescence are related to indicators of social and psychological well-being. Indeed, research suggests that attachment security has been linked to decreased risk of internalizing and externalizing psychopathology among adolescents (Allen et al., 2007; Fortuna & Roisman, 2008). Further, research implicates adolescent attachment styles as important indicators of various transdiagnostic processes, including emotion regulation (Allen & Miga, 2010), stress processing (Kobak et al., 2006), and hostile-impulsive behaviors (Kobak, Zajac, & Smith, 2009). Research has shown that children are more likely to develop insecure attachments to traumatized caregivers (Enlow et al., 2014). However, no studies, to our knowledge, have examined the relationship between adolescents' states of mind

and caregivers' physiological response to a trauma-reminder. Taken together, adolescent attachment represents an important developmental marker for overall adolescent adaptation and represents one domain through which caregivers' physiological response to a trauma reminder may relate to adolescent well-being and caregiver cortisol response.

1.5 The Current Study

The current study profiles caregivers' cortisol responses to a trauma-related laboratory-stressor. Our central hypothesis was that caregivers' physiological responses to the trauma interview and throughout the afternoon laboratory visit would be related to disrupted parenting and dimensions of insecure adolescent attachment. First, we tested associations between caregivers' cortisol responses to an extensive trauma interview and their reports of trauma exposure and current PTSD symptomatology. Our second aim was to explore the associations between caregiver cortisol responses, degree of perceived nurturance towards their adolescents, and adolescent states of mind in the AAI.

Chapter 2

METHOD

2.1 Participants And Procedures

Participants were 176 caregivers [M(SD)=40.2(7.9) years old] and their adolescent children [M(SD)=15.21(0.35) years old] who were part of a larger, three-wave longitudinal study of low-income families. Regarding the nature of the relationship between the caregiver and the adolescent, approximately 87% were biological mothers, 6% were grandmothers, 4% were biological fathers, and 3% were aunts. Participants were recruited from families who met income guidelines for free and reduced lunch in a mix of urban and suburban schools. The data for the present study were collected during the age 15-laboratory visits. During the lab visit at age 15, caregivers and adolescents completed interviews and questionnaires in separate rooms. At the beginning of the visit, caregivers were interviewed about their trauma history and asked to recall their most traumatic event in a five-minute trauma narrative. In the last 30 minutes of the visit, the caregiver and adolescent were reunited and completed questionnaires about areas of conflict in their relationship followed by a ten-minute conflict discussion. Families were then debriefed and paid for their participation.

Caregivers' salivary cortisol samples were obtained at five time points during the visit. An overview of the lab protocol and average time (in minutes) between cortisol samples are presented in Table 1. The average lab visit lasted two hours and 52 minutes. Laboratory visits were typically scheduled for late afternoon, given that cortisol secretion follows a circadian rhythm with higher levels of cortisol in the morning and lower and more stable cortisol levels in the afternoon. High morning levels of cortisol may confound findings with steeper declines in cortisol levels (Adam

et al., 2007). Thus, 31 families who had morning appointments were excluded, leaving a total of 133 participants for the present analyses. The average start time was approximately 4:40pm.

2.2 Measures

2.2.1 Demographics

Caregivers completed standard demographic forms, which included sociodemographic information for themselves and the adolescent, including age, race, gender, and income.

2.2.2 Salivary Cortisol

Research participants were asked to abstain from any food intake prior to the session. Saliva samples were taken using cotton rolls placed in the participant's mouth for a minimum of 45 seconds before being transferred into individual salivettes (SARSTEDT). The samples were frozen immediately following the session at approximately 225°C. On the day of analysis, samples were thawed and spun in a centrifuge at 3000 rpm for 15 minutes. Approximately 25 milliliters of the sample were then transferred to a high-sensitivity enzyme immunoassay plate provided by Salimetrics, LLC. The assay has a lower limit sensitivity of 0.007 ug/dl and an upper sensitivity of 1.8 ug/dl. All samples were analyzed in duplicate, and any test values varying more than 8% were reassayed. The average intra- and interassay coefficients of variation were 4.13% and 8.89%, respectively. The average reliability of duplicate standards across plates was $r = .985$. The average of the duplicate samples was used in all subsequent analyses.

2.2.3 The Stressful Life Events Screening Questionnaire (SLESQ; Goodman et al., 1998).

Caregivers were interviewed using the SLESQ, which is designed to cover lifetime exposure to traumatic events (e.g., life-threatening illness or accident, assault, physical or sexual abuse, rape, traumatic loss), as well as any other event that caregivers identified as frightening or traumatic. After identifying a traumatic event, caregivers were asked relevant follow-up questions, such as the age at which they experienced the traumatic event and how often it occurred and symptoms of PTSD.

2.2.4 Trauma Exposure

Caregivers reported a high frequency of lifetime traumatic events ($M(SD)=4.61(5.20)$, range: 0-27, skewness=1.89(SE=.21). The percentage of participants who endorsed each type of traumatic event is listed in Table 2. To account for this positive skewness, caregivers' total number of traumatic events was categorized into 5 categories: 0 (15.8% of sample), 1 (20.3% of sample), 2 (11.3% of sample), 3 (6.0% of sample), 4 (10.5% of sample), or 5 or more (36.1% of sample) traumatic events. This frequency variable showed an improved skewness of -0.14. The average exposure to traumatic events using this binned variable was 2.83($SD=1.97$) traumatic events.

2.2.5 PTSD-Related Symptoms

In the last part of the interview, caregivers identified their most distressing event. For participants who reported no qualifying traumatic events ($n=21$), questions regarding a stressful event were used. Seventeen follow-up questions were then asked to assess for current PTSD-related symptoms. Sample items include: "having upsetting thoughts or images about the traumatic event that came into your head when you

didn't want them to," "trying not to think about, talk about, or have feelings about the traumatic event," "feeling distant or cut off from people around you," and "being jumpy or easily startled." A PTSD symptom severity score was computed by summing all items, with greater scores indicating higher levels of PTSD symptoms. This composite variable showed high reliability (Cronbach's $\alpha=0.93$).

2.2.6 Adult Attachment Interview (AAI; George, Kaplan, & Main, 1996).

The AAI is a semi-structured 60- to 90-minute interview that focuses on an adult's or adolescent's memories of childhood experiences with attachment figures. Reliability and validity of the AAI are well established (Bakermans-Kranenburg & van IJzendoorn, 1993). All AAIs were recorded and transcribed, and transcripts were coded using the AAI Q-sort (Kobak, Cole, Fleming, Ferenz-Gillies, & Gamble, 1993), which is based on the Main and Goldwyn (1998) experience and state of mind scales. Two blind and certified raters sorted 100 Q-sort items to describe each transcript. At least one of the two raters coding each transcript had attended a training workshop and passed reliability testing on the Main and Goldwyn (1998) coding method. If inter-rater reliability fell below .60 (Spearman-Brown formula), a third rater sorted the transcript, and the highest two-rater correlation was used to form a composite description. A third rater was required on 45 (23%) transcripts. The average reliability for the composite Q-sorts across all transcripts was .82 (Spearman-Brown formula). Compositing Q-sorts were correlated with prototype sorts for Secure, Dismissing, and Preoccupied derived from the Main and Goldwyn (1998) system, resulting in continuous scores for each adolescent on all three dimensions. Because Secure and

Dismissing prototypes are inversely correlated, only Dismissing and Preoccupied dimensions are used in subsequent analyses. These dimensions closely parallel the two dimensions derived from a principal components analysis (PCA) of Main and Goldwyn's state of mind scale (Roisman, Fraley, & Belsky, 2007) and PCAs of AAI Q-sort items in multiple adolescent and adult samples (Haydon et al., 2011; Haydon et al., 2014; Kobak & Zajac, 2011; Roisman et al., 2017). The Q-sort items most and least consistent with Dismissing and Preoccupied dimensions are listed in Table 3.

2.2.7 What I Am Like Questionnaire-Nurturance Scale (Messer & Harter, 1986).

This 4-item scale is used to assess adults' perceived ability to foster the growth of others and care for children. Caregivers were asked to respond to these questions as if they were answering from their adolescent's point of view. Items included "some adults feel they are good at nurturing others BUT other adults are not very nurturant" and "some adults do not enjoy nurturing others BUT other adults enjoy being nurturant." Items were rated on a 1 (untrue) to 4 (true) scale, and an average nurturance score was created, with higher scores indicating more perceived nurturance.

2.3 Data Analytic Plan

Preliminary analyses using SPSS Version 24 were conducted to examine zero-order correlations between demographic variables, trauma-related variables, adolescent states of mind, and cortisol response. Consistent with previous studies, log-10 transformations were used to account for skewness in cortisol samples (Miller & Plessow, 2013). Individual cortisol levels were used to calculate area under the curve

with respect to ground (AUC_g) and increase (AUC_i), as recommended by Pruessner et al. (2003). The AUC_g provides an index of overall cortisol output across the five time points. The AUC_i quantifies the amount of change in cortisol that occurred during the lab visit, accounting for each individual's starting level. In the case where there is an overall decline in cortisol, the AUC_i is referred to as an "index of decrease" (Pruessner et al., 2003). In order to account for variance in total lab duration across participants, average AUC variables were created. AUC variables are reported in nmol/L units. Significant correlations were used to identify key variables to use as covariates in subsequent analyses. Next, linear regression analyses were used to test effects on overall cortisol output (AUC_g) and (AUC_i). All preliminary and regression analyses were conducted using SPSS v25 (Armonk, NY: IBM Corporation)

Hierarchical Linear Modeling (HLM; Raudenbush & Bryk, 2002) was used to analyze individual growth models of caregivers' salivary cortisol across five time points during the lab visit. HLM has several analytic advantages, such as accounting for repeated measurements of cortisol levels within individuals and the retention of participants despite missing data. HLM also allows for the use of robust standard errors that better account for non-normality and outliers in the data, providing increased accuracy in significance testing (Raudenbush & Bryk, 2002). The multilevel modeling approach allows for the specification of within-subjects and between-subjects models. All level-1 variables were entered uncentered, and all between-subject variables were grand-mean centered. Results were evaluated using robust standard errors to account for non-normality in the data.

Chapter 3

RESULTS

3.1 Descriptive and Preliminary Analysis

Caregivers' overall cortisol output (AUCg) was negatively associated with lab start time, family income, and trauma exposure, and positively associated with adolescents' Dismissing attachment. Caregivers' overall cortisol change (AUCi) was positively associated with adolescents' Dismissing attachment and negatively related to caregiver nurturance. Caregivers' PTSD symptom severity was related to greater trauma exposure and reduced nurturance. Caregiver nurturance was also negatively related to adolescent dismissing attachment. Notably, adolescent preoccupation showed no significant associations with caregivers' trauma variables, nurturance, or cortisol parameters.

3.2 Missing Data

Most caregivers (79.0%) provided all five cortisol samples, 18.2% completed four measures, and 2.8% completed four or fewer. The number of completed cortisol samples was not related to any included demographic variables (all p 's > .05), trauma exposure ($r = -.03$, $p = .66$), total PTSD symptoms ($r = -.10$, $p = .20$), or adolescent's Dismissing ($r = .01$, $p = .95$) and Preoccupied ($r = -.03$, $p = .71$) states of mind. Therefore, missing data was assumed to be missing at random. A final total of 144 participants were used in subsequent analyses

3.3 Aim 1

The first aim of this study was to examine associations between caregivers' trauma exposure and PTSD symptom severity and cortisol response to the trauma

interview. The results of Aim 1, after controlling for lab start time and family income can be found in Table 5. Regression analyses revealed that no trauma variables were related to caregivers' overall cortisol output (AUCg). However, results indicated a significant effect of family income, such that caregivers with lower family incomes were more likely to show greater cortisol output during the lab visit ($\beta=-.003$, $p=.007$). No significant associations were found with caregivers' change in cortisol (AUCi); however, a trending effect showed that more trauma exposure was marginally related to a greater rate of decrease in cortisol ($\beta=-.02$, $p=.06$).

3.4 Aim 2

The second aim of this study was to explore the associations between caregivers' cortisol response to the trauma interview, nurturance, and adolescent adaptation. First, two separate regressions were conducted to examine the role of parental perceived nurturance and adolescent dismissing attachment on caregiver AUCg and AUCi after controlling for lab start time and family income. Results of these analyses are presented in Table 6. Findings show that adolescent dismissing attachment was associated with caregivers' AUCg, indicating that caregivers with dismissing adolescents showed greater overall cortisol during the lab visit. Similarly, family income was negatively associated with caregivers' AUCg, suggesting that caregivers with less family income showed more cortisol output during the lab visit ($\beta=-.003$, $p=.01$). With regards to AUCi, caregivers' perceived nurturance showed negative associations, indicating that caregivers with more perceived nurturance exhibited greater rates of decrease in cortisol during the lab visit.

HLM analyses were then conducted to further elucidate the associations between caregivers' perceived nurturance, adolescent dismissing attachment, and

caregivers' cortisol response to the SLESQ interview (see Table 7). Specifically, we were interested in testing the moderating effect of adolescent attachment on caregivers' cortisol response, after accounting for covariates and caregivers' degree of nurturance. A level-1 (within-subject) model specified individual linear and quadratic growth curves of cortisol, with time elapsed from the baseline assessment as the independent variable. Because we were interested in analyzing differences in cortisol response during the SLESQ, time was zero centered at Time 2, capturing cortisol levels during the SLESQ trauma interview. The intercept (β_{0i}) represents the predicted value of cortisol level when time is centered at zero. Due to the polynomial nature of the level-1 model, the linear term (β_{1i}) represents the slope of the line tangent to the curve at time zero, providing an indication of instantaneous rate at time zero. In this study, β_{1i} represents cortisol reactivity during the SLESQ. β_{2i} represents the pattern of curvature change in cortisol across the five time points. Lastly, ϵ_{ti} represents the error in the model.

An unconditional model used the five log-transformed cortisol values as the outcome variable with no predictors. The intra-class correlation coefficient (ICC), or the ratio of the within-group variance to the total variance ($ICC = \frac{\sigma^2_{\tau}}{\sigma^2_{\tau} + \sigma^2_{\epsilon}}$) across the five time points, was 0.4561, indicating that approximately 46% of the variance in cortisol trajectory is accounted for by within-subject stability, leaving approximately 54% to be explained at the between-subjects level.

First, a level-1 model was fitted to provide an average growth trajectory of cortisol response. This model revealed that, on average, cortisol levels at time 2 were significantly different from zero ($\beta_{0i} = -1.25$, $p < .001$), that there was a significant average rate of decline in cortisol at time 2, ($\beta_{1i} = -0.28$, $p < .001$), and that there was a

significant curvilinear effect that conformed to a convex pattern across the five time points ($\beta_{2i} = 0.04$, $p = .04$).

Preliminary zero-order correlation analyses revealed no significant relation between adolescent Preoccupied attachment and caregiver cortisol response. Further analyses examining these associations were therefore not conducted. However, significant associations with Dismissing attachment were observed. Therefore, adolescents' dismissing attachment and caregivers' nurturance were tested as between-subjects moderators of caregivers' response during the laboratory visit, after controlling for related covariates. Results are presented in Table 7.

3.5 Adolescent Attachment

Findings indicate a significant association between adolescent dismissing attachment and all three level-1 predictors. Specifically, adolescent dismissing attachment was related to caregivers' cortisol level during the SLESQ interview ($\beta_{03} = 0.07$, $p = 0.017$), suggesting that caregivers with dismissing adolescents had higher cortisol levels during the SLESQ. Further, adolescent dismissing attachment was also related to the linear term ($\beta_{13} = 0.08$, $p = 0.007$), indicating that caregivers with dismissing adolescents demonstrated a flatter decline in cortisol to the trauma interview. Finally, adolescent dismissing attachment was related to the overall curvature of maternal cortisol response during the lab visit ($\beta_{23} = -0.06$, $p = 0.001$), indicating that caregivers with dismissing adolescents showed a concave pattern of response over the course of the laboratory visit. As a post-hoc probe of this effect, z-scores were created to indicate high Dismissing (+1 SD) and low Dismissing (-1 SD) adolescents. Figure 1 depicts the association between adolescent dismissing attachment and maternal cortisol trajectories.

3.6 Caregiver nurturance

Results indicate that caregiver nurturance was associated with the linear term ($\beta_{14} = -0.11$, $p = 0.026$), suggesting that caregivers with greater perceived nurturance showed a steeper decrease in cortisol during the SLESQ interview than did caregivers characterized by less nurturance. No associations between caregiver nurturance and cortisol levels during the SLESQ or curvature of response were observed.

3.7 Family Income

Additionally, total family income was marginally associated with rates of decline in cortisol ($\beta_{12} = -0.002$, $p = 0.061$), such that caregivers with less family income showed flatter decline in cortisol during the SLESQ. No associations between family income and caregivers' cortisol levels during the SLESQ or throughout the laboratory visit were found.

Chapter 4

DISCUSSION

The current study described caregivers' cortisol response over the course of a laboratory visit and examined moderators of this response. We initially examined the associations between caregivers' trauma exposure and PTSD symptoms and cortisol response to a trauma interview. With regards to caregivers' overall cortisol output during the lab visit (AUC_g), regression models revealed that only family income had a significant effect on cortisol output, with less family income contributing to increased cortisol output during the laboratory visit. Analyses of an overall measure of change in cortisol during the lab visit (AUC_i) indicated that on average caregivers' cortisol decreased across samples. Regression analyses revealed no significant effects of caregivers' family income or trauma-related variables on average decline in cortisol over the course of the visit.

Caregivers' who attended the lab visit with a Dismissing adolescent showed greater overall cortisol output during the lab visit. Subsequent analysis indicated that caregivers with Dismissing adolescents had higher cortisol levels following the trauma interview, less of a decline during the trauma interview, and greater concave curvature of cortisol response throughout the laboratory visit. In addition, caregivers who reported more perceived nurturance showed greater declines in cortisol across the lab visit, as well as faster rates of decline during the trauma interview. There were no significant associations between caregivers' cortisol response, perceived nurturance and adolescents' preoccupied attachment states of mind.

The failure to link caregivers' cortisol response to trauma exposure and trauma-related symptoms contributes to a literature marked by inconsistent findings.

Indeed, prior studies have reported both hyper- and hypo-reactivity to laboratory stressors among individuals with trauma histories. The majority of these studies have largely relied on the acute lab stressors, such as public speaking or performance-based paradigms. Far less is known about the degree to which trauma history and current-trauma related symptoms might impact adults' cortisol response to a trauma interview. It is notable that caregivers with less family income had greater overall cortisol response over the course of the laboratory visit. This finding is consistent with previous research linking socioeconomic status and long-term HPA-axis dysfunction (Ursache et al., 2017; Serwinski et al., 2016). However, one review paper noted that the relationship between socioeconomic status and HPA-axis functioning has produced inconsistent findings driven largely from methodological differences across studies (Dowd et al., 2009). The range of income was substantially restricted in this sample to families who met federal criteria for free or reduced lunch. Future research should continue to examine the relationship between socioeconomic status and cortisol response to acute laboratory stressors across middle- and higher-class samples.

Findings showed robust associations between caregivers' cortisol response and adolescents' Dismissing states of mind. Specifically, caregivers who were accompanied to the lab with a Dismissing adolescents had more overall cortisol output during the visit, higher cortisol levels following the trauma interview, less of a decline during the interview, and a more concave curvature of cortisol response over the course of the laboratory visit. The concave curvature in cortisol indicates that caregivers with Dismissing adolescents showed increased response during the first part of the visit followed by a decline toward the end of the visit. The association between caregiver cortisol and adolescents' Dismissing states of mind is open to

alternative interpretations based on directions of effects in the caregiver-adolescent relationship. One possibility is that caregivers' cortisol response to a trauma-related stressor may indicate a latent aspect of caregiver functioning that influences the adolescents' state of mind. For instance, an adolescent with a caregiver who displays more cortisol reactivity to stress may have developed a strategy for deactivating the attachment system as a way of distancing themselves from more reactive caregivers. Indeed, dismissing adolescents are less likely to express outward presentations of distress, minimize negative experiences, and are less likely to discuss problems within the parent-child relationship (Hesse, 2016, Chapter 6).

Caregivers' rating of adolescent perceptions of nurturance sheds some light to this potential interpretation. Perceived nurturance was associated with cortisol increase across the visit (AUCi), and with slower rates of cortisol decline during the trauma interview. This indicates that caregivers who were more reactive to the trauma interview believe their adolescent is less likely to view them as a nurturing parent. This association would be consistent with a caregiver-child effect in which caregivers' cortisol reactivity to a trauma-related stressor may interfere with sensitive parenting and increase the likelihood of the adolescents' Dismissing state of mind. Alternatively, a Dismissing adolescent may minimize their attempts to gain nurturance from a parent and their independent or disengaging style may lead the parent to more accurately notice their adolescent's perception of low nurturance. The findings from this study may be in line with previous research that has identified HPA-axis functioning as a key mechanism linking caregivers' trauma history and parenting styles among mothers with infants (Gonzalez et al., 2012; Juul et al., 2016).

Given that the data presented in this study were cross-sectional, we cannot make conclusions about direction of effects. An alternative possibility is that adolescent Dismissing states of mind influence caregivers' cortisol response over the course of the lab visit. In this view, the Dismissing strategy of distancing from the caregiver and minimizing discussion of attachment related topics could predispose the adolescent toward being less cooperative with attending a laboratory visit focused on the assessment of the caregiver-adolescent relationship. From the caregiver's perspective, attending this extensive laboratory session with a less cooperative and disengaged adolescent could be a source of discomfort, as opposed to a Preoccupied adolescent who may be more cooperative. Additionally, given that we did not measure caregivers' diurnal pattern of cortisol response outside of the lab, we cannot rule out the possibility that this pattern of cortisol response is not related to the laboratory visit, but in fact a representation of daily cortisol functioning. In either scenario, it is likely that the adolescents adaptation influences caregivers' cortisol response to some degree, as have been shown with parent-child dyads (Merwin, Smith & Dougherty, 2015; Seltzer et al., 2009).

The current study has several notable strengths and weaknesses. First, our examination of caregivers' cortisol response to a lab visit as well as their cortisol response to a trauma interview adds to the limited research indexing cortisol response to trauma-specific, lab-based stressors. The use of repeated measurements of cortisol during the laboratory visit allows us to move beyond pre-post analyses and examine curvilinear patterns and global indices of cortisol response during the lab visit. The use of both AUC analyses and growth modeling allowed us to test individual between-subject moderators of this cortisol response. The use of multiple informants and

methods (e.g. cortisol, self-report, interviews) is another strength in the study design. Finally, our diverse and economically disadvantaged sample of caregiver-adolescent dyads extends the generalizability of our research findings to high-risk samples. However, the study was limited by a cross-sectional design. This limits our ability to establish temporal precedence between our study variables. As a result, the question about direction of effects between caregivers' cortisol response and their adolescents' Dismissing states of mind remains unanswered. Future studies should address directions of effect by using a longitudinal and cross-lag panel designs. Second, because cortisol sampling was conducted based on the completion of lab-tasks, there was variability in the timing between cortisol samples across participants. A more consistent and regimented schedule of cortisol samples could provide greater precision of changes in cortisol response across the lab visit.

The results from this study extend findings from previous literature aiming to a) examine individual differences in caregivers' cortisol trajectories during the laboratory visit, b) clarify the associations between caregivers' cortisol response to a trauma interview and trauma exposure history and c) explore the associations between caregivers' cortisol response to adolescents' psychosocial adaptation. Future studies should replicate these findings, and identify other biomarkers that moderate individual differences, including recent work showing epigenetic differences in cortisol response (Schechter et al., 2015; Alexander et al., 2018). Further, future research should continue to explore mechanisms that may implicate caregivers' stress reactivity as a potential mechanism of ITT on adolescents.

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Appendix A

TABLES

Table 1. Description of cortisol samples

Sample	Time M(SD)	Range	Time Elapsed M(SD)	Description of Sample*
1	16.67(1.48)	12.03-19.00	0.00(0.00)	Approximately 15 minutes prior to lab entry
2	17.25(1.47))	12.42-19.50	34.82(13.03)	SLESQ Interview
3	17.76(1.47)	12.73-20.17	65.66(19.09)	Trauma Narrative/ Questionnaires
4	18.88(1.46)	14.13-21.73	131.38(25.58)	Parenting Questionnaires
5	19.54(1.45)	14.92-22.42	171.92(24.62)	Pre-Conflict Discussion

*Estimation of when cortisol was secreted (~25 minutes from sampling)

Table 2. Rates of exposure to various traumatic experience types

Trauma Types	% of Participants Who Endorsed
Traumatic Illness	25.2
Serious Accident	25.7
Attacked with a Weapon	9.6
Traumatic Loss	31.9
Child Rape	19.2
Adult Rape	9.6
Attempted Rape	11.1
Molestation	11.2
Child Physical Abuse	24.2
Adult Physical Abuse	35.4
Threatened with a Weapon	18.2
Witnessing an Assault	12.6
Other	17.6

Table 3 Top Q-sort items consistent with Dismissing and Preoccupied states of mind

	Most Characteristic Items	Least Characteristic Items
<i>Dismissing</i>		
	Responses are superficial and require further probes	Subject recalls specific childhood memories of distress
	Is detached or uninfluenced by childhood experiences	Relies on others in frustrated or dissatisfied way
	Parental descriptions are stereotyped	Acknowledges setbacks that have been overcome
	Subject reports negative experience that is not accompanied by feelings of hurt or distress	Parental faults or limitations are depicted directly
<i>Preoccupied</i>		
	Is currently preoccupied with negative experiences with parents	Responses maintain focus on interview questions
	Is confused and overwhelmed with information about parents	Responds in a clear, well-organized fashion
	Vacillates between positive and negative attitudes toward parents	Provides only minimal responses
	Is conflicted or confused about parents	Integrates specific memories with more general abstractions

Table 4. Associations between Caregivers' Trauma-Related Variables and Cortisol (Aim 1)

Outcome Variable	Predictor Variables	β	Est./SE	p	95% CI
Caregiver AUCg	Lab Start Time	-.04	.02	.03	[-.08, -.01]
	Family Income	-.003	.001	.01	[-.004, -.001]
	Trauma Exposure	-.02	.02	.14	[-.06, .01]
	PTSD symptoms	-.01	.05	.84	[-.10, .08]
Caregiver AUCi	Lab Start Time	.01	.01	.48	[-.02, .04]
	Family Income	-.001	.001	.16	[-.002, .001]
	Trauma Exposure	-.02	.01	.11	[-.04, .004]
	PTSD symptoms	.04	.03	.27	[-.03, .10]

Table 5. Associations between Adolescent Attachment and Caregivers' Cortisol Response

Outcome Variable	Predictor Variables	β	Est./SE	p	95% CI
Caregiver AUCg	Lab Start Time	-.04	.02	.07	[-.07, .0003]
	Family Income	-.003	.001	.01	[-.01, -.001]
	Nurturance	-.05	.04	.30	[-.13, .04]
	Adolescent Dismissing	-.13	.05	.01	[-.03, .23]
Caregiver AUCi	Lab Start Time	.01	.01	.57	[-.02, .04]
	Family Income	-.001	.001	.31	[-.002, .001]
	Nurturance	-.09	.03	.004	[-.16, -.03]
	Adolescent Dismissing	.06	.04	.11	[-.01, .13]

Table 6. Final estimation of fixed effects (with robust standard errors)

Predictor	<i>B(SE)</i>	<i>t</i>	<i>p</i>
Caregiver cortisol level during SLESQ			
Intercept	-1.13(.03)	.39.61	<.001
Lab Start Time	-.05(.04)	-1.43	.16
Income	-.002(.001)	-1.22	.23
Adolescent Dismissing	.13(.05)	2.42	.02*
Caregiver Nurturance	.001(.03)	.02	.98
Caregiver rate of change during SLESQ			
Intercept	-.29(.03)	-9.85	<.001
Lab Start Time	.07(.03)	2.24	.03
Income	-.002(.001)	-1.89	.06 ^t
Adolescent Dismissing*	.15(.05)	2.70	.01*
Caregiver Nurturance	-.06(.03)	-2.26	.03*
Caregiver curvature throughout lab visit			
Intercept	.04(.02)	2.33	.02
Lab Start Time	-.04(.02)	-1.65	.10
Income	.0003(.001)	.73	.47
Adolescent Dismissing	-.12(.03)	-3.49	.001*
Caregiver Nurturance	.02(.02)	.83	.41

Appendix B

FIGURES

Figure 1. Caregiver's cortisol response and adolescent dismissing attachment

