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SHORT COMMUNICATION

Trait and state perseverative cognition and the cortisol awakening response

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Summary Perseverative cognition (i.e., rumination, worry) may amplify or maintain cortisol stress responses. The present study examined the effects of trait and state perseverative cognition (PC) on the cortisol awakening response (CAR). We hypothesized that trait PC and state (prior day's) PC would be associated with greater CARs. Undergraduates scoring high (N = 77) and low (N = 42) on trait PC were included. Participants reported worries about upcoming events and ruminations on past events that occurred throughout the day as a measure of state PC. The next morning, saliva samples were collected 0, 30, 45, and 60 min after awakening to assess the CAR. Area under the curve (AUC) and 30-min increase (30-min Inc) were calculated to capture the salivary cortisol total output and increase relative to baseline in the hour after awakening. There was no effect of trait PC on the CAR. In contrast, reports of worrying and/or ruminating the night before predicted greater increases in cortisol concentration and total cortisol output compared to those who neither ruminated nor worried the night before. These effects were not accounted for by depressed mood, anxiety, sleep, or recent stressors. Findings suggest differential effects of trait and state PC on the CAR and highlight the importance of using proximal measures in examining individual differences in the CAR.
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1. Introduction

For individuals who worry or ruminate, the physiological effects of stress may be longer lasting which could lead to negative health consequences. Consistent with the perseverative cognition hypothesis (PCH; Brosschot et al., 2006), rumination may prolong physiological activation by amplifying acute responses, delaying recovery, or reactivating responses later in time. Recent studies have linked perseverative cognition (PC) processes (i.e., worry, rumination) to prolonged cortisol activation in the laboratory and in everyday life. For example, stress-related[1] PC measures predict

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[1] Depressive rumination (i.e., rumination on sad mood or depressive symptoms) has also been examined in the context of cortisol reactivity. Given the conceptual differences between stress-related PC and depressive rumination (c.f. Watkins, 2008), these studies are not reviewed here.

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greater cortisol reactivity and delayed recovery to laboratory stressors (e.g., Zoccola et al., 2008) and are positively associated with basal cortisol levels (McCullough et al., 2007).

The cortisol awakening response (CAR) is also of particular interest in the context of PC and prolonged physiological activation. The CAR is a naturally occurring, robust increase (50–75%) within the first hour of awakening, which is relatively stable across days (Wüst et al., 2000b). However, there is individual variability in the CAR, which may be explained, in part, by PC processes.

There is some support for an association between trait PC and the CAR. The CAR is positively associated with chronic worrying (Wüst et al., 2000a; Schlotz et al., 2004), and tendencies for work-related worry in female (but not male) white-collar workers (Gustafsson et al., 2008). To date, only one study has examined a state PC measure and its association with the CAR, and it showed that sleep-related thoughts and rumination in bed predicted a reduced CAR the next morning (Backhaus et al., 2004). This finding contradicts expectations of the PCH and may be a result of methodological issues (e.g., the sample included insomnia patients, who showed greater rumination and decreased morning cortisol).

The present study examined whether trait and state measures of PC were associated with the CAR. Consistent with theoretical expectations outlined in the PCH (Brosschot et al., 2006), we hypothesized that trait and state PC would predict a more pronounced CAR. Specifically, those high on trait PC would have greater CARs than those low on trait PC; and those who engage in state PC the day prior will have greater CARs compared to those who do not.

2. Methods

2.1. Participants

Participants included 119 healthy undergraduate students (*M* age = 20.8, SD = 4.0 years; 60% female), who were ethnically diverse: 59% Asian, 11% non-Hispanic white, 10% Hispanic or Latino/a, 8% middle eastern, 12% multi-ethnic/other.

Interested students completed a 5-min questionnaire through the online university subject pool, and were screened out for behaviors, conditions, and medications which influence the hypothalamic–pituitary–adrenal (HPA) axis (e.g., smoking, pregnancy, medication use) based on self-reported information. Individuals were also screened for PC tendencies and risk for depression. Those who scored in the top and bottom 33% of the Rehearsal subscale of the Revised Emotion Control Questionnaire (ECQ2-R; Roger and Najarian, 1989) were invited to participate: high trait PC group: *N* = 76; 63% female, low trait PC group: *N* = 43; 53% female. The full range of depressed mood scores was included among those in the high trait PC group to examine its independent effect on the CAR since depression and trait depressive rumination have been associated with blunted CAR and stress responses in past studies (Burke et al., 2005; Zoccola et al., 2008). Within the low trait PC group, only individuals scoring below the risk-for-depression cutoff were invited to participate (details below).

2.2. Procedures

During an initial laboratory visit, participants provided demographic and health information and filled out standardized questionnaires. Before bed and after awakening, participants completed questionnaires assessing state PC, daily stressors, and sleep. Participants wore actigraphs on their wrists throughout the night and collected saliva samples the next morning. Later that day, participants returned materials to the laboratory and were compensated with course credit. Informed consent was obtained from all participants. All procedures were approved by the University of California, Irvine, Institutional Review Board.

2.3. Measures

2.3.1. Trait PC

Trait PC was measured with the ECQ2-R (Roger and Najarian, 1989) during the screening. Higher scores reflect a greater tendency to mentally rehearse past negative events (range: 0–14). The current sample was comprised of individuals with above- and below-average tendencies to ruminate: high trait PC range: 8–14, *M* = 9.41, SD = 1.2; low trait PC range: 2–5, *M* = 4.00, SD = 0.87.

2.3.2. State PC

State PC was assessed with two yes/no questions on the night of the laboratory visit (before bed): (1) rumination: ''Today, were there times when you tended to 'ruminate' or dwell over negative things that happened to you or upset you any time in the past?'' (2) Worry: ''Today, were there times when you tended to worry or focus on negative things that may occur or happen to you in the future?'' Based on these responses, participants were categorized in one of three groups: both worried and ruminated (*N* = 42); either worried or ruminated (*N* = 45); and neither (*N* = 32).

2.3.3. Depressed mood

Depressed mood was assessed in two ways. For the screening, the short (9-item) Center for Epidemiological Studies Depression Scale (sCES-D) measure was used (cutoff score = 4; Santor and Coyne, 1997). The current sample had the following scores: high trait PC range: 0–9, *M* = 3.42, SD = 2.92; low trait PC range: 0–3, *M* = 0.42, SD = 0.76. The 20-item CES-D measure was completed during the laboratory session to examine current depressed mood (Radloff, 1977).

2.3.4. Current anxiety and recent stressors

State anxiety was assessed in the laboratory with the Spielberger State-Trait Anxiety Inventory (Spielberger et al., 1970). Before bed, participants reported the frequency of 17 negative event items that occurred throughout that day as a measure of recent stressors.

2.3.5. Sleep

Sleep was assessed with the Pittsburgh Sleep Quality Index (Buysse et al., 1989) and actigraphy (GT1M monitors; ActiGraph, LLC: Pensacola, FL). Motion was continuously monitored by the actigraph throughout the night. Actigraphic raw data was downloaded and each minute between time in-bed and time out-of-bed (self-reported) was scored as sleep or

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