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Cognitive reappraisal increases neuroendocrine reactivity to acute social stress and physical pain

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Summary Cognitive reappraisal can foster emotion regulation, yet less is known about whether cognitive reappraisal alters neuroendocrine stress reactivity. Some initial evidence suggests that although long-term training in cognitive behavioral therapy techniques (which include reappraisal as a primary training component) can reduce cortisol reactivity to stress, some studies also suggest that reappraisal is associated with heightened cortisol stress reactivity. To address this mixed evidence, the present report describes two experimental studies that randomly assigned young adult volunteers to use cognitive reappraisal while undergoing laboratory stressors. Relative to the control condition, participants in the reappraisal conditions showed greater peak cortisol reactivity in response to a socially evaluative speech task (Experiment 1, $N = 90$) and to a physical pain cold pressor task (Experiment 2, $N = 94$). Participants in the cognitive reappraisal group also reported enhanced anticipatory psychological appraisals of self-efficacy and control in Experiment 2 and greater post-stressor self-efficacy. There were no effects of the reappraisal manipulation on positive and negative subjective affect, pain, or heart rate in either experiment. These findings suggest that although cognitive reappraisal fosters psychological perceptions of self-efficacy and control under stress, this effortful emotion regulation strategy in the short-term may increase cortisol reactivity. Discussion focuses on promising psychological mechanisms for these cognitive reappraisal effects.

Cognitive reappraisal is an emotion regulation strategy that entails mentally modifying the way a situation is evaluated typically prior to the elicitation of a full-scale, negative emotional response (for a review, see Gross and Thompson, 2007). For example, one could reframe an upcoming public

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speaking engagement as a welcome opportunity to disseminate research findings rather than perceive it as a negative, socially evaluative event. Reappraisal typically includes mentally distancing oneself from a stressor, thinking about the stressor in objective, non-emotional terms, and positively re-evaluating the stressor. Classic work on stress and coping has long emphasized the effects of appraisal and reappraisal processes in supporting mental and physical well-being (Lazarus and Folkman, 1984; Folkman et al., 1986). Some studies suggest that habitual use of cognitive reappraisal, as an emotion regulation strategy, is associated with greater levels of positive affect, better interpersonal functioning, and well-being under some circumstances (Gross and John, 2003; John and Gross, 2004; Troy et al., 2013).

Some researchers have posited that reappraisal may be associated with lower physiological reactivity (Gross and John, 2003; John and Gross, 2004). Indeed, studies have shown that intensive training in cognitive—behavioral techniques (which emphasize reappraisal strategies) can reduce neuroendocrine stress reactivity in healthy volunteers (e.g., Gaab et al., 2003). However, this previous work implemented therapy that consisted of multiple components such as relaxation, cognitive restructuring, problem solving, and self-instruction (Gaab et al., 2003). In order to experimentally isolate the effects of cognitive reappraisal on cortisol responses to stress, we instructed participants to only use cognitive reappraisal. Furthermore, a recent study showed that reappraisal was associated with heightened neuroendocrine reactivity to acute stress. Specifically, this study showed that dispositional tendencies to use reappraisal (as measured by self-report) was associated with increased cortisol response to a modified version of the Trier Social Stress Task (TSST) (Kirschbaum et al., 1993; Lam et al., 2009; cf. Koh et al., 2006). These initial studies provide mixed evidence for the effects of cognitive reappraisal on acute stress reactivity, but did not experimentally test the use of cognitive reappraisal under stress. To address these issues, the present investigation experimentally manipulated the use of a cognitive reappraisal strategy on neuroendocrine responses to a stressful public speech (i.e., the TSST) (Experiment 1) and to a cold pressor task (Experiment 2).

Although no previous studies have tested whether manipulating cognitive reappraisal effects neuroendocrine stress reactivity, two initial studies suggest that experimental manipulations of cognitive reappraisal alter cardiovascular stress reactivity. In these experiments, participants were exposed to stressors and asked to reappraise their physiological arousal as performance enhancing. Relative to control participants, those who reappraised showed less vasoconstriction and heightened cardiac output (Jamieson et al., 2012). In a second experiment, participants who reappraised arousal due to problems from the Graduate Record Examination (GRE) showed increases on a measure of sympathetic nervous system arousal (i.e., salivary alpha amylase). They even performed better on the math section of the actual GRE (Jamieson et al., 2010). Moreover, this work argues that reappraising stressful situations can elicit challenge appraisals and physiological activation for effective coping (Jamieson et al., 2013). Thus, cognitive reappraisal during acute stressors may be challenging and effortful, yet simultaneously enhance feelings of self-efficacy and control over the stressor.

The present research describes the first experimental investigations of cognitive reappraisal on cortisol reactivity to stress. We hypothesized that reappraisal would increase cortisol responses to public speaking (Experiment 1) and physical pain (Experiment 2). Given the emerging research showing that reappraisal increases sympathetic nervous system arousal (Jamieson et al., 2010), we also predicted that reappraisal would increase heart rate responses to the stressors.

1. Experiment 1

In Experiment 1, participants completed a modified TSST (Kirschbaum et al., 1993). The original TSST contains a 10-min preparation period followed by 10 min of the speech and mental arithmetic. Our modified version contained a 10-min preparation period and 5 min of speech. We intentionally used the same modified TSST as Lam et al. (2009) because that was the only study to date to examine reappraisal and cortisol. Participants in the reappraisal condition were given instructions on how to use cognitive reappraisal during the stressor. Participants in the control condition did not receive any instructions. Relative to the control condition, we expected to see a greater increase in cortisol reactivity to the stressor among participants in the reappraisal condition.

1.1. Method

1.1.1. Participants and design

A total of 90 healthy undergraduates (47 women; M_{age} = 20.54 years, SD = 3.62) from UNSW Australia participated in the experiment for course credit or AUD$25. Participants provided written informed consent and all procedures were conducted in accordance with the Declaration of Helsinki. We asked participants not to eat, exercise, or consume caffeine 2 h prior to the experiment. Exclusion criteria included smoking, regular recreational drug use, chronic infections, cancer, tumors, any immune, autoimmune, or metabolic disease, endocrine disorders, use of contraceptive medication, pregnancy, and breastfeeding. Participants were randomly assigned to either the cognitive reappraisal condition (n = 45), or the control condition (n = 45). Men and women were equally distributed across conditions, $\chi^2(1, N = 90) = 0.05$, $p = 83$, as was menstrual cycle phase, $\chi^2(2, N = 47) = 3.85$, $p = 15$.

1.1.2. Materials and procedure

Research participation occurred between the hours of 1200 h and 1800 h. Participants were informed that the study was investigating the link between communication abilities and physiological responses. Participants were seated at a desk and fitted with a Polar™ Watch heart rate monitor. A 40-min passive rest period followed, during which participants completed questionnaires and read affectively neutral nature magazines in the remaining time. Following the rest period, the experimenter took the first of three saliva samples for cortisol with a cotton Salivette (Nümbrecht, Germany).