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Emotion Regulation Regulates More than Emotion: Associations of Momentary Emotion Regulation with Diurnal Cortisol in Current and Past Depression and Anxiety

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Abstract

Maladaptive emotion regulation and dysregulated hypothalamic-pituitary-adrenal (HPA) axis functioning are characteristic of depression and anxiety. However, little research examines whether and how emotion regulation affects HPA axis functioning. We utilized an experience sampling methodology to examine associations between three emotion regulation strategies (problem solving, disengagement, and emotional expression/support seeking) and diurnal cortisol rhythms and reactivity in everyday life. Participants were young adults with current, past, or no history of internalizing disorders (depression or anxiety; $N = 182$). Across participants, problem solving was associated with an elevated cortisol awakening response (CAR) while disengagement was associated with a steeper cortisol slope. Only for individuals with internalizing disorders was momentary problem solving and emotional expression/support seeking associated with higher cortisol reactivity and emotional expression/support seeking associated with a flatter diurnal slope and blunted CAR. Results provide insight into associations between emotion regulation and day-to-day HPA-axis functioning.

Keywords

cortisol; emotion regulation; diurnal; depression; anxiety

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In the presence of an emotional response, emotion regulation is often employed as a way to modulate that response. Difficulties with regulating emotions, or maladaptive types of emotion regulation, have repeatedly been associated with the onset and maintenance of internalizing disorders such as depression and anxiety (e.g., Aldao, Nolen-Hoeksema, & Schweizer, 2010; Kring & Sloan, 2009). Although much is known of how emotion regulation regulates emotions, less is known about how emotion regulation exerts its effects on biological stress processes, particularly hypothalamic-pituitary-adrenal (HPA) axis functioning in the context of everyday life. HPA axis dysregulation is consistently demonstrated in major depression (for review see Cowen, 2010; Thase, 2009) and emerging evidence implicates HPA dysregulation in anxiety disorders (e.g., Adam et al., 2014; Yehuda, 2001). It is not yet understood, however, whether or how maladaptive emotion regulation that is characteristic of internalizing disorders is associated with HPA axis functioning. The current study aimed to assess the effects of naturalistic emotion regulation use on momentary cortisol responding and diurnal cortisol rhythms in both healthy and clinical samples with current and past internalizing disorders.

The HPA axis plays a central role in the body's response to stress and cortisol is the primary hormone released from the HPA axis (Kirschbaum & Hellhammer, 1989). Cortisol increases in response to acute stressors and also follows a circadian or diurnal rhythm. Upon waking, normative levels of cortisol are elevated and increase 50-70% to peak during the first 30 to 40 minutes after waking. This post-awakening surge in cortisol is also known as the cortisol awakening response (CAR). After this peak, cortisol quickly declines over the next couple of hours and continues to gradually decline until the nadir is reached at about midnight, resulting in a negative diurnal cortisol slope from waking to bedtime (Adam & Kumari, 2009; Pruessner et al., 1997).

Disturbances in diurnal HPA axis functioning have repeatedly been implicated in major depressive disorder. Individuals with depression demonstrate elevated cortisol throughout the day and a flatter diurnal cortisol slope (Cowen, 2010; Doane et al., 2013; Knorr, Vinberg, Kessing, & Wetterslev, 2010). Moreover, elevated morning cortisol and an elevated CAR prospectively predict the onset of depression (Adam et al., 2010; Harris et al., 2000). Mixed results are reported for current depression though as some work indicates a blunted CAR (Huber, Issa, Schik, & Wolf, 2006) while other findings indicate an elevated CAR (Dienes, Hazel, & Hammen, 2013). Although less work has examined the role of HPA axis dysregulation in anxiety disorders, in the presence of depression, anxiety is independently associated with a flatter diurnal cortisol slope (Doane et al., 2013). Anxiety disorders are also associated with HPA axis underactivity (Yehuda, 2001) and an elevated CAR predicts the onset of anxiety disorders (Adam et al., 2014). We know that HPA axis alterations are characteristic across depression and anxiety, yet we know little about the factors that contribute to these HPA axis alterations. Gaining insight in these factors may provide a better understanding of how this biological functioning goes awry and potentially how these alterations may link aberrant emotion regulation to internalizing disorders.

Individual emotion regulation strategies are often referred to as adaptive or maladaptive depending on outcomes. Adaptive emotion regulation has repeatedly been linked with positive mental health outcomes (John & Gross, 2004) while maladaptive emotion regulation

has consistently been associated with psychopathology (e.g., Aldao et al., 2010; Gross & Jazaieri, 2014; Kring & Sloan, 2009). Problem solving is an approach-focused strategy typically linked with adaptive outcomes and positive psychological health (Zeidner & Saklofske, 1996). Problem solving focuses on changing the stressor itself and a lack of problem solving is strongly associated with both depression and anxiety (Aldao et al., 2010) while training in problem-solving is a major component of cognitive behavioral therapies (e.g., Beck, Rush, Shaw, & Emery, 1979). A lack of problem-solving may also create gaps in ways to deal with stressors and subsequently lead to more opportunities for maladaptive emotion regulation (Aldao et al., 2010). A second form of regulation, namely disengagement, involves disengaging from and avoiding emotional stimuli. Disengagement has typically been conceptualized as maladaptive as it has repeatedly been associated with depression and worse mental health (Aldwin & Revenson, 1987; Rohde, Lewinsohn, Tilson, & Seeley, 1990). In fact, avoidance and suppression—two forms of disengagement from emotional stimuli (Borkovec, Alcaine, & Behar, 2004; Gross & Levenson, 1997) have demonstrated in a meta-analysis to be highly implicated in internalizing disorders (Aldao et al., 2010). A third type of regulation emphasizes engaging with an emotional experience internally or externally by allowing oneself to experience the emotion and process it with others (e.g., emotional expression and emotional processing; Endler & Parker, 1990; Stanton, Kirk, Cameron, & Danoff-Burg, 2000). The (mal)adaptiveness of emotional expression shows less conclusive evidence. In some cases it is associated with increased depression and decreased life satisfaction (Stanton et al., 2000) while others speculate that experiencing and expressing emotions (rather than suppressing or avoiding them) is adaptive (e.g., Gross & Levenson, 1997; Smyth & Pennebaker, 1990; Thompson, 1994). Moreover, multiple therapies (e.g. mindfulness and acceptance based approaches) emphasize training in emotional experiencing and expression (e.g., Hayes, Wilson, Gifford, Follette, & Strosahl, 1996; Segal, Williams, & Teasdale, 2002).

We know that various emotion regulatory strategies are associated with adaptive and maladaptive outcomes, including psychopathology, yet we know little of the underlying biological processes, especially those implicated in stress responding (i.e., HPA axis functioning), that might be associated with these outcomes. With regards to problem solving, some work finds no statistically significant association with cortisol (M. A. Hoyt et al., 2014; Koh, Choe, Song, & Lee, 2006; O'Donnell, Badrick, Kumari, & Steptoe, 2008). Conversely, problem-solving has been associated with lower levels of average daily cortisol output (M. A. Hoyt et al., 2014; O'Donnell et al., 2008) and treatments aimed to increase problem solving (i.e., cognitive behavioral therapy) show longer-term effects by buffering cortisol reactivity (Gaab et al., 2003). However, a similar approach-related emotion regulation strategy, reappraisal, has been associated with increased momentary cortisol response (Lam, Dickerson, Zoccola, & Zaldivar, 2009) and individuals who reappraised a stressor had greater peak cortisol responding to the stressor (Denson, Creswell, Terides, & Blundell, 2014). Although problem-focused engagement has been linked with lower cortisol levels in the longer term, there is some indication that in the moment, approaching a stressor is associated with increased cortisol responding.

Disengagement with emotional stimuli shows more consistent results, indicating overall maladaptive profiles of cortisol responding. Disengagement is associated with a slower

cortisol decline following a stressor (Nicolson, 1992), flatter cortisol slopes in cancer survivors (M. A. Hoyt et al., 2014) and higher cortisol responding to an acute stress of knee surgery (Rosenberger, Ickovics, Epel, D'Entremont, & Jokl, 2004). However, it should be noted that some researchers find that emotional disengagement shows no statistically significant association with cortisol output, CAR or diurnal slope (O'Donnell et al., 2008).

Research examining emotional expression in relation to cortisol demonstrates that on the one hand, expressing emotions and seeking support is associated with greater cortisol responding in men dealing with relationship stress (Gunlicks-Stoessel & Powers, 2009). On the other hand, emotional expression has been associated with lower cortisol output levels over the course of the day in healthy older adults (O'Donnell et al., 2008). Emotional expression and seeking support have also both been repeatedly shown to be statistically unrelated to various cortisol indices, including slope, CAR, and reactivity (M. A. Hoyt et al., 2014; Master et al., 2009; O'Donnell et al., 2008).

Present Study

It appears HPA axis functioning and emotion regulation are associated with each other, however it appears the findings are quite disparate. One reason may be that many of the above studies examined trait self-report measures or standardized lab measurements of emotion regulation. Recent work emphasizes the importance of examining emotion regulation outside the lab in order to provide a more ecologically valid assessment that better captures daily life and decreases self-report biases (Myin-Germeys et al., 2009). Moreover, the above studies often only examined the influence of *one* strategy on cortisol responding. In fact, when O'Donnell and colleagues (2008) examined multiple regulation strategies together, emotional expression no longer remained significantly associated with cortisol, as problem-solving appeared to account for cortisol findings. It is now understood that multiple regulation strategies are employed in the context of lab procedures (Aldao & Nolen-Hoeksema, 2012) and daily life (Heij & Cheavens, 2014). Thus, the present study aimed to address these issues by examining the association of multiple emotion regulation strategies in day-to-day life with diurnal cortisol responding. Furthermore, we wanted to examine how these processes might differ in individuals with current internalizing disorders, individuals with a history of internalizing disorders, and individuals with no history of internalizing disorders. By examining the influence of momentary emotion regulation on cortisol responding, we hope to gain insight into how emotion regulatory responses may be associated with cortisol responding in internalizing disorders of depression and anxiety.

Methods

Participants

Participants included emerging adults (age range 21-23 years old) originally recruited from two large public high schools in suburban Chicago and suburban Los Angeles for a longitudinal investigation of risk for mood and anxiety disorders (Youth Emotion Project; see Zinbarg et al., 2010). The Youth Emotion Project (YEP) was approved by the two respective locations' institutional review boards. Over 1900 juniors in high school were screened for neuroticism using the Eysenck Personality Questionnaire-Revised (EPQ-R-N;

Eysenck & Eysenck, 1975) and given that neuroticism is a risk factor for mood and anxiety disorders (Kendler, Kuhn, & Prescott, 2004), individuals scoring in the top third on this measure were oversampled (59%). This was done to increase the proportion of students in the sample at high risk for onset of mood and anxiety disorders. The full study sample included 627 individuals who consented to the longitudinal study and completed the baseline assessment. Approximately 6 months later, 491 youth were randomly selected and invited to participate in a follow-up diary study and cortisol assessment, and 344 completed the first diary and cortisol assessment. The current analyses used data from the fourth follow-up diary and cortisol assessment, approximately 6 years after their individual baseline (this is when emotion regulation items were added to the protocol). Insufficient cortisol data to compute cortisol indices and insufficient diary data due to attrition in the study at this fourth follow-up assessment resulted in a final sample of 182 youth (134 Female, 74%), average age of 22.78 (SD = 0.79) and with a racial/ethnic distribution of 54% Caucasian, 7% African American, 13% Hispanic, 6% Asian, 21% Multiracial/other. Higher sampling of females is due in part to the oversampling of high neuroticism (see Zinbarg et al., 2010) given that, on average, females score higher on this personality trait (Costa, Terracciano, & McCrae, 2001) and also are at greater risk for unipolar mood disorders and anxiety disorders (e.g., Craske, 2003; Nolen-Hoeksema & Hilt, 2008).

Procedure

Participants were interviewed at baseline for lifetime Axis I psychopathology using the Structured Clinical Interview for DSM-IV-TR Axis I Disorders (First, Spitzer, Gibbon, & Williams, 2002) to diagnose current and past mood and anxiety disorders. Participants also self-reported basic demographic data including age, gender, race/ethnicity, and employment, and socioeconomic status was coded using the Hollingshead system (Hollingshead, 1975). Participants were then interviewed yearly for the next 6 years to assess development of any mood or anxiety disorders since baseline. At approximately the 6-year point, participants were invited to participate in the fourth follow-up cortisol assessment. Using ecological momentary assessment, participants completed diary and salivary cortisol samples six times a day for three consecutive weekdays during the school year. We asked participants to avoid important days such as during exams, birthdays or vacations. Participants received a study packet including a programmed digital wristwatch, three diary books, straws and 18 vials and labels for saliva sampling. Individuals received \$60 for their participation in the fourth cortisol follow-up. Participants who completed all four waves received a \$30 bonus.

Cortisol assessment

The cortisol collection procedure has been described in detail previously (e.g., Adam et al., 2010). Cortisol was assessed via passive drool six times over the course of three weekdays: upon awakening (S1), 40 minutes after waking (S2), three semi-random times throughout the day using a programmed watch beep (approximately 3h post-waking (S3), mid-afternoon 8hrs post-waking (S4), and mid-evening (12hrs post-waking (S5)) and immediately before bedtime (S6). For scheduled samples participants were asked not to eat, drink, or brush their teeth 30 minutes prior to sampling. Participants were instructed to label and refrigerate completed samples until samples were returned to the lab. At this point samples were stored at -20°C at the lab until they were shipped to Trier, Germany where they were assayed in

duplicate using a time-resolved immunoassay with fluorometric detection (DELFI) (Dressendorfer, Kirschbaum, Rohde, Stahl, & Strasburger, 1992). Intra-assay variation ranged between 4.0% and 6.7% and inter-assay variation was 7.1% to 9.0%. Raw cortisol data were transformed with a natural logarithmic transform to correct a positive skew prior to use in analyses.

Momentary stressors and emotion regulation

Prior to completing each saliva sample, participants completed a short (5 min) diary report regarding their location, activities, and the most stressful situation or event they encountered in the past hour. Participants were then asked to describe the stressful event in a free response (93% of samples included descriptive stressor information) and these were coded as one the following: performance related (y/n) (e.g., academic, work, study participation, extracurricular, schedule), interpersonal (y/n) (e.g., peer, friend, family, romantic), self (y/n) (e.g., mental state, identity, well-being, future plans, past actions), sleep (y/n) (e.g., waking up, tired, alarm, groggy), daily hassles (y/n) (e.g., household issues, lost item, waiting for someone, errands), other (y/n), (e.g., money, general or unspecified, world events), and no stress (y/n) (e.g., not stressed, relaxing, n/a). Participants also provided the perceived severity of stress elicited by each reported stressor by rating how stressful each event was from 0 (*not at all*) to 3 (*a lot*). Participants were then asked how much their response to the stressor included a series of coping and emotion regulation strategies from 0 (*not at all*) to 3 (*a lot*). Questions queried about included eight items, seven modified from the daily coping inventory (Stone & Neale, 1984) and one from the Brief-COPE (Carver, 1997). Data were factor analyzed using principal axis factoring with an oblimin rotation of the items averaged across moments for each person.

Factor analyses revealed three distinct emotion regulation factors: problem solving (*“thinking of a solution or gathering information”* and *“doing something to solve the situation”* $\alpha = 0.90$); expressing emotion and seeking support (*“expressing my feelings to reduce tension”* and *“seeking emotional support from others”* $\alpha = 0.81$) and disengagement (*“giving up trying to deal with it,”* *“accepting it, there is nothing to be done”* and *“distracting myself with thoughts or activities”* $\alpha = 0.71$). An item assessing relaxation (*“doing something to relax”*) did not load on any factors and so was omitted from analysis. These same factors were obtained at the momentary (Level 1), day (Level 2) and average (Level 3) levels. Both expressing emotions/support seeking and disengagement factors were mildly positively skewed and the square root transformation was used for all analyses. Momentary use (L1), average daily use (L2), and average use (L3) of emotion regulation over the course of the three days were used in analyses.

Diagnostic assessment

The Structured Clinical Interview for DSM-IV (SCID; First et al., 2002) was administered to assess lifetime psychiatric diagnoses. Interviewers were extensively trained and supervised, included graduate students or BA level research assistants, and all diagnoses were finalized by consensus meetings (see Zinbarg et al., 2010). Inter-rater reliability was assessed for a subset of interviews (approximately 10%) and Kappa values assessing aggregated disorders were on average 0.82. The current study focused on internalizing disorders, including major

depressive disorder (MDD), (but not dysthymia, minor depressive disorder or depressive disorder NOS) and anxiety disorders, including specific phobia, generalized anxiety disorder, social phobia, panic disorder with or without agoraphobia, obsessive compulsive disorder, and post-traumatic stress disorder. Participants were classified as having a past internalizing disorder and/or having a current disorder at the time of the cortisol and emotion regulation momentary assessment.

Demographic, health, and stressor covariates

Demographic variables were included as covariates, including age, gender, and ethnicity. Ethnicity was first included as dichotomous race variables with each ethnicity (e.g., Caucasian as the excluded group compared individually with African American, Hispanic, Asian, Other), however because the number of variables saturated the models and ethnicity did not appear to influence outcomes, race was dichotomized as Caucasian (0) versus Minority (1) status. Health behaviors were reported in the diary booklet at each time point a saliva sample was taken. We focused on variables previously shown to influence HPA axis functioning (Adam & Kumari, 2009), including time of waking, hours of sleep, recent sleep, eating, alcohol intake, caffeine intake, subjective pain, and medication use. Time of waking and hours of sleep were continuous, the other health behavior variables were dichotomous. Health behavior covariates were only retained in final models if they showed significant associations with the cortisol outcome. We also examined qualities of the stressful situations as covariates (perceived severity of stress dichotomized as high/low and the dichotomized types of stressor experienced). Lastly, given the sample was recruited based on neuroticism and neuroticism has been shown to influence emotion regulation tendencies (John & Gross, 2007), we also used neuroticism, as measured by a composite variable described in detail in Zinbarg (2010), as a covariate. The Cronbach's alpha for the neuroticism composite was 0.81.

Data Analytic Plan

Descriptive statistics and bivariate correlations were examined between key dependent and independent variables. The main analysis tested associations among emotion regulation, cortisol, and diagnoses of current and past internalizing disorders using three-level hierarchical linear modeling that is able to account for the nesting of moments within days and days within persons (Byrk & Raudenbush, 1992). We used the software HLM 7.01 (Raudenbush, Byrk, Cheong, Congdon, & du Toit, 2011). In these growth models, level of cortisol for each person at each moment was the outcome variable and cortisol was regressed on time of day variables as well as moment-level predictors (Level 1), day-level predictors (Level 2) and stable person-level predictors (Level 3).

Models—We analyzed two hierarchical linear models. In the first model (Model 1) we analyzed the basal cortisol rhythm within each individual by including, at Level 1, a time variable indicating how long since waking the sample was given (growth parameter indicating slope over course of day), a time since waking squared variable to capture the quadratic curvilinear change in cortisol over the course of the day, and a dummy variable representing the CAR (cortisol value at 40 min post-wake). In this model (Model 1), the intercept π_{0ij} , represented each person's average cortisol level at wake-up, π_{1ij} reflected the

CAR, and π_{2ij} and π_{3ij} reflected the average linear and quadratic slope across the day from the waking sample to the bedtime sample, excluding the CAR. We then added demographic (age, gender, and race) covariates at Level 3 and momentary health behavior covariates at Level 1 to assess whether these variables influenced cortisol outcomes. The only variables that influenced cortisol measures were Level 1 sleep and exercise and Level 3 age, gender and ethnicity, thus only these variables were included in all final models, in addition to the neuroticism covariate at Level 3. Adding Level 1 stressor quality variables, neither the severity of stress nor type of stressor showed significant associations with the cortisol outcome and thus were not retained in the final models.¹ Of note, the sleep stressor type was highly correlated with the above mentioned recent sleep health covariate and thus was unable to be modeled. We then added the three emotion regulation factors at all levels to assess the effects on cortisol outcomes: momentary emotion regulation (Level 1), average use of emotion regulation across the day (day-level; Level 2) predicting Level 1 coefficients for the Level 1 waking cortisol (intercept), CAR, slope and quadratic slope, and average emotion regulation use across the three diary days of sampling (average use; Level 3) predicting the Level 1 waking cortisol, CAR, slope, and quadratic slope.

In the second model (Model 2), all of Model 1 predictors were identical and we added dichotomous variables assessing past and current internalizing disorders (depression and anxiety disorders) at Level 3 predicting Level 1 coefficients for waking cortisol, the CAR, and cortisol slope, and Level 1 and Level 2 coefficients for the impact of momentary emotion regulation on cortisol. Level 3 internalizing disorder variables were also tested as modifiers of the effects of day-level (Level 2) emotion regulation on cortisol outcomes.

Results

Descriptive Statistics

In the analytic sample of 182 participants, 92 (50.5%) had no current or past diagnosis of internalizing disorders, 19 (10.4%) participants had current diagnosis of an internalizing disorder and 71 (30.0%) had a past diagnosis of an internalizing disorder. Of those 19 participants with current internalizing disorders, 3 (16%) were experiencing a current major depressive episode and 16 (84%) met criteria for a current anxiety disorder. For those 71 participants with past internalizing disorders, 62 (78%) had a past major depressive episode, 45 (56%) had a history of anxiety disorders, and 27 (34%) experienced both a history of major depression and an anxiety disorder. There were 10 participants (5%) who met for both a current and a past internalizing disorder. These participants were included in both groups in order to examine the independent influences of having current and past pathology. See Table 1 for descriptive statistics by diagnostic group and within the full sample. There were no differences on age, gender, ethnicity, or socioeconomic status (p 's > .05) between the diagnostic groups p 's > .05. Not surprisingly, the diagnostic groups differed on neuroticism, $F(2,179) = 17.16$, $p < .001$, with the current and past internalizing groups showing higher

¹Although the 'no stress' category did not show significant associations with momentary cortisol, we ran our final Model 1 and Model 2 covarying for this variable to consider whether a lack of stress reported influenced the relationship between emotion regulation and cortisol responding. Results were parallel when including this covariate and a lack of stress experienced demonstrated no significant association with cortisol outcomes.

neuroticism than the group with no internalizing disorders; the current and past internalizing groups did not significantly differ from each other. There were also no differences by age or individual ethnicities on average emotion regulation use of any of the three strategies across the days of cortisol sampling. However, it should be noted that when minority ethnicities were combined to create a dichotomous Caucasian vs. Minority ethnicity variable, Caucasians demonstrated reliably greater use of disengagement $t(180) = 2.05, p = .04$ but no significant differences emerged for the other two regulation strategies. Lastly, females engaged in significantly more expressing emotion and seeking support $t(180) = 2.72, p = .007$ and problem solving $t(180) = 2.07, p = .04$ compared with males. The sexes did not differ reliably on disengagement. Moreover, there were no differences by internalizing group on average emotion regulation use for any of the three strategies.

For daily stressor qualities, the groups differed on the severity of perceived stress reported, $F(2, 2913) = 18.42, p < .001$ with all three groups significantly differing from each other: individuals with current internalizing disorders reported significantly higher stress severity, followed by individuals with past internalizing disorders, followed by those with no internalizing disorders (p 's, $< .003$). For type of stressor reported, the only omnibus group difference was on whether no stress was reported, $F(2, 2913) = 11.30, p < .001$. Bonferroni post-hoc tests revealed that individuals with a history of internalizing disorders reported significantly fewer instances when they experienced no stress compared with both individuals with current internalizing disorders ($p = .001$) and individuals no internalizing disorders ($p < .001$).

Given the significant group difference in perceived stress severity we wanted to examine whether this was specific to some types of stressors versus others (e.g., interpersonal stress severity). To examine this, we multiplied the stress severity rating by each stressor category to assess group differences in the degree to which each stressor category was reported to be stressful. We found a significant effect for severity of performance stress, $F(2, 2905) = 3.20, p = .04$, however Bonferroni post-hoc tests revealed no significant group differences. We also found a significant difference for severity of interpersonal stress, $F(2, 2909) = 7.95, p < .001$, and Bonferroni post-hoc tests revealed that current internalizing disorders ($M = 0.26, SD = .073$) reported interpersonal stress to be significantly more stressful compared with those with a history of internalizing disorders ($M = 0.17, SD = 0.58$) and no internalizing disorders ($M = 0.13, SD = 0.47$); the latter two groups did not differ significantly from each other.

Intercorrelations among independent variables and cortisol

As seen in Table 2, lower waking cortisol was associated with significantly greater likelihood of having a current internalizing disorder ($r = -0.22, p = .002$) whereas an elevated CAR was significantly associated with past internalizing disorders ($r = 0.15, p = 0.04$) and being Caucasian ($r = -0.15, p = 0.04$). Current ($r = 0.19, p = 0.01$) and past ($r = 0.15, p = 0.04$) internalizing disorders were reliably associated with a flatter slope. All three regulation strategies were significantly associated with each other (p 's $< .0001$) indicating that participants often employed multiple strategies at each time point. Interestingly, increased use of expressing emotion and seeking support ($r = 0.19, p = 0.01$) and disengagement ($r =$

0.22, $p < 0.001$) were both significantly associated with neuroticism while problem solving showed no reliable association. Similar to findings above, males used significantly less expressing emotions and support seeking ($r = -0.20$, $p = 0.01$) and problem solving ($r = -0.15$, $p = 0.04$) and Caucasians used significantly more disengagement compared with all other ethnic categories ($r = -0.15$, $p = 0.04$).

Multilevel models of emotion regulation, cortisol, covariates and psychopathology

Cortisol diurnal rhythm—Model 1 illustrates the diurnal rhythm of cortisol with the intercept representing average wake-up cortisol at $\pi_0 = -1.44$, indicating a waking cortisol level of .24 $\mu\text{g/dl}$ and a significant and positive CAR, $\pi_1 = 0.50$, $p = .001$, indicating individuals experienced a 64.8%² increase in cortisol on average from the first to the second (40 minutes later) sample (see Table 3). The time since waking slope variable demonstrated a significant negative slope across the day, $\pi_2 = -0.17$, $p = .001$, demonstrating a 15.6% decrease per hour on average at the time of waking as well as a significant positive quadratic slope, $\pi_3 = 0.003$, $p = .001$.

Multivariate associations between cortisol and emotion regulation—Model 1 indicated that across all participants, higher average use of disengagement was significantly associated with about 23% higher waking cortisol and on average and about 7% steeper slopes (see Table 3 for results). For problem solving, higher average problem solving was significantly associated with, on average, about 15% greater CAR. Expressing emotion and seeking support was not related to diurnal or momentary cortisol in Model 1.

Multivariate associations between cortisol, emotion regulation and psychopathology—Model 2 added associations between current and past history of internalizing disorders and all cortisol indices. All main effects of emotion regulation on diurnal cortisol from Model 1 remained³ (see Table 3 for results). With regards to the influence of psychopathology on cortisol responding, individuals with current internalizing disorders exhibited 29% lower waking cortisol compared to individuals without current internalizing disorders. Moreover, on days when these individuals engaged in more expressing emotions and support seeking, they also experienced even lower waking cortisol—approximately 63% lower waking cortisol compared with individuals without current internalizing disorders. Related, on days when expressing emotions and seeking support, individuals with current internalizing disorders demonstrated approximately a 13% flatter slope than individuals without current internalizing disorders. On days when engaging in more expressing emotions and seeking support (Level 2), individuals with a history of internalizing disorders (but not current internalizing disorders) demonstrated a 48% smaller CAR. Individual differences in momentary effects of emotional regulation on cortisol responding occurred for both expressing emotions/seeking support and problem solving. Specifically, individuals with a history of internalizing disorders had about 7% higher cortisol levels when engaging in momentary emotion expression and support seeking compared with individuals without past internalizing disorders while individuals with

²The dependent variable (cortisol) has been log transformed, thus we can interpret the coefficients as percentage change per unit change in the dependent variable using the calculation of $B\% \text{ change} = \exp(B_{\text{raw}}) - 1$.

³The association of average problem solving with a higher CAR dropped to $p = .050$.

current internalizing disorders demonstrated about 12% higher cortisol responding when engaging in momentary problem solving compared with individuals without current internalizing disorders.

As a follow up, we also completed identical Model 2 analyses replacing dichotomous (y/n) ratings of experiencing current or past internalizing disorders with dimensional current and most severe past clinical severity rating (CSR) scores for internalizing disorders. CSR ratings were coded for all participants during the diagnostic interview and ranged from 0 to 8 with 4 denoting clinical significance. Results from this Model 2a were identical to those reported using dichotomous ratings, with these noted exceptions: a higher current CSR rating was no longer associated with lower waking cortisol, a higher current CSR rating was no longer associated with higher momentary cortisol when problem solving, nor was a higher past CSR rating associated with higher momentary cortisol when expressing emotions or seeking support. As was found in Model 1, average levels of problem solving were still associated with a higher CAR (this finding dropped to $p = .050$ in the original Model 2).

Exploratory Influence of Stressor Qualities—Although different stressor types or stressor severity did not appear to significantly influence cortisol responding when entered individually into the model (see Descriptive Statistics Results section), there were group differences on the interaction between perceived stress severity and interpersonal stress type (severity $\times$ interpersonal stressor), indicating that those with internalizing disorders experienced their interpersonal stress to be more severe. Given that interpersonal stress demonstrates strong associations with cortisol responding (e.g., Dickerson & Kemeny, 2004; Kirschbaum, Pirke, & Hellhammer, 1993) we wanted to further explore how this type of stressor in particular might influence the relationship between emotion regulation and cortisol. To do this, we first tested whether the severity of interpersonal stress variable influenced cortisol responding when only Level 1 diurnal cortisol modeling variables (CAR, slope, quadratic slope) were included, and it was in fact associated with elevated cortisol ($\gamma_{400} = 0.07$, $SE = 0.03$, $p = .01$). Next, we entered this variable into a model that again included the cortisol modeling variables at Level 1, Level 3 covariates (age, sex, neuroticism, ethnicity) modeled onto L1 cortisol variables, and with added Level 2 and Level 3 emotion regulation, Level 3 covariates, and Level 3 current or past internalizing disorders modeled only onto this Level 1 interaction term. The average influence of the interpersonal stress severity variable on momentary cortisol was no longer significant, ($\gamma_{600} = -0.02$, $SE = 0.03$, $p = .56$) and none of the day (Level 2) or average (Level 3) emotion regulation variables or current or past internalizing disorders interacted with interpersonal stress severity to influence cortisol responding (*all* p 's $> .05$). The only significant interactive associations with cortisol were among the covariates: females experienced 18% higher cortisol when experiencing a interpersonal stressor ($\gamma_{606} = -0.21$, $SE = 0.06$, $p < .001$) while individuals higher in neuroticism experienced 9% higher cortisol when experiencing an interpersonal stressor ($\gamma_{600} = 0.10$, $SE = 0.04$, $p = .02$). Lastly, we also completed identical Model 1 and Model 2 analyses covarying for the interpersonal stress severity rating (within the subset of the sample that completed descriptions of their stressor) with demographic and emotion regulation variables again modeled onto this variable. Results were parallel to

original findings and the interpersonal stress severity rating similarly was not associated with cortisol responding in Model 1 (Intercept $\gamma_{900} = -0.02$, SE = 0.03, $p = .61$) or Model 2 (Intercept $\gamma_{900} = -0.02$, SE = 0.03, $p = .56$), except for the interaction with sex. Thus, it appears that although interpersonal stress severity appears to play a role in cortisol responding, this association is no longer significant when emotion regulation and covariates are entered into the model, possibly indicating that emotion regulation is detracting from or decreasing associations between momentary interpersonal stress and cortisol outcomes.

Discussion

Results of the current study demonstrate the importance of assessing purported adaptive and maladaptive emotion regulation strategies with diurnal cortisol and also shed light on how the use of emotion regulation is differentially associated with diurnal cortisol in individuals currently experiencing internalizing disorders, those with a history of internalizing disorders, and individuals without any history of internalizing disorders. We found that across all participants, average tendencies to problem solve were associated with an elevated CAR while average use of disengagement was associated with a steeper slope and higher waking cortisol. We also found that expressing emotions and seeking support was especially implicated in divergent diurnal cortisol rhythms in individuals with internalizing disorders. Lastly, the only associations between momentary emotion regulation and cortisol responding were in individuals with internalizing disorders: those experiencing current internalizing disorders demonstrated elevated cortisol when engaging in momentary problem solving while those with past internalizing disorders demonstrated elevated cortisol when engaging in momentary emotion expression and support seeking. Moreover, all results replicated (except for momentary cortisol responding) when utilizing dimensional assessments of depression and anxiety. Together these findings illustrate the importance of studying the nuances of *when* (e.g., being able to flexibly utilize strategies depending on context) and *for whom*, (e.g., with or without internalizing disorders) emotion regulation may be associated with differential HPA axis functioning.

Without taking into consideration the role of psychopathology, the tendency to engage in more problem solving over the course of the three days was associated with an elevated CAR across participants. On first pass, this finding appears somewhat counterintuitive as problem-solving is associated with adaptive outcomes and lower psychopathology (Aldao et al., 2010; Zeidner & Saklofske, 1996) while an elevated CAR is associated with onset of depression (Adam et al., 2010) and anxiety (Adam et al., 2014). However, the CAR itself has been hypothesized to be an adaptive response to the environment such that it provides a “boost” in energetic resources to help take on the upcoming demands of the day (Adam, Hawkley, Kudielka, & Cacioppo, 2006). The current findings support the boost hypothesis such that those individuals who tended to engage in more problem solving over the course of the three days also appeared to display a corresponding elevated CAR. This increase in biological resources may be associated with actively engaging with and tackling daily stressors head on in the short term of the three-day study. This is similar to recent work demonstrating that a higher CAR on specific days is associated with better cognitive and executive performance that day (Law, Evans, Thron, Hucklebridge, & Clow, 2015). However, in the current study we are unable to draw causal conclusions, so it may be that

actively approaching and engaging with stressors is associated with a subsequent increase in the CAR. Either interpretation, our findings indicate that approaching and engaging with the stressors via the use of problem solving is associated with increased cortisol responding in the short term of three days (i.e., the “*when*”). It has been hypothesized that it is a *repeated* elevated CAR over time that contributes to maladaptive outcomes as over time it leads to changes in glucocorticoid receptors via an allostatic load mechanism (McEwen, 1998).

Interestingly, individuals with current internalizing disorders experienced elevated cortisol responding when engaging in momentary problem solving, although this finding did not replicate when utilizing dimensional assessments, so findings should be interpreted with caution. Other research indicates that cognitive reappraisal (a similar approach-focused regulatory strategy) is associated with higher peak cortisol reactivity, hypothesized to be due to the novelty of the instructed regulation paradigm requiring more effortful control during the stressor (Denson et al., 2014). Although speculative, the current findings may similarly indicate that for individuals who are currently depressed or anxious, problem-solving may require more cognitive effort, and thus higher momentary cortisol, while engaging in problem solving. Conversely, problem solving may be more automatic for those individuals who are not currently depressed or anxious, and thus fewer biological resources are necessary.

Interestingly, those individuals with internalizing disorders demonstrated divergent cortisol outcomes especially when engaging in another emotion regulatory strategy, expressing emotions and seeking support. Replicating previous work (Adam et al., 2010; Knorr et al., 2010), current findings indicated that individuals with internalizing disorders demonstrated lower waking cortisol. Moreover, on days when these individuals engaged in expressing emotions and support seeking, they exhibited even lower cortisol at waking. Lower waking cortisol predicts greater fatigue and lower perceived energy over the course of the day (Adam et al., 2006). This lower perceived energy and fewer coping resources may be associated with more emotional expression and support seeking that day as a way to counteract a perceived fatigued state. Related, individuals with current internalizing disorders exhibited flatter diurnal slopes on days when engaging in more emotional expression and support seeking. The lower waking cortisol and flatter slopes in individuals with current internalizing disorders might be associated with less preparatory biological mobilization, which might lead to (or be due to) less active and approach-focused (i.e., problem solving and reappraisal) regulation. Additionally, on days when experiencing a lower CAR, individuals with a history of internalizing disorders engaged in more expressing emotions and seeking support. This lower CAR may indicate a lack of a “boost,” of energetic resources (Adam, Hawkley, Kudielka & Cacioppo, 2006), which then may be associated with more passive and automatic emotion regulation (i.e., emotional expression and support seeking) rather than adaptive, approach-focused problem-solving strategies. Lastly, individuals with a history of depression experienced elevated momentary cortisol when engaging in emotional expression and support seeking, although this finding did not replicate in analyses using dimensional measures of pathology.

It should be noted that the above findings only emerged for individuals with current or past internalizing disorders, indicating that expressing emotions and seeking support may operate

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differently in these individuals compared with individuals without psychopathology. These findings may clarify previous discrepant findings on this type of emotion regulation by shedding light on how the use of this strategy may vary across individuals (i.e., the “*for whom*”). Emotional expression and support seeking on the one hand demonstrates maladaptive relationships with mental health and on the other hand is purported to be an adaptive way to deal with stress (e.g., Segal, Williams, & Teasdale, 2002; Stanton et al., 2000). Although speculative, individuals without internalizing disorders may utilize emotional expression and seeking support by effectively leaning on social supports and allowing themselves to experience their emotions mindfully while individuals with internalizing disorders may be using a superficially similar strategy, but in fact may be engaging in something more akin to passively co-ruminating with others or excessively seeking support or reassurance. Co-rumination, or excessively discussing problems while focusing on negative emotions, has been associated with increased depressive and anxiety symptoms (Rose, Carlson, & Waller, 2007) while excessive reassurance is associated with depression (Joiner & Metalsky, 2001) and anxiety (Joiner, Katz, & Lew, 1999). These different types of emotional expression and support seeking may be associated with divergent cortisol patterns evidenced among those with and without internalizing disorders in the current data.

Lastly, the only association between disengagement and cortisol responding was somewhat perplexing: average use of disengagement was associated with steeper cortisol slopes across all participants. Steeper slopes have been linked with adaptive outcomes (e.g., Adam, 2012) while flatter slopes are indicated in disorders such as depression and chronic fatigue (Doane et al., 2013; Nater et al., 2008). Disengagement is often purported to be maladaptive (e.g., Borkovec et al., 2004; Rohde et al., 1990), however some research indicates that in the *short term*, distraction and disengaging from stressors may be adaptive as a way to gain distance from ones' emotions prior to attempting to solve them (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). It appears in the current sample disengagement is associated with a purportedly more adaptive cortisol profile. However, we are unable to disentangle the temporal precedence concerning whether flatter slopes contribute to higher use of disengagement, whether disengagement contributes to a flatter diurnal slope, or whether a third unknown variable contributes to this association.

One hypothesized third variable could be the type of stressor or the severity of perceived stress experienced. However, in the current sample, we surprisingly saw no significant influence of the severity of perceived stress or the type of stressor experienced in relation to the associations between cortisol and emotion regulation. We did find that by itself in the model, the severity of perceived momentary *interpersonal* stress was significantly associated with elevated momentary cortisol, but this was no longer significant once momentary emotion regulation strategies were accounted for. Thus, the impact of emotion regulation strategies on cortisol did not appear to strongly depend on stressor type or severity, and indeed, may reduce the impact of interpersonal stress severity on momentary cortisol. Future work would greatly benefit from further exploring the interactive roles between stressor type, emotion regulation use and cortisol patterns.

Taken together, the current findings provide potential clinical implications for teaching *flexibility* of emotion regulation use to individuals experiencing internalizing disorders. First, findings indicated that problem solving was associated with an elevated CAR across all individuals and increased cortisol mobilization in the moment for individuals with current internalizing disorders. These elevations in cortisol responding may indicate that problem solving may be adaptive, but only to a certain extent. Thus, emphasizing *flexibility* in using emotion regulation strategies, rather than always turning to approach-focused problem-solving, may be warranted. Further, findings surrounding the strategy of expressing emotions and seeking support shed light on how an emotion regulation strategy is associated with differential cortisol patterns once an individual has experienced an internalizing disorder. Findings will need to be replicated and future work would benefit from elucidating how and why expressing emotions and seeking support operates differently in individuals with internalizing disorders. Gaining a better understanding of what contributes to these associations may help these individuals flexibly utilize this strategy as part of their emotion regulatory repertoire.

Findings from the current study should be interpreted within a few limitations. First, our groups of current and past internalizing disorders included individuals with both major depressive disorder and a variety of anxiety disorders. Due to small sample sizes within each diagnostic category, we were unable to test the independent effects of emotion regulation and diurnal cortisol within depression and anxiety. Moreover, even when combining depression and anxiety into one category of internalizing disorders, only 19 (10%) of participants met criteria for a current internalizing disorder. Thus, our results (especially concerning current internalizing disorders) should be interpreted with caution. Future research would benefit from utilizing larger sample sizes experiencing current pathology to disentangle how various emotion regulation strategies may be associated with cortisol dysregulation across different forms of psychopathology. Second, we didn't use objective compliance monitoring of cortisol samples, which has been found to influence cortisol estimates (Kudielka, Broderick, & Kirschbaum, 2003). Third, we did not assess whether the emotion regulation strategies used in response to daily stressors were subjectively reported as effective. Without knowing whether or not emotion regulatory efforts were successful, we are unable to determine whether associations of emotion regulation strategies and cortisol responding are truly adaptive or maladaptive. Fourth, given that this study was part of a larger project and was assessed as part of a six year follow up, selection bias could be occurring and might be influencing findings. We are unable to determine how participants who dropped out of the study might have differed on cortisol indices, psychopathology, or emotion regulation measures, and future research may wish to examine research naïve individuals who have not previously undergone multiple clinical assessments and previously participated in momentary assessment protocols.

The current study was unable to assess causal relations between HPA axis functioning and emotion regulation and a pressing unknown in the field is 1) how emotion regulation causally influences HPA axis functioning and vice versa and 2) how these transactions contribute to the initial onset of psychopathology. This first point is ripe for future research and could be examined with increased intensity of salivary cortisol and emotion regulatory sampling to examine a more precise temporal relationship between emotion regulation and

cortisol. For instance, rather than including six daily cortisol/emotion regulation assessments, hourly assessments from waking to bedtime would allow for time series analyses to be employed. This would utilize ecologically valid assessments to provide insight into how emotion regulation strategies may be associated with subsequent rises or drops in cortisol responding at a later time point in the day (or conversely increases in cortisol in response to stress may predict the use of specific forms of emotion regulation at a later point in the day). Recent research has used a similar protocol assessing emotion and cortisol and found that increases in momentary cortisol are associated with increases in alert, active, and relaxed self-reports one hour later (L. T. Hoyt, Zeiders, Ehrlich, & Adam, in press). Understanding how HPA axis functioning may influence later use of emotion regulation (or vice versa) may provide one pathway by which emotion regulation leads to psychopathology through a biological mechanism.

Addressing the second above point, the current study was unable to draw causal conclusions due to its cross-sectional nature and thus it is unknown whether divergent HPA-emotion regulation patterns are a cause or consequence of internalizing disorders. An area ripe for future research would be to assess how trajectories of diurnal cortisol patterns and emotion regulatory use change longitudinally prior to the onset of psychopathology. With repeated momentary assessment protocols (e.g., a 3 day assessment every 6 months for 2 years in a high-risk sample) growth curve modeling could provide a better understanding of the bi-directional and causal nature of cortisol and emotion regulatory relationships. Furthermore, in conjunction with clinical assessments, assessing trajectories of cortisol-emotion regulation relationships may help shed light on how their interactive effects relate to the onset of psychopathology.

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Table 1
Demographic/Descriptive Statistics (N = 182)

Variable	Full Sample (n = 182)	No Internalizing Disorders (n=92)	Current Internalizing Disorders (n = 19)	Past Internalizing Disorders (n = 71)
Age	22.78 (0.79)	22.66 (0.55)	22.78 (0.75)	22.93 (1.02)
Gender (% <i>Female</i>)	134 (74%)	66 (71%)	12 (63%)	56 (80%)
Ethnicity				
African American	12 (7%)	8 (9%)	2 (11%)	2 (3%)
Hispanic	24 (13%)	11 (12%)	1 (5%)	12 (17%)
Asian	10 (5%)	5 (5%)	1 (5%)	4 (6%)
Caucasian	98 (54%)	50 (54%)	10 (53%)	38 (54%)
Other	38 (21%)	19 (20%)	5 (26%)	14 (20%)
Socioeconomic status	49.26 (12.35)	48.69 (12.33)	50.83 (11.08)	49.56 (12.83)
Problem Solve	1.37 (0.66)	1.30 (0.67)	1.38 (0.54)	1.47 (0.66)
Express/Seek Support	0.41 (0.43)	0.39 (0.41)	0.33 (0.25)	0.46 (0.48)
Disengagement	0.75 (0.44)	0.71 (0.41)	0.75 (0.42)	0.80 (0.47)
Neuroticism	56.39 (10.17)	52.73 (9.77) [*]	58.83 (7.87)	60.58 (9.51)
Daily Stressor Qualities				
Severity of stressor	1.18 (0.49)	1.08 (0.89) [^]	1.41 (1.01)	1.21 (0.90)
Performance (%)	782 (27%)	377 (26%)	81 (26%)	373 (27%)
Interpersonal (%)	320 (11%)	140 (10%)	43 (14%)	155 (11%)
Self (%)	172 (6%)	80 (5%)	16 (5%)	83 (6%)
Sleep (%)	367 (12%)	185 (13%)	30 (10%)	173 (13%)
Daily hassles (%)	751 (26%)	367 (26%)	73 (24%)	365 (27%)
Other (%)	112 (4%)	54 (4%)	9 (3%)	52 (4%)
No stress (%)	410 (14%)	232 (16%) ^a	56 (18%)	159 (12%)

Note: Mean(SD) unless otherwise noted as N(%). Socioeconomic status (SES) measured by Hollingshead system. Other ethnicity included Pacific Islander, Native American, multiracial or if participants indicated 'other'. Daily stress rated as 'other' included money, general or unspecified stress or other.

^{*} $p < .05$; current & past internalizing > no internalizing.

[^] $p < .05$; current internalizing > past internalizing > no internalizing

^a $p < .05$; current & no internalizing > past internalizing

Table 2
Intercorrelations of independent variables, covariates and cortisol (N = 182)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Waking cortisol	1.0													
2. CAR	-.39**	1.0												
3. Cortisol slope	-.70**	.36**	1.0											
4. Express/seek support factor	.03	-.72	-.72	1.0										
5. Problem solving factor	-.03	.12	.26	.39**	1.0									
6. Disengagement factor	.10	-.74	-.21	.51**	.34**	1.0								
7. Neuroticism	-.03	.15	.14	.19**	.14	.22**	1.0							
8. Past internalizing disorder	-.13	.15*	.15*	.02	.11	.06	.41**	1.0						
9. Current internalizing disorder	-.22**	-.00	.19*	-.05	.00	-.00	.08	.06	1.0					
10. Sleep	-.02	.11	-.13	-.01	.13	.03	.03	.03	-.13	1.0				
11. Exercise	.07	-.07	-.07	.05	-.11	.01	.07	.12	-.04	-.11*	1.0			
12. Age	-.01	.09	.02	.00	-.07	.04	.08	.19*	.02	-.06	.08	1.0		
13. Gender (Male = 1)	-.14	-.14	.09	-.20**	-.15*	.01	-.14	-.08	.08	-.07	-.08	.02	1.0	
14. Ethnicity (Minority = 1)	.12	-.15*	-.07	.11	.03	-.15*	-.00	-.04	.01	-.15*	.02	-.00	-.08	1.0

*Note: Emotion regulation factors are averaged across individuals (Level 3), CAR = Cortisol awakening response, sleep and exercise measured at the moment (Level 1), ethnicity measured as Caucasian vs. Minority status.

* $p < .05$

** $p < .01$.

Table 3
Cortisol predicted by emotion regulation and psychopathology ($N = 182$)

Variable	Model 1			Model 2		
	Coefficient	SE	p-value	Coefficient	SE	p-value
Level 1 intercept: Wake-up cortisol level π_0						
Level 1 Intercept γ_{000}	-1.44**	0.04	<.001	-1.44**	0.04	<.001
Level 2 Day disengagement β_{03}	0.04	0.09	.67	0.03	0.09	.75
Level 2 Day express emotion/seek support β_{01}	0.07	0.10	.49	0.03	0.11	.81
Current internalizing γ_{015}	--	--	--	-1.00*	0.42	.02
Past internalizing γ_{016}	--	--	--	0.23	0.17	.18
Level 2 Problem solve β_{02}	0.07	0.06	.24	0.10	0.07	.16
Average Disengagement γ_{001}	0.20*	0.09	.03	0.20*	.09	.02
Average Express emotion/seek support γ_{002}	-0.09	0.12	.46	-0.13	0.11	.25
Average Problem solve γ_{003}	-0.07	0.06	.27	-0.05	0.06	.35
Current internalizing γ_{008}	--	--	--	-0.34**	0.12	.004
Past internalizing γ_{009}	--	--	--	-0.11	0.07	.13
Cortisol awakening response π_1						
Level 1 Intercept γ_{100}	0.50**	0.04	<.001	0.49**	0.04	<.001
Level 2 Day disengagement β_{13}	-0.12	0.11	.28	-0.11	0.11	.30
Level 2 Day express emotion/seek support β_{11}	-0.05	0.11	.66	0.04	0.11	.72
Current internalizing γ_{115}	--	--	--	0.53	0.41	.20
Past internalizing γ_{116}	--	--	--	-0.66**	0.25	.009
Level 2 problem solve β_{12}	0.00	0.09	.99	-0.03	0.08	.76
Average disengagement γ_{101}	-0.16	0.10	.10	-0.15	0.09	.10
Average express emotion/seek support γ_{102}	-0.17	0.13	.20	-0.15	0.13	.25
Average problem solve γ_{103}	0.14*	0.06	.03	0.13^A	0.06	.05
Time since waking (Slope) π_2						
Level 1 Intercept γ_{200}	-0.17**	.01	<.001	-0.17**	0.01	<.001

Variable	Model 1			Model 2		
	Coefficient	SE	p-value	Coefficient	SE	p-value
Level 2 Day disengagement β_{23}	0.00	0.03	.96	-0.00	0.03	.96
Level 2 Day express emotion/seek support β_{21}	0.00	0.03	.94	0.01	0.03	.78
Current internalizing γ_{215}	--	--	--	0.12**	0.04	.007
Past internalizing γ_{216}	--	--	--	-0.02	0.03	.38
Level 2 Day problem solve β_{22}	-0.03	0.02	.07	-0.04	0.03	.06
Average disengagement γ_{201}	-0.08*	0.03	.01	-0.08**	0.03	.009
Average express emotion/seek support γ_{202}	0.00	0.04	.95	0.01	0.04	.90
Average problem solve γ_{203}	0.04	0.02	.06	0.04	0.02	.08
Momentary disengagement intercept γ_{600}	0.01	0.01	.36	0.01	0.01	.41
Momentary express emotion/seek support intercept γ_{400}	-0.00	0.02	.87	-0.00	0.01	.86
Current internalizing γ_{405}	--	--	--	0.03	0.05	.56
Past internalizing γ_{406}	--	--	--	0.07*	0.03	.03
Momentary problem solve intercept γ_{500}	0.03	0.02	.09	0.03	0.02	.10
Current internalizing γ_{505}	--	--	--	0.12*	0.04	.03
Past internalizing γ_{506}	--	--	--	-0.02	0.03	.57

Note: Internalizing= major depressive disorder and anxiety. Model 1 and 2 also controlling for sleep and exercise at Level 1, wake-time at Level 2, and age, gender, ethnicity, and neuroticism at Level 3, only significant results presented for internalizing disorders (above model was run and findings were similar to original models).

^ $p = .050$

* $p < .05$

** $p < .01$.