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Adolescents' Cortisol Reactivity and Subjective Distress in Response to Family Conflict: The Moderating Role of Internalizing Symptoms

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Abstract

Purpose—Internalizing symptoms have been associated with both higher and blunted cortisol responses in adolescents. Little attention has been paid to subjective experiences of distress in conjunction with internalizing symptoms in hypothalamic-pituitary-adrenal (HPA) axis responses to laboratory stressors. This report examines whether adolescents' internalizing symptoms moderate the association between cortisol responses and distress in response to a common stressor in adolescence: family conflict. Differences are also examined between adolescents with current, past only, and no history of internalizing symptoms.

Methods—Adolescents ($N = 70$) discussed areas of conflict with their parents and subsequently reported on distress experienced during the discussion. Baseline and 5 post-stressor saliva samples were collected. Adolescents' internalizing symptoms were assessed concurrently with the discussion and at three previous time-points.

Results—Internalizing symptoms moderated the association between adolescents' reported distress and cortisol reactivity in response to family conflict. Adolescents with current and past internalizing symptoms had a blunted cortisol response, whereas adolescents with no history of internalizing symptoms showed greater cortisol reactivity when reporting greater distress.

Conclusions—This study expands the understanding of how current and remitted internalizing symptoms are related to adolescents' responses to everyday family conflicts. Adolescents with current and past internalizing symptoms demonstrated a lack of correspondence between psychological and physiological stress, whereas adolescents with no history of internalizing symptoms showed the anticipated correspondence. This study has important implications for understanding the link between internalizing symptoms and adolescents' HPA functioning in response to common social stressors.

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Introduction

Extensive research illustrates the importance of salivary cortisol as an index of the hypothalamic-pituitary-adrenal (HPA) axis for understanding arousal and stress reactivity. Similar to physical stressors, acute psychological stress typically activates HPA responses; however, stress responses are related to the nature of the stressor and are subject to individual differences in the way threat is perceived [1,2,3,4]. The connection between psychological stress and short-term HPA activation is studied primarily via responses to laboratory-induced stressors, e.g. the Trier Social Stress Test (TSST) [5], as well as through monitoring stressful events in youths' daily activities [1,6]. The present study examines adolescents' HPA activity surrounding the social stress of conflictual parent-child discussions.

We also examine adolescents' internalizing symptoms and subjective distress as putative influences on HPA activity. Because internalizing disorders include symptoms of social rejection and anxiety in social situations, persons with internalizing symptoms are anticipated to show heightened cortisol reactivity to tasks involving social evaluation. Studies examining HPA reactivity to short-term stressors show that adults and adolescents with internalizing symptoms demonstrate higher cortisol reactivity to stressors [7,8]. However, studies wherein parent-child discussions are the social stressor show mixed results. Klimes-Dougan and colleagues [9] reported that internalizing symptoms were associated with reductions in cortisol activity; Granger et al. (1996) reported that children's internalizing symptoms were associated with HPA reactivity, but the direction of that reactivity was not clear [10]. Overlooked in previous studies is adolescents' subjective experience of stress associated with family conflict and how this relates to and interacts with internalizing symptoms. Youth are likely to experience varying levels of distress in response to any stressor task, but particularly in response to parent-child conflict discussions. In adults, trait anxiety amplified the association between the subjective experience of short-term stressors and HPA axis reactions [11]. Examining whether symptoms of anxiety and depression amplify participants' perceived situational stress may explain discrepant findings for cortisol reactivity.

Diurnal patterns of cortisol activity are another consideration in understanding HPA reactivity to short-term stressors in adolescents with internalizing disorders. The characteristic diurnal pattern for cortisol tends to be different in persons with internalizing disorders compared to those without, although the results vary [1,12,13]. The most consistent feature associated with internalizing symptoms is a flattening of the typical diurnal rise and fall, e.g., less decline overall [9], flatter evening patterns, [14] higher cortisol around sleep onset [15], and sluggish nocturnal rise [16]. Moreover, in youth with major depressive disorder, follow-up data show higher evening cortisol in youth with recurring, chronic depression, but not in youth without further episodes [17,18]. These findings highlight the need to consider time of day and whether internalizing symptoms are current or have remitted.

The present study examines youth's experience of stress in conflictual family discussions with their parents and whether internalizing symptoms moderate their psychological and cortisol stress responses. Stress is examined in two ways: adolescents' self-reports of distress following the discussion (subjective), and cortisol samples collected before and following the discussion (objective). The primary question is: Does subjective distress relate to cortisol activity in the same way for adolescents currently experiencing internalizing symptoms as those without such symptoms? We hypothesized an interaction between internalizing symptoms and adolescents' reports of subjective distress related to the conflict discussions; we did not hypothesize whether internalizing symptoms will lessen or increase

the anticipated association between subjective distress and cortisol activity given prior mixed findings. Second, we compare adolescents with current, past only, and no internalizing symptoms. Both current and past internalizing groups were expected to show different HPA responses from the group without internalizing symptoms, with greater differences for current symptoms. In all analyses, we controlled for time of day, pubertal status [19], use of medications [20], and gender [21] given reported associations with alterations in cortisol patterns.

Methods

Participants

Seventy adolescents (32 females; 38 males) and their parents participated in this study as part of a multi-wave project examining family conflict and children's adjustment and physiology. Inclusion criteria for wave 1 were that the family had a child age 9-10, both parents lived with the child for at least three years, and all three participating family members spoke English. Of the 119 families participating in wave 1, 101 families were invited to participate in wave 4. The families represented here include those who agreed to participate in the discussion and to provide saliva samples (4 refused participation and 13 had scheduling difficulties or could not be located). Although a total of 84 families participated wave 4 procedures, 11 did not provide saliva samples (9 participated from home, and 2 declined participation in saliva collection). Two families had missing youth internalizing symptom data, and one adolescent reported mouth sores—these cases were not included, resulting in 70 adolescents. Adolescents' mean age in the present study was 15.3 ($SD = .8$); 12.3 ($SD = .7$) in wave 3, 11.1 ($SD=.7$) in wave 2, and 10.0 ($SD=.6$) in wave 1. Adolescents are 41.4% Hispanic/Latino; race is 15.7% African American, 32.9% Caucasian, 10.0% Asian, and 41.4% multi-ethnic. Mean family income is \$69,421 ($SD = \$36,813$); 10% of families had an income < \$20,000. Families participating in wave 4 did not differ significantly from non-participating families in terms of wave 1 internalizing and externalizing symptoms, mother's education, and family income (all p values >.05). Participating wave 4 fathers had slightly more years of education, $M=14.48$ ($SD=2.43$) than non-participants, $M=13.37$ ($SD=2.52$), $t(117) = -2.30$, $p = .02$. Wave 4 boys vs. girls showed no significant differences in internalizing and externalizing symptoms, subjective distress, or cortisol measures.

Procedures

Waves 1-4 involved a 3-4 hour laboratory visit with both parents and the youth. The university IRB approved all procedures and we obtained parents' consent and adolescents' assent at each data collection wave. The assessment of internalizing symptoms was consistent across all waves. Wave 4 procedures included a 10-minute relaxation task, a 15-min conflictual family discussion, 6 saliva samples and several questionnaires. When scheduling the wave 4 appointment, we instructed participants not to eat or smoke for 1-hr before their appointment and not to consume alcohol or caffeine for 24-hrs prior to the appointment. Before saliva collection, parents and their adolescents completed a questionnaire on recent eating, drinking, smoking, and other health behaviors (e.g., medications taken) that could affect cortisol measurements. If families had eaten, we postponed cortisol measurements to allow for a 1hr interval before collection. We limited the hours in which we collected data to avoid the morning cortisol peak; the earliest T1 sample was 11:15, $M = 13:56$ hrs, $SD = 2:04$, range = 11:15 to 19:17. In general, we scheduled lab appointments at 11:00 and at 14:00; 80% of the families began before 16:00 with several exceptions due to parents' work schedules.

Conflictual Family Discussion

To maximize the likelihood that the family discussed a topic that truly was conflictual, we administered a questionnaire assessing how much conflict they experienced with one another concerning 33 topics, and how upset these conflicts made them. Experimenters then conducted 5-min individual priming interviews with each family member, identifying areas of most intense and frequent conflict, and encouraging them to express their viewpoints. Based on the questionnaires and interviews, experimenters identified the three topics that were most conflictual and, when the family members were back together, gave the following instructions: "...Our purpose in having you do this discussion is to understand family disagreements and family members' different points of view. So please make sure that each of you get your points across..." Immediately after the discussion, family members completed a questionnaire assessing reactions to the discussion and emotions they experienced. Twelve of the families engaged in dyadic discussions due to the unavailability of one parent, whereas all other families engaged in triadic discussions with both parents.

Saliva Samples

The 6 saliva samples occurred at the following intervals: baseline (T1), post-discussion (T2 standardized at T1 + 40 min), and four additional post-discussion (T3-T6) intervals: T2 + 10 min, T2 + 20 min, T2 + 40 min, T2 + 60 min. Experimenters set timers to ensure consistent timing of saliva collection. Baseline cortisol measurements (T1) occurred immediately after a standardized procedure in which family members watched a 10-minute video of nature images with relaxing music. T2 occurred directly after the discussion. During the next hour (T3-T6), family members worked on questionnaires in separate rooms with brief interruptions for additional saliva samples. The saliva samples were stored at -20 degrees Celsius and then shipped in dry ice for commercially available assay procedures (Salimetrics, State College PA) using a high-sensitive enzyme immunoassay. The samples were assayed for cortisol in duplicate for reliability, $r(497) = .99$, $p < .0001$; the mean of these two values was used for all analyses. Repeated analysis was used for sample pairs that had results differing more than 7%.

Salivary Cortisol

In addition to cortisol scores at baseline, two summary scores were calculated as indices of cortisol total output and reactivity. Cortisol output was measured through the total area under the curve with respect to ground (AUC_G), and cortisol reactivity was measured through area under the curve with respect to increase (AUC_I) [22]. As per Granger et al. (2006) [23], we followed a common procedure for outlier values on cortisol concentration (11 out of 490 total samples) and rescaled those values to three *SDs* above the mean for the relevant sampling interval. Cortisol AUC_G scores were log-transformed to decrease the skewness of the distribution; AUC_I was sufficiently normally distributed and did not require transformation.

Youth-Reported Internalizing and Externalizing Symptoms Collected in Waves 1-4

The Youth Self Report [24], a widely used 112-item questionnaire, measures broadband scales of internalizing ($\alpha = .89$) and externalizing ($\alpha = .90$) symptoms in youth ages 6-18 years. We examined wave 4 T-scores, based on national age norms for males and females, to measure current internalizing and externalizing symptoms. To examine the difference between youth who had current, past, or no internalizing symptoms over the four waves, we categorized adolescents into three groups: (a) those who currently report internalizing symptoms at a T-score ≥ 60 ($n = 10$); (b) those who had a T-score ≥ 60 in waves 1, 2, or 3, but not currently ($n = 23$); and (c) those who never had a T-score ≥ 60 ($n = 37$). Wave 4 internalizing T-scores ranged from 26 to 77, $M = 49.0$ ($SD = 10.4$). Externalizing

symptoms, tested as a control variable in the analyses, ranged from 32 to 74, $M = 51.8$ ($SD = 9.9$).

Youth's Subjective Ratings of Distress

The Post-Discussion Questionnaire contained 8 negative emotions (e.g., angry, frustrated, sad) reflecting subjective distress. Youth rated the degree to which they experienced each emotion on a scale from 0 (*none*) to 4 (*a lot*). Cronbach's alpha for these items was .84. Scores ranged from 0 to 26 out of a possible 32 ($M = 7.1$, $SD = 6.0$). For group analyses, we defined high subjective distress as scores ≥ 10 , indicating more than some distress on average across all distress items.

Saliva Sample Information

The saliva information questionnaire, given immediately following consent, included 20 questions regarding time of awakening, medications, and mouth sores (used as covariates and to assess sample validity), as well as most recent food and drink.

Pubertal Status

Parents completed Repetti and colleagues' [25] non-intrusive estimate of pubertal development that assesses the degree to which growth spurts, skin changes, and body hair growth have begun on a scale from 1 (*has not yet begun*) to 4 (*has been completed*). For the three items, scores ranged from 6 to 10 ($M = 8.5$, $SD = .9$) for males, and from 6 to 12 ($M = 9.2$, $SD = 1.5$) for females, indicating that all adolescents had begun puberty.

Results

Table 1 displays the means and SD s for the total sample and each internalizing group. Other than the current internalizing T-score, which was used for grouping, analyses of covariance (ANCOVA), adjusting for time since awakening, the perception of puberty-related changes, and gender revealed no significant differences between internalizing groups. Partial correlations between the Table 1 variables using the same covariates yielded a positive correlation between subjective reports of distress and current internalizing T-scores, $r(70) = .38$, $p = .002$. There were no other significant correlations. In our sample, 41% of adolescents were "responders," or demonstrated an increase in cortisol after the discussion (i.e., a positive AUCi).

Internalizing Symptoms as a Moderator of the Association between Subjective Distress and Cortisol Reactivity

Table 2 presents multiple regression analyses examining the effects of current internalizing symptoms, subjective distress, and their interaction on cortisol AUCg and AUCi. Exploratory analyses controlled for externalizing symptoms because of their co-morbidity with internalizing symptoms [26] and their association with low cortisol [27], but the results were not altered; they were not examined further. Annual family income, days since last period (for females), parents' years of education, and medications were also examined as covariates. These controls did not significantly affect the results and were thus not included. All analyses presented in this report adjust for time since awakening, the perception of puberty-related changes, and gender. Youth-reported internalizing symptoms and subjective distress were entered into the model, centered on mean scores, followed by the interaction between these two variables. For total cortisol output (AUCg), there was a significant main effect for subjective distress, which was associated with higher cortisol AUCg, and a significant effect for internalizing symptoms, which were associated with lower cortisol

AUCg. The interaction between internalizing symptoms and subjective distress for AUCg was not significant.

In contrast, for cortisol AUCi, there was a significant interaction between internalizing symptoms and subjective distress. The interaction indicates that internalizing symptoms moderate the association between subjective distress and cortisol reactivity. The slope for adolescents with low internalizing symptoms was greater than zero, $T(4,66)=3.04$, $p=.003$, whereas the slope for internalizing adolescents did not differ from zero $T(4,67)=-.32$, *ns*. For youth with few internalizing symptoms, high distress during the discussion relates to high AUCi, and low distress relates to low AUCi. Youth with high internalizing symptoms, in contrast, show low cortisol reactivity, even when reporting high subjective distress. This interaction suggests that current internalizing symptoms are associated with a blunted physiological response to the family discussion.

Cortisol Reactivity and Subjective Distress in Adolescents with No, Past Only, and Current Internalizing Symptoms

Figure 1 displays mean cortisol concentrations over time by internalizing symptom group and level of subjective distress. To clarify whether HPA activation is differentially related to current, past, or no history of internalizing symptoms, we conducted 3 (group: no, past only, and current internalizing symptoms) by 2 (high versus low subjective distress) ANCOVAs on AUCg and AUCi. There were no significant findings for cortisol AUCg. However, we found a significant main effect for group with cortisol AUCi, $F(2,70) = 3.28$, $p = .04$, and for the interaction between group and subjective distress, $F(2,70) = 3.50$, $p = .04$. Figure 2 displays AUCi means for high and low subjective distress in the three internalizing symptom groups. Simple contrasts demonstrate that cortisol AUCi is greater in adolescents with no internalizing symptoms than in adolescents with past only, $p \leq .05$, and current internalizing symptoms, $p \leq .05$. No significant difference in cortisol AUCi was found between past only and current internalizing symptom groups. Furthermore, planned comparisons show significantly higher cortisol AUCi at high versus low reports of subjective distress for adolescents with no internalizing symptoms, $F(1,37) = 3.28$, $p = .02$, but not in the internalizing groups. In addition, there is a significant correlation between distress and AUCi for adolescents with no history of internalizing symptoms, $r(37) = .37$, $p < .05$, but not for those with current or past internalizing symptoms, $r(33) = -.05$, *ns*.

Discussion

The present study demonstrates that internalizing symptoms are linked to a lower HPA response in adolescents, even after accounting for time since awakening, pubertal development, gender, and other potentially influential factors. Specifically, there is a correspondence between subjective distress and HPA reactivity in adolescents without internalizing symptoms. However, those with internalizing symptoms do not show a correspondence between subjective distress and HPA reactivity. To assess whether a lower HPA response persists after internalizing symptoms have remitted, we also examined whether the presence of current, previous, or no history of internalizing symptoms differentially affects HPA reactivity to family conflict. A history of internalizing symptoms related to lower cortisol reactivity, even if symptoms were not currently present.

Increased HPA activity focuses attention, improves cognitive functioning, and regulates behavioral and emotional responses [28]. Thus, HPA activity generally increases when individuals face emotionally or physically challenging circumstances. We designed the present study to create an ecologically-valid, stress-evoking situation for adolescents through conflictual family discussions. Adolescents' subjective ratings show that some youth actually experienced the conversations as distressing whereas others did not. Those

who reported subjective distress also displayed anticipated cortisol increases—but only if they did not report internalizing symptoms. Thus, in the group of adolescents without internalizing symptoms, there was a correspondence between reported emotional distress and physiological activity. These adolescents displayed what might be characterized as emotionally and physiologically attuned responses to a situation experienced as personally distressing.

The adolescents with current and past internalizing symptoms, in contrast, did not show the anticipated correspondence between subjective distress and HPA activity. Adolescents with internalizing symptoms reported comparable rates of subjective distress to the group without internalizing symptoms; we cannot attribute this low HPA activity to lack of subjective distress. Moreover, there was a modest positive correlation between internalizing symptoms and subjective distress, suggesting that adolescents with internalizing symptoms might be expected to show greater, rather than less, cortisol reactivity. The low HPA axis activity for adolescents with internalizing symptoms thus reflects a lack of correspondence between subjective distress and physiological reactivity—not a lack of emotional distress.

The lack of concordance between reported distress and physiological reactivity has several possible explanations. On the one hand, the absence of HPA reactivity to stressors may reflect disruptions in the neurobiological stress response and may be a marker for psychological problems in adolescents [13]. Without the benefit of HPA reactivity, which typically prepares individuals to handle the external environment, some adolescents may be more prone to show the poor coping that accompanies internalizing symptoms [29]. On the other hand, reduced cortisol reactivity to distress may be a functional pattern for adolescents with internalizing symptoms. That is, those experiencing chronic stress may have physiologically habituated to common emotionally distressing stimuli. Whereas some research on internalizing adolescents supports HPA hyper-arousal in response to a performance task, a few studies show the opposite pattern of lower cortisol activity in response to psychosocial stressors [9,30], which is the pattern demonstrated here. Adolescents with internalizing symptoms may become accustomed to recurring psychosocial stressors, family conflict being one such example. Thus, for these adolescents, low HPA activity may be adaptive.

Our findings of lowered cortisol reactivity in adolescents with remitted internalizing symptoms adds to a growing literature on longitudinal associations between HPA functioning and internalizing symptoms. Those who have remitted major depression demonstrate blunted HPA reactivity to psychosocial stressors [31]. Although sometimes viewed as a consequence of depression, alterations in HPA activity also appear to be biological risk factors for longer recovery and relapse of internalizing symptoms in adolescents [13,32,33,34,35]. Despite increasing evidence supporting links between HPA activity and internalizing problems, particularly in the context of high social stress [33], the direction of effects and implications of HPA reactivity for adaptation are unknown.

Limitations and future directions warrant consideration. Due to the sample size, the number of participants in the current and past only internalizing groups was small, potentially obscuring differences between these two groups that we were unable to detect. Moreover, although we differentiated adolescents with current versus past internalizing symptoms, there is complexity to the trajectories of internalizing symptoms beyond what we could examine here. For example, future research should address questions related to symptom onset, duration, time elapsed following symptom remission, and differences in those with both past and current versus current only internalizing symptoms. Examining depression or anxiety alone, as contrasted with internalizing symptoms, could further explain certain results as different emotions have been linked to different HPA responses [36]. In addition,

measuring cortisol over several days would provide an assessment of intra-individual differences in situations of high versus low interpersonal stress. Other clinically relevant future research suggested here includes whether interventions would lead to increased HPA reactivity in adolescents after internalizing symptoms lessen [37], and whether, by incorporating observational measures, we would find concordance between behavioral measures of stress, self-reported stress, and systems of physiological stress [38,39].

Despite some limitations, this study demonstrated that family conflict, an experience common to adolescents [40], elicited a cortisol response in some adolescents but led to decreased cortisol in others. By examining subjective distress and HPA reactivity, this study reveals patterns of concordance between perceived distress and physiological reactivity and thus expands upon previous findings of internalizing youth and HPA activity where the emotional impact of the stressor was unknown. These results, however, highlight the need for future research identifying under what circumstances lack of correspondence between cortisol activity and perceived distress ultimately is protective or problematic for adolescents.

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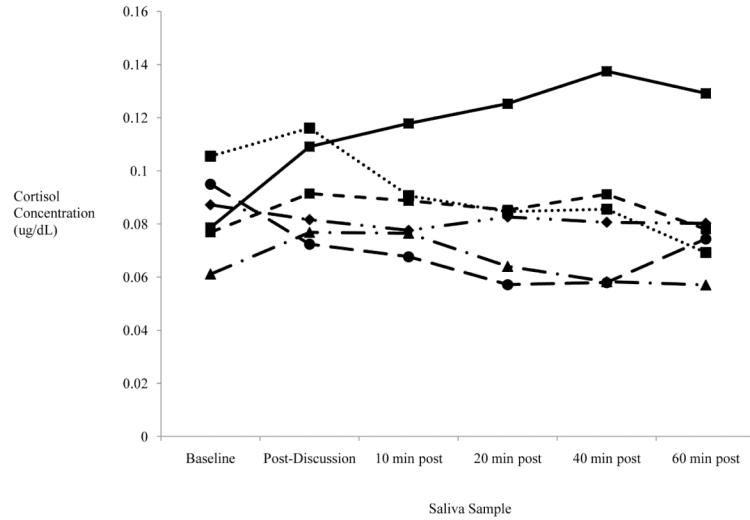


Figure 1.
 Cortisol Concentrations Across Time by Internalizing and Distress Group

- ◆— .No Internalizing Symptoms-Low Distress
- Past Only Internalizing Symptoms-Low Distress
- ▲— Current Internalizing Symptoms-Low Distress
- No Internalizing Symptoms-High Distress
- Past Only Internalizing Symptoms-High Distress
- Current Internalizing Symptoms-High Distress

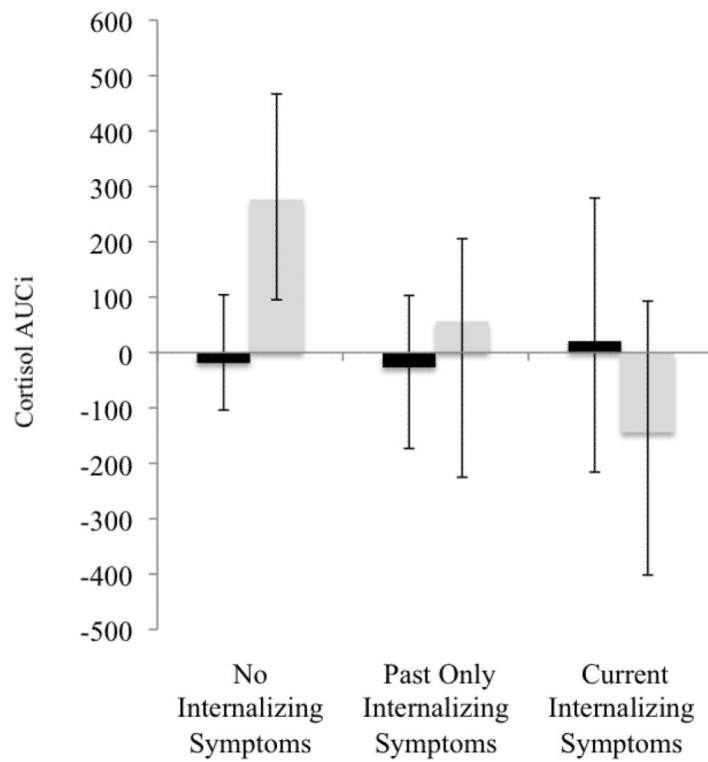


Figure 2.
 Cortisol AUCi Across Internalizing Symptom Groups and Subjective Distress Level
 ■ Low Subjective Distress
 ■ High Subjective Distress
 Note. AUCi = Area under the curve with respect to increase.

Table 1

Means (and Standard Deviations) for the Total Sample and for Adolescents with No, Past Only, and Current Internalizing Symptoms

Variables	Total Sample (<i>n</i> = 70)	No Internalizing (<i>n</i> = 37)	Past Only Internalizing (<i>n</i> = 23)	Current Internalizing (<i>n</i> = 10)	<i>F</i> (2, 70)
% Female	45.7	48.6	39.1	50.0	---
Mean Age	15.3 (.8)	15.3 (.7)	15.4 (1.0)	15.4 (.5)	.43
Subjective Distress	7.1 (6.0)	6.1 (5.6)	7.2 (4.7)	10.7 (8.9)	1.09
Current Internalizing <i>T</i>	49.0 (10.4)	45.0 (8.7)	48.2 (7.2)	65.9 (4.4)	11.62**
Cortisol AUCg	526.9 (311.9)	528.3 (326.7)	578.8 (328.9)	402.2 (174.6)	1.40
Cortisol AUCi	14.5 (267.5)	45.0 (308.5)	-1.5 (242.0)	-61.9 (117.1)	1.30
Baseline Cortisol	.09 (.06)	.09 (.06)	.10 (.06)	.08 (.03)	.40
Post-discussion Cortisol	.09 (.07)	.09 (.07)	.11 (.08)	.08 (.04)	.39

** $p < .001$ Note. Above analyses adjusted for time since awakening, pubertal development, and gender (excluded for ANCOVA with gender as the dependent variable). Cortisol AUCg was log-transformed for ANCOVA. Baseline and post-discussion cortisol concentrations are in ug/dL.

Table 2
 Regressions Examining Subjective Distress, Current Internalizing Symptoms, and Cortisol AUCg and AUCi

	Cortisol AUCg				Cortisol AUCi			
	β	T	F	Adj R ²	β	T	F	Adj R ²
Step 1			2.94*	.12			1.46	.03
Current Internalizing Symptoms	-.35	-2.80**			-.19	-1.45		
Subjective Distress	.31	2.48*			.19	1.49		
Step 2			2.42*	.11			2.34*	.10
Current Internalizing Symptoms	-.35	-2.75***			-.25	-1.94		
Subjective Distress	.31	2.27*			.34	2.47*		
Current Internalizing Symptoms X Subjective Distress	-.02	-.13			-.32	-2.48*		

* $p < .05$.

** $p < .01$.

Note. Equations adjust for time since awakening, perceived puberty-related changes, and gender. Cortisol AUCg was log-transformed; Cortisol AUCi was sufficiently normally distributed and did not need transformation. YSR T -scores and subjective distress scores were centered on their means.