

Writing about Stressful Events Using Cognitive Reappraisal:
Consequences for Emotional Well-Being

A Senior Honors Thesis submitted by

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Abstract

Cognitive reappraisal (CR) is an adaptive emotion regulation strategy that has been shown to be effective at down-regulating the neural and physiological impact of emotional stimuli. Despite its benefits, it seems that people rarely use CR to deal with stressful situations in their daily lives. The current study sought to encourage the use of CR in the context of daily life stressors using an expressive writing paradigm. Participants were 61 undergraduate and graduate students. Participants wrote about the most stressful event of their day on three consecutive days. They were randomly assigned to receive either CR writing instructions or Expressive Writing (EW) instructions. The EW group was asked simply to write about their deepest thoughts and feelings surrounding the chosen event, while the CR group was asked to write with the explicit goal of stress reduction, and were provided with several examples of ways to facilitate cognitive reappraisal. In addition, ambulatory physiological signals related to emotional arousal were measured for the duration of the study. It was predicted that participants in the CR group would experience less negative emotions immediately following writing, would show greater reductions in depression symptoms after the three-day writing period, and would experience less emotional arousal over the course of the study. Results show that negative mood increased significantly after writing in the EW group but not in the CR group. Depression scores in the CR group significantly decreased over the course of the study, while the EW group's scores did not, resulting in a significant difference between the two groups. There were no group differences in average galvanic skin response or skin temperature. The self-report results lend further support to the idea that writing about daily stress using cognitive reappraisal can lead to improved emotional

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well-being. However, the physiological null effect indicates that more research is needed to better understand the physiological mechanism underlying the perceived benefits conferred by CR writing.

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Writing about Stressful Events Using Cognitive Reappraisal:

Consequences for Emotional Well-Being

Stressful life events, though trying in the moment, are sometimes unavoidable, and can even be desirable as some risks have the potential to lead to greater rewards. However, if left unchecked stress can take a heavy toll on physical and mental health. It has been shown that stressful life events can lead to or exacerbate the expression of psychopathology (Dohrenwend, 2000). Of course, there are individual differences in the ways in which people respond to the same stressor. For example, many people would have no problem giving a presentation in front of a small audience, while for others this same task might cause a tremendous amount of perceived stress and anxiety, and consequently pose a large obstacle. Some of these individual differences have been attributed to differing abilities to regulate emotions, and indeed the consistent inability to appropriately regulate one's emotions is associated with several mental illnesses including depression, anxiety disorders, conduct disorder, bipolar disorder, borderline personality disorder, substance abuse disorders, and eating disorders (Cole, Hall, & Hajal, 2008).

According to prominent theories of emotion and emotion regulation, there are five points in the emotion generative process in which an individual can regulate their emotional response to a stimulus. These include antecedent-focused changes such as situation selection, situation modification, attentional deployment, and cognitive change, which occur before the completion of the emotional response, as well as response modulation which can take place after the initial appraisal and reaction to the stimulus (Gross & Thompson, 2007). Much attention has been paid to the use of cognitive change

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as a means of regulating emotions, and it underpins one of the most empirically supported therapies for the treatment of depression and anxiety, Cognitive Therapy or Cognitive-Behavioral Therapy (Butler, Chapman, Forman, & Beck, 2006). Additionally, in laboratory settings it has been shown that participants instructed to use cognitive reappraisal to down-regulate emotional responses while viewing negative stimuli, that is changing the way they evaluate the stimulus in order to change its emotional impact, subjectively report experiencing less negative emotion than those not instructed to reappraise (Gross & John, 2003; Denny & Ochsner, 2014). Cognitive reappraisal has also been shown to be effective at down-regulating neural and physiological reactions to emotional content (Ochsner, Silvers, & Buhle, 2012; Urry, 2010). However, the ecological validity of commonly used emotion eliciting paradigms done in the laboratory remains in question (Aldao, 2013).

Habitual use of cognitive reappraisal in daily life has been linked to fewer depressive symptoms (Gross & John, 2003; Garnefski & Kraaij, 2006). In clinical populations, it has been reported that those with major depressive disorder (MDD) use significantly less positive reappraisal than non-clinical populations as assessed by The Cognitive Emotion Regulation Questionnaire (CERQ), and that positive reappraisal use is negatively correlated with depressive symptoms in MDD patients (Lei, Zhang, Cai, Wang, Bai, & Zhu, 2014). In one field study using a non-clinical population, 30 trainee teachers participated in an ambulatory emotion-regulation intervention, and were either encouraged to use engaging or diverting emotion regulation strategies over the course of four days. Not only was the intervention successful at getting the participants to increase their usage of particular strategies in daily life as assessed by ecological momentary

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sampling every 2 hours, those who were encouraged to use more engaging strategies including reappraisal reported increased cheerfulness during the intervention compared to the diversion group, and reappraisal use was a positive predictor of cheerful mood overall (Totterdell & Parkinson, 1999). Despite the apparent benefits of cognitive reappraisal use, in an experience sampling study of emotion regulation strategy use in daily life, reappraisal was found to be used less frequently than reflection, distraction, rumination, and suppression (Brans, Koval, Verduyn, Lim & Kuppens, 2013).

In light of these results, it can be asked whether encouraging the use of cognitive reappraisal in the context of daily life stressors could lead to improved psychological health and well-being. One way that this has been done is by modifying an existing paradigm borrowed from the Expressive Writing literature. The theory of expressive writing, advanced primarily by the work of James Pennebaker, is based on the idea that disclosing traumatic events through writing, specifically by writing about one's thoughts and feelings about them over a number of sessions, can confer significant benefits to both physical and psychological well-being as compared to control subjects writing about neutral topics (Pennebaker & Beall, 1986; Smyth, 1998). Although a specific mechanism for how written disclosure confers these benefits is as of yet still unknown, it has been proposed that expressive writing involves regulating emotions related to the stressful or traumatic events, which in turn improves physical and mental health outcomes (Lepore, Greenberg, Bruno, & Smyth, 2002). If this is in fact the case, it follows that instructing participants to write about their experiences in a way that explicitly utilizes an adaptive emotion regulation strategy like cognitive reappraisal might result in more substantial benefits to well-being than expressive writing alone.

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Preliminary support for this hypothesis comes from a study that used text analysis of expressive writing samples to find out what kinds of writing resulted in better outcomes. In the study by Pennebaker and Francis (1996), student participants in the experimental condition wrote for twenty minutes on three consecutive days about their deepest thoughts and feelings concerning the transition to college. Those participants whose use of words associated with insight (e.g., understand, realize) or causation (e.g., because, reason), both concepts related to cognitive change, increased over the three days of writing had significantly fewer illness-related visits to the health center in the two months following the manipulation. Additionally, it was found that those who used more positive emotion words also demonstrated improved health (Pennebaker & Francis, 1996). Thus, although participants were not explicitly told to use cognitive reappraisal in their writing, it would appear that those who spontaneously demonstrated more positive cognitive change in their writing had better outcomes; however it is important to note that directional causation cannot be inferred.

Although there have been few studies asking participants to specifically use cognitive reappraisal in their writing, some have included conditions that might logically lead to more reappraisal use. In one study, participants were asked to journal twice a week for one month about either a stressful or traumatic topic in their own lives, or to write factually about one chosen from the media (Ullrich & Lutgendorf, 2002). Participants writing about personal events were given either traditional expressive writing instructions asking them to write about their deepest thoughts and feelings about the chosen topic, or instructions meant to facilitate cognitive processing of the event. In addition to asking them to write about their deepest thoughts and feelings, participants in

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this latter group were told to write about how they were making sense of the situation, how they were trying to deal with it, and how they expected their emotions about it to change, each of which could elicit cognitive reappraisal. Only participants in this second cognitions and emotions group showed increases in positive growth from trauma over the writing period (Ullrich & Lutgendorf, 2002).

In another recent study participants were asked to write each day for one week about the most stressful event of their day (Ng & Diener, 2013). Participants were randomly assigned to control, focusing, or reappraisal conditions. Those in the control group briefly described the most negative event of their day and then proceeded immediately to emotion ratings. In the focusing group, after describing their chosen event, participants were prompted to think and write about the situation in a ruminative manner, focusing on what they were thinking and feeling as it occurred, and considering what the causes and consequences of the event were, before moving on to the emotion ratings. Those in the reappraisal group were instructed to try to reinterpret the event, to think about possible positive outcomes of the event, and to consider ways to improve the situation. Consistent with their hypothesis, the researchers found that participants who used cognitive reappraisal strategies when writing about unpleasant daily events felt less severe negative emotions about these events than those in the other two conditions. This conclusion provides perhaps the most compelling evidence to date that encouraging cognitive reappraisal in the ecologically valid context of daily stressors can lead to improved emotional well-being.

Finally, prompted by these promising results, a weeklong internet-based study was conducted comparing the effects of cognitive reappraisal writing and traditional

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expressive writing about daily stressors on self-reported psychological well-being (Raskin, Floerke, Vujovic, & Urry, 2015). As expected, textual analyses revealed that although some participants in the expressive writing condition spontaneously demonstrated cognitive reappraisal use, approximately 25%, it was used significantly more when explicitly encouraged by cognitive reappraisal instructions, bringing the percentage of those who used it in their writing to just over one half in the cognitive reappraisal instruction condition. Although improvements in mood across the week of writing was reported in both groups, participants in the expressive writing group reported experiencing an increase in negative emotions immediately following the daily writing paradigm, perhaps due to the negative emotional arousal involved with re-experiencing the stressful event while writing. This increase in negative emotions following writing was not seen in the cognitive reappraisal group, suggesting that the reappraisal instructions protected against the rise in negative emotions associated with thinking about a past stressor. This in turn mediated an indirect effect of group on depressive symptoms, with those who did not show a rise in negative emotions after writing reporting less depressive symptoms at the conclusion of the study. A similar writing paradigm was used in the current study in an attempt to replicate and extend these findings. Specifically, the study was shortened to see if benefits of cognitive reappraisal writing could be seen after only three writing sessions, and a physiological measure of emotional arousal was added to see if changes in self-report ratings of emotional well-being could be linked to differences in sympathetic nervous system activation.

In the current study, participants were asked to write about the most stressful event of their day for between 5 and 15 minutes on three consecutive days. Participants

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were randomly assigned to receive either expressive writing (EW) instructions, which prompted them to write about their deepest thoughts and feelings about the event, or cognitive reappraisal (CR) writing instructions, which prompted them to write about their deepest thoughts and feelings about the event with the explicit goal of facilitating stress reduction. Examples of several common cognitive reappraisal strategies were provided to this latter group in order to guide them in their task. Participants completed emotion regulation, depression, and physical health questionnaires before and after the three day writing period, as well as mood ratings immediately prior to and following the writing task itself on each writing day.

One of the common limitations of studies assessing emotion regulation strategies in daily life is their reliance on self-report outcome measures, which are susceptible to demand characteristics. To avoid this potential confound, participants were also given armbands to wear for the duration of the three-day writing period, which collected ambulatory physiological measures related to emotional arousal. The hope was that by adding objective physiological measures, the self-report findings could be corroborated by measures less likely to be affected by participant expectations or bias. There is some evidence that reappraisal-related changes to autonomic physiology index emotional arousal, and that electrodermal activity is significantly lower when participants are instructed to use CR to down-regulate their emotions when exposed to unpleasant stimuli than when they are instructed to maintain their natural emotional response (Urry, van Reekum, Johnstone, & Davidson, 2009). However, several studies only found a difference in electrodermal activity when the subjects were instructed to increase their emotional response using CR, and saw no change from the maintain condition when

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instructed to use CR to decrease negative emotions (Urry, 2009; Urry 2010; Eippert et al., 2007).

Based on previous findings, it was expected that the EW group would report an increase in negative emotions from pre to post-writing, but that this increase would not be seen in the CR group. Although the previous study did not find a direct effect of group on depression symptoms, there was an indirect effect of group mediated by post-writing emotion ratings, so again it was hypothesized that the CR group might show a greater reduction in depression symptoms after the three days of writing than the EW group. Furthermore, it was hypothesized that the CR group might experience less emotional arousal over the course of the writing period.

Method

Participants

Participants were 61 Tufts University undergraduate and graduate students. Of these, 41 participants were female (67%), 29 were White (48%), 26 were Asian (43%), 9 were Black or African American (15%), 3 were multiracial (5%), and one person did not wish to disclose this information (2%); 3 of our participants considered themselves to be of Hispanic or Latino origin (5%). Participants ranged in age from 18 to 32 ($M = 20.32$, $SD = 2.66$), with one participant declining to answer.

Study participants were recruited through online advertisements posted on a university message board (www.tuftslife.com), and were randomly assigned to Cognitive Reappraisal Writing ($n = 32$) or Expressive Writing ($n = 29$) conditions. All participants indicated their informed consent to the study procedures during their first laboratory session, which were approved by the Social, Behavioral, and Educational Research

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Institutional Review Board at Tufts University. Participants were compensated \$50 for completing all parts of the study.

Materials

Well-Being Survey. The Well-Being Survey consists of several self-report instruments designed to assess aspects of psychological and physical well-being. The measures being reported on in the current study are described in further detail below. Additional measures assessing emotion regulation strategy use, approach and avoidance, sleep, physical health, and life events were also collected but will not be reported in the interest of focusing on the primary hypotheses (see Appendix for a more detailed description of the Well-Being Survey). The Well-Being Survey was administered online via Qualtrics (Provo, UT) on one of the laboratory desktop computers, and took approximately 25 minutes to complete. Each participant completed the Well-Being Survey twice, once at baseline and again on Day 4 of the study after having completed three days of the writing protocol.

BDI. The Beck Depression Inventory II (BDI-II) is a 21-item scale assessing severity of depression (Beck, Steer & Brown, 1996). Items are grouped by depression criteria and symptoms, and participants are asked to respond to each item according to how much they felt each during the past month. Internal consistency estimates for reliability are good for the BDI-II total scale for a college sample (.90), and the BDI-II total scale is significantly related to the STAI-D and STAI-A, indicating good convergent validity (Storch, Roberti, & Roth, 2004). Items are scored on a 4-point Likert scale ranging from least to most severe, including a “Decline to Answer” option. Items assessing sleep and appetite are scored differently to reflect their bi-directional nature.

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Item 9 assessing suicidality was not presented due to the non-clinical nature of the sample and item 11 assessing agitation was not presented due to an oversight by the experimenter, these omissions were compensated for in our analyses using a mean substitution procedure in which those two items were included for each subject as their mean score on the total scale (Schafer & Graham, 2002).

Demographics. Basic demographic information including race, age, gender, education level, marital status, children, and number of people living with the participant was collected as a part of the Well-Being Survey. Each question included the option to decline to answer.

Debriefing Questions. In addition to the information listed above, the second Well-Being Survey administered on Day 4 also included a series of debriefing and manipulation check questions. Specifically, participants were asked what they thought the researchers expected to find in the study and what effect they thought the writing was intended to have on them. Finally, participants were asked whether or not they thought their data should be included in the final analyses of the study and if not, why.

Writing Survey. The Writing Survey was also administered online via Qualtrics. A link to the survey was sent to participants by email at 6:00pm on three consecutive evenings during the study for subjects to complete at home. The first page of the survey reminded participants that by continuing they reaffirm their consent to participate in the study.

Before Writing. Prior to the writing protocol, subjects were asked to rate their overall level of happiness for the day on Likert scale ranging from 0 (Very Unhappy) to 7 (Very Happy). Next they were asked to make a similar rating for their level of overall

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daily stress. Subjects were then presented with a list of 17 mood triplets and were asked to indicate using sliders how much they were feeling each at the current moment on a scale from 0 (Not at all) to 7 (Very much). Triplets included related emotion words such as “anxious/ worried/ fearful” and “happy/ pleased/ contented.” Dispersed randomly among the triplets were two manipulation check instructions that ask the subject to move the slider to a specific place on the number line. Next, subjects in both conditions were asked to write one sentence describing the most stressful situation of their day. They were then prompted to indicate approximately at what time the event began and ended, who they were with during the event, and what category the stressful event best fit under, for example “My job” or “Relationship with my family,” etc. Participants rated how stressed they were during the event on a scale from 0 (Not at all stressed) to 7 (Very stressed).

Writing Protocol. Participants in the Expressive Writing (EW) and Cognitive Reappraisal Writing (CR) conditions received slightly different instructions for the writing portion of the survey. Both groups were asked to write for between 5 and 15 minutes about their deepest thoughts feelings related to the stressful event they chose in the previous section. Subjects in the CR condition were additionally instructed to reappraise the situation in a more positive light, that is, to think and write about the event in a way that will make them feel less stressed. See the sample instructions below.

EW Instructions: “You described your stressful event as follows: [Participant’s one sentence description]. With this stressful event clearly in mind, we’d like you to write about it in more detail. For the next 5-15 minutes, please write about your *deepest thoughts and feelings* about the stressful event. Describe what happened, how you felt, and what you were thinking at the time. Also describe how you’re feeling and what

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you're thinking now. Importantly, as you write about the event, do your very best to express exactly how you feel and what you think about this event. The goal is to write down whatever thoughts and emotions naturally occur for you. Please do your best to achieve this goal.”

CR Instructions: “You described your stressful event as follows: [Participant’s one sentence description]. With this stressful event clearly in mind, we'd like you to write about it in more detail. For the next 5-15 minutes, please write about your *deepest thoughts and feelings* about the stressful event. Describe what happened, how you felt, and what you were thinking at the time. Also describe how you're feeling and what you're thinking now. Importantly, as you write about the event, do your very best to think and write about this event in such a way that you feel less stressed. Specifically, try to reassess the situation in a way that makes you feel better about it. There are many ways to accomplish this goal. Here are several examples of what you might write about:

- consider whether the negative consequences are actually less negative than imagined
- consider whether there are positive consequences or opportunities
- consider the event from an objective perspective, doing your best to separate the facts of the event from your thoughts and feelings about it
- consider what you'd say to a close friend to help him or her feel less stressed in the same situation
- if another person was the source of the stressful event, consider his or her perspective

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Any of these options are fine and you may have other ideas too. The goal is to think and write about this event in such a way that you feel less stressed. Please do your best to achieve this goal.”

Subjects in both conditions were instructed to describe in their own words what their task was for the writing protocol. Then, subjects were taken to a page with a text box into which they were directed to enter their writing. A timer was visible at the bottom of this page to help participants keep track of how long they had been writing.

After Writing. After completing the writing portion, participants were instructed to complete the mood triplets questionnaire for a second time. The final portion of the Writing Survey asked participants how they felt about the writing task. They were given nine statements about the task such as “The writing task was difficult” and “There was little value in today’s writing” and are instructed to rate on a 7-point Likert scale how much they agree with each statement. Finally, participants came to a page thanking them for completing the day’s survey.

BodyMedia SenseWear Armband. Participants in both conditions were given a BodyMedia SenseWear Armband model MF-SW (Pittsburgh, PA) to wear for the duration of the study. The SenseWear Armband is a small ambulatory monitoring device that is worn on the back of the upper arm and secured by an elastic Velcro strap. The armband contains multiple sensors for measuring 3-axis accelerometry, heat flux, skin temperature, near body temperature, and galvanic skin response (GSR). The SenseWear Professional 8.0 Software uses this data to calculate energy expenditure, activity level, and sleep duration and quality. Ambulatory GSR and skin temperature data were of primary interest in this study because electrodermal activity is a peripheral measure of

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sympathetic nervous system activation, which can indicate emotional arousal. The GSR sensor's calibrated range is 56k Ohms to 20 MOhms (50.0 nSiemens - 17.0 μ Siemens), two-standard-deviation of error of \pm 9.0 nSiemen, 50 to 225 nSiemens, two-standard-deviation error of \pm 4.0% otherwise. The skin temperature sensor has a calibrated range of 20.0°C to 40.0°C, with a minimum resolution of 0.05°C and two standard deviation accuracy of \pm 0.8°C. Average GSR and skin temperature were sampled at a rate of 1 Hz. Participants were instructed to wear the armband for approximately 23 hours a day, removing it while bathing, until returning it at the final laboratory session. Participants were instructed to clean the sensors daily using a moistened paper towel. Armbands were disinfected between uses with 70% isopropyl alcohol wipes and the straps were washed between subjects with water and detergent.

Procedures

Upon their enrollment in the study, all participants were randomly assigned to either the Expressive Writing (EW) condition or the Cognitive Reappraisal writing (CR) condition. During the initial laboratory visit, participants indicated their informed consent to the study procedures. The consent form included descriptions of the study components and any potential risks or benefits, participants were informed that they would be writing about daily stressful events, but the differences in writing instructions for each group were not described in detail. Participants then completed the first Well-Being Survey, which was administered via Qualtrics (Provo, UT) on one of the desktop computers in the laboratory. At this time the researcher also obtained the height, weight, birth month and year, and smoking status of the participants. This information must be entered for each participant in order for the SenseWear Professional 8.0 software to accurately analyze the

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raw data collected by the armband. They were then fitted with a BodyMedia SenseWear Armband. Participants were instructed on how to properly use the device, and were asked to wear the armband for as close to 23 hours a day as possible until returning to the lab on Day 4. At 6:00pm on Days 1, 2, and 3, all participants were sent an email link to the Writing Survey to be completed on the computer at home. Both groups were asked to write for between 5 and 15 minutes about the most stressful event of their day on the three consecutive evenings following their initial lab visit according to instructions described above. On Day 4 of the study, participants in both groups came back to the laboratory to complete the second Well-Being Survey and return the armband. At this session participants also received a debriefing form describing the purpose of the study, and received their \$50 compensation for completing the study (See Table 1 for an overview of the study timeline). Due to hazardous weather conditions, four subjects completed the final Well-Being Survey at home via email link, and came back to the laboratory on a later date to return their armband, get debriefed, and receive their payment.

Results

Data Reduction

Dependent variable measures were mean positive and negative mood before and after writing, mean BDI scores, and mean GSR and skin temperature on each day. Mean positive mood was calculated by averaging ratings (ranging from 0 - Not at all to 7 - Very much) of the 6 positive mood triplet items separately for before and after writing. The same was done to calculate mean negative mood scores using the 10 negative mood triplet items.

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Depressive symptoms were measured using 19 items from the BDI-II. Items were coded on a scale of 0-3 from least to most severe, and items 16 and 18 assessing sleep and appetite changes were coded according to their bidirectional nature. A mean substitution was used to convert the scores to a 63-point scale comparable to that used in the 21-item version of the measure. Subjects with missing values were excluded from our analyses, yielding a final sample of $N = 57$, ($CR = 31$; $EW = 26$).

To control for circadian effects (Doberenz, Roth, Maslowski, Wollburg, & Kim, 2011), only physiological data collected during a fixed 5-hour time interval that was present for all participants, 7:00pm-12:00am, was included in the analyses of average ambulatory GSR and skin temperature. Data for all dependent variables were analyzed using General Linear Models (GLMs).

Does encouraging CR actually lead to more CR use when writing about stressful events?

To determine whether the CR writing instructions actually lead to more CR use, writing samples from Day 3 were coded for the presence of CR use by an independent rater who was blind to group assignment. Data from Day 3 were used for this analysis because it was assumed that by the last day of writing participants would be comfortable with the instructions and most likely to be successful at their respective tasks. The same coding scheme was employed as was used in Raskin, Floerke, Vujovic, & Urry (2015). The rater coded each writing sample on a scale from 0 - CR definitely absent to 3 - CR definitely present. CR use was defined as the participant engaging in any of the following with the goal of feeling better about their chosen event: generating an interpretation, explanation, insight, or finding meaning; finding some higher meaning in the situation;

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separating facts from thoughts/feelings; seeing the event from another's perspective to understand his or her point of view (as opposed to negative mind-reading or finger-pointing); seeing the event from an objective perspective; restructuring one's way of thinking about the situation in a more positive light; seeing positive consequences or opportunities as direct outcomes; finding the silver lining; or finding that consequences are actually less negative than imagined.

In total, 59 writing samples from Day 3 were coded for CR use (CR = 31; EW = 28). Two writing samples were excluded because the authors' indicated that they did not want their writing used in our analyses for privacy reasons. As expected, the average score for CR use was higher in the CR writing group ($M = 1.87, SD = 1.02$) than in the EW group ($M = 0.82, SD = 0.90$). An independent samples t-test confirmed that this difference was statistically significant $t(57) = 4.15, p < 0.01$, suggesting that CR writing instructions did result in more CR use than EW instructions when writing about daily stress. Effects of mean writing time (from first click in the text box to submission of the writing sample on each day) were analyzed using a GLM. No systematic difference in writing duration was seen between groups, $F(1, 59) = 0.313, p = 0.587$, and therefore could not have contributed to the between-groups difference in CR use.

Does writing about stressful events using CR protect against negative emotions?

In the GLM examining self-reported mood, there were four factors: group (CR, EW), day (1, 2, 3), time (before writing, after writing), and valence (positive, negative). There was no main effect of group, $F(1, 58) = 0.087, p = 0.769$, and no two-way interactions between group and time, $F(1, 58) = 0.292, p = 0.591$, or group and day, $F(2, 116) = 0.107, p = 0.899$. There were, however, significant interactions between group and

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valence, $F(1, 58) = 9.929, p = 0.003$, and between group, valence, and time, $F(1, 58) = 13.688, p < 0.001$. The latter suggests that the effect of group on mood depended on whether the mood was negative or positive and whether it was measured before or after writing. There were no effects involving group and day, suggesting that the interactive effect of group, valence, and time was constant across study days, all $ps > .05$.

Importantly, the two groups reported similar levels of negative and positive mood before writing on day 1, both $ps > .05$.

In the EW group, the simple effects of time revealed that mean positive mood decreased significantly from before to after writing with a mean difference of $-0.600, F(1, 58) = 40.444, p < 0.001$. In the CR group, positive mood also decreased significantly from before to after writing but to a lesser extent, with a mean difference of $-0.263, F(1, 58) = 8.289, p = 0.006$. Negative mood increased significantly from before to after writing in the EW group, with a mean difference of $0.304, F(1, 58) = 13.428, p = 0.001$. Mean negative mood decreased slightly from before to after writing in the CR group, with a difference of -0.109 , however the difference was not significant, $F(1, 58) = 1.838, p = 0.180$. These results suggest that the three-way Group x Valence x Time interaction can be explained by the fact that the EW group experienced a decrease in positive emotions and an increase in negative emotions from before to after writing, while the CR group experienced a decrease in positive emotions but to a lesser extent than the EW group, and reported no significant changes in negative emotions from before to after writing (see Figure 1).

In Group x Valence x Time univariate tests of group, there were no significant differences between groups before writing in mean positive mood, $F(1,58) = 3.573, p =$

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0.064, or mean negative mood, $F(1, 58) = 2.772, p = 0.101$, however there was a trend for the EW group have higher negative mood scores and lower positive mood scores pre-writing. After writing there were significant differences between group means for positive mood, $F(1, 58) = 7.093, p = 0.010$, and negative mood, $F(1, 58) = 9.876, p = 0.003$, with the CR group having significantly higher positive mood and significantly lower negative mood than the EW group post-writing across all days. Excluding outliers and including gender in the model did not change the overall pattern of results.

Does CR writing about daily stress reduce depression symptoms?

In the GLM used to analyze BDI scores, the within-subjects factor was day (1, 4) and the between-subjects factor was group (CR, EW). There were significant main effects of group, $F(1, 55) = 4.138, p = 0.047$, and day, $F(1, 55) = 5.762, p = 0.020$, but no significant group x day interaction, $F(1, 55) = 1.047, p = 0.311$. As expected in our healthy sample, mean scores for Day 1 were relatively low, ($M = 8.486, SD = 6.604$) for the CR group and ($M = 12.160, SD = 9.181$) in the EW group. Mean BDI scores in both groups were lower on Day 4, ($M = 7.097, SD = 6.050$) for the CR group and ($M = 11.601, SD = 9.006$) for the EW group, but according to multivariate tests of the simple effect of day, the difference between BDI scores on Days 1 and 4 was only significant in the CR group, $F(1, 55) = 6.424, p = 0.014$. This suggests that only those in the CR group experienced significant reductions in depression symptoms after the three days of writing. Although the EW group started out with slightly higher BDI scores on average than the CR group, pairwise comparisons revealed that this between-groups difference was only approaching the level of significance on Day 1, $F(1, 55) = 3.073, p = 0.085$, and reached significance on Day 4, $F(1, 55) = 5.048, p = 0.029$ (see Figure 2).

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To make sure these results were not due to outliers or individual differences of gender, the same analyses were run this time excluding 6 participants with outlying BDI scores, and including gender first as a covariate and then as a factor in the model. For the sake of brevity these additional analyses will not be reported on, except to say that the same pattern of results emerged in each case, with the main effect of group and the day x group interaction both approaching significance. Again there was a significant decline in BDI scores from day 1 to day 4 in the CR group but not in the EW group. Excluding outliers, the baseline between groups difference in BDI scores on day 1 was much smaller and did not even reach trend level of significance, $F(1,48) = 1.765, p = .190$.

Does CR writing lead to decreased emotional arousal?

Average GSR and skin temperature collected between 7:00pm and 12:00am on Days 1-3 were analyzed using a GLM with day (1, 2, 3) being the within-subjects factor and group (CR, EW) the between-subjects factor. For average GSR there were no main effects of day, $F(2, 58) = 1.644, p = 0.202$, or group, $F(1, 59) = 0.190, p = 0.664$, and no Day x Group interactions, $F(2, 58) = 0.688, p = 0.506$ (see Figure 3). For average skin temperature, there was again no main effect of group, $F(1, 59) = 0.117, p = 0.734$, but there was a main effect of day, $F(2, 58) = 3.584, p = 0.034$, reflecting that skin temperatures appeared to decrease in a linear fashion from Day 1 to Day 3. Consistent with this decrease, and contrary to the hypothesis, average skin temperatures in the CR group were significantly lower on Day 3 than on Day 1 with a mean difference of $-0.0345, p = .034$ (see Figure 4). There were no significant between-groups differences in skin temperature on any day. Taken together, these results do not indicate differences in emotional arousal between groups.

Does group assignment relate to participant expectations?

In the final Well-Being survey, participants were asked to describe what they thought was the intended purpose of the writing paradigm. These responses were coded to reflect whether or not participants thought that the writing paradigm was meant to confer psychological benefits such as stress reduction. In the CR group, 90.3% of participants reported that they thought the writing was meant to confer some benefit, while this expectation was only reported 58.6% of the EW group. A chi-square test determined that the expectation of benefits from writing was not equally distributed across group assignment, $\chi^2(1, N = 60) = 8.03, p < .005$. This leaves open the possibility that results could have been influenced by demand characteristics.

Discussion

Summary

Encouraging cognitive reappraisal use in laboratory settings has repeatedly been shown to down-regulate the subjective feelings and physiological responses related to experiencing negative emotional stimuli (Ochsner & Gross, 2008; Urry, 2010.) In addition, the idea that practicing positive cognitive reappraisal of seemingly negative events can improve one's future emotional responses is a theoretical pillar of cognitive therapy and its offshoots. However, until recently there has been very little research addressing whether encouraging CR use in a naturalistic, non-therapeutic, setting could a) lead to more CR use in daily life, and b) result in improvements in well-being. One recent internet-based study found that one week of writing about daily stressful events using CR had an indirect effect on depression symptoms, which was mediated by the lower negative emotions immediately following writing seen in the CR writing group (Raskin, Fleorke, Vujovic, & Urry, 2015).

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In the current study, participants engaged in three sessions of expressive writing about the most stressful event of their day. Participants were randomly assigned to receive either traditional expressive writing (EW) instructions, asking them to write about their deepest thought and feelings about the event, or cognitive reappraisal writing (CR) instructions, which asked them to think and write about the event using cognitive reappraisal strategies with the explicit goal of making themselves feel less stressed. It was predicted that 1) those receiving CR instructions would use more CR in their writing, 2) that those in the CR group would experience less negative emotions following writing than those in the EW group, 3) that those in the CR group might show decreased depression symptoms after the three days of writing compared to the EW group, and 4) that those in the CR group would experience decreased physiological emotional arousal as measured by average electrodermal activity and skin temperature. Evidence was found in support of the hypotheses that CR instructions results in more CR use, that CR writing buffers against negative emotions, and that CR writing over multiple days can result in reduced depression symptoms in our non-clinical sample. Results did not support the hypothesis of decreased physiological arousal in the CR group, however the evidence remains inconclusive.

Explanation of Results

As was found in Raskin et al. (2015), some of those in the EW group spontaneously used CR in their writing, but levels of unprompted CR use was relatively low, with those in the EW group scoring only 0.82 out of a possible 3 on average for Day 3 in the current study. One proposed explanation for why reappraisal might be used less often than other emotion regulation strategies in the context of real world scenarios is that

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CR is demanding of cognitive resources, and therefore may take more effort to implement than other strategies, distraction being one, which might be easier in the short term, but potentially less beneficial in the long term (Brans, Koval, Verduyn, Lim & Kuppens, 2013). When explicitly prompted to use CR, as in our CR writing condition, participants were able to employ the strategy with more success, on average scoring 1.87 out of 3 for CR use. The fact that the instructional manipulation caused a significant increase in actual CR use during the writing paradigm tells us that expressive writing using CR instructions is successful at getting people to practice CR use in the context of daily life stressors, a skill which can hopefully be carried over into real-world settings after the writing sessions are over. A future direction would be to measure using an experience sampling paradigm whether or not daily CR writing actually causes people to use more CR in vivo when they encounter stressful situations. One way to do this would be to administer a survey of emotion regulation strategy use periodically throughout the day via a smartphone application.

In both CR and EW groups, mean positive mood ratings decreased significantly from immediately before to immediately following the writing periods. This makes sense intuitively because the writing procedure asks them to recall and re-experience what they were thinking and feeling during the most stressful moment of their day. In the expressive writing literature, immediate short-term decreases in positive mood, and increases in distress, negative mood, and physical symptoms have been noted compared to controls, with physical and psychological improvements seen typically in longer-term follow-ups (Baikie & Wilhelm, 2005). Importantly, in this study while negative emotion ratings increased significantly in the EW group following writing, there was no

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significant change in negative emotions in the CR group post-writing. This supports the hypothesis that writing with the goal of reappraising the chosen stressful event protects against the otherwise expected increase in negative emotions. The same protective effect was seen in Raskin et al. (2015), which found using latent growth curve modeling that while negative emotions in the EW group increased after writing, there was no change in the level of negative emotions in the CR group, even though, as in the current study, both groups were re-experiencing an event that was initially perceived as stressful.

Unlike in Raskin et al., (2015), there was a significant direct effect of group on depression symptoms. As hypothesized, the CR group reported significant reductions in depression symptoms from study days 1 to 4, while the EW group showed no change. The fact that only three CR writing sessions lasting 15-30 minutes total could result in decreased depression symptoms is a remarkable finding, and suggests that online writing paradigms such as this one could be used as a low-cost alternative or supplemental treatment for depression symptoms. However, as this was a non-clinical sample, with low levels of depression symptoms to begin with, this result should be interpreted with caution. This sample was smaller and more homogenous than that of Raskin et al., and the significance of this finding could be reflecting the generally low levels of variability in depression symptoms seen in this healthy sample. There was also a trend level difference between group BDI scores on Day 1, which might have accounted for some of the differences seen on Day 4. However, this baseline difference disappeared when outlying BDI scores were excluded from the analysis, while the between groups difference on Day 4 held steady, still approaching the level of significance. Another

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limitation is that the full 21-item BDI-II was not used, which could have influenced the results to some degree.

The results of the ambulatory physiological measures do not support the original hypothesis that the CR group would show decreased emotional arousal as indicated by lower average GSR and higher average skin temperature, the physiological profile that one would expect to see in a more relaxed emotional state. Although mean GSR was lower for both groups on Day 3 than Day 1, there were no significant effects of day or group assignment. Contrary to the hypothesis, mean skin temperature was lower on Day 3 compared to Day 1, and this difference was significant only in the CR group. There is no clear explanation for this result, and might even be a false positive reflecting the relative lack of variation in the skin temperature data overall. One study reported that instructing the use of CR to decrease emotional response to a sadness inducing film resulted in significantly higher skin conductance and lower skin temperature compared to those instructed to use distraction in order to down-regulate (Sheppes, Catran, & Meiran, 2009). The authors hypothesized that the observed increase in sympathetic activation was due to the increased inhibitory-self control effort demanded by CR, which might have been the case in the current study as well. This converges with the idea that CR is more effortful than other emotion regulation strategies, however it is likely that methodological limitations also contributed to the null findings.

The fact that this study was unable to replicate in a naturalistic context the physiological down-regulation that has sometimes been associated with positive reappraisal in laboratory settings (Ochsner, Silvers, & Buhle, 2012; Urry, 2010) could be due to a variety of differences in materials and methodologies. For one, in the laboratory

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it is possible to pinpoint physiological responses to specific controlled stimuli. Although the time period analyzed in this study encompassed the time of writing for most subjects, averaging ambulatory data collected over the course of 5 hours does not allow for the kind of fine-grained analysis of acute arousal states associated with recalling the stressful event that one might be able to get in the laboratory. One possible future direction would be to have participants indicate the time of day during which stressful events actually occurred using the event marker option on the armbands in order to see if group differences in stress reactivity emerged over the writing days. Additionally, the instrument used in this study measured GSR and skin temperature from the back of the upper arm rather than the pads of the fingertips, as is typically done in the laboratory, and thus the placement and corresponding density of sweat glands could contribute to differing sensitivities (Taylor & Machado-Moreira, 2013). Finally, in order to ensure that the armband battery lasted for all four study days, the armband was set to sample skin temperature and GSR at a rate of only 1Hz. Battery life is not a rate-limiting factor in laboratory sessions, and indeed electrodermal activity is often sampled at a rate of 20 Hz or more. How well ambulatory devices like the BodyMedia SenseWear Armband stack up against more traditional electrophysiological instruments is a topic in need of more research.

As it relates to the current study, the lack of physiological support corroborating the hypothesis that practicing cognitive reappraisal leads to improvements in emotional well-being leaves open the possibility that the improvements seen on the self-report measures could be due to demand characteristics. Because the participants in the CR instruction group were told explicitly to try to make themselves feel less stressed, they

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might have reported more positive outcomes than the EW due to demand bias. In the final Well-being Survey, when asked what effect they thought the writing was supposed to have on them, the majority of participants in both groups said they thought the writing was meant to make them feel less stressed or benefit them in some way, however this expectation was significantly more prevalent in the CR group.

Conclusion

In sum, this study replicated and extended previous findings about the psychological benefits of writing about stressful daily events using cognitive reappraisal. Cognitive reappraisal writing instructions were successful in getting people to use CR strategies when thinking and writing about stressful events. Similar to what was seen in Raskin, et al. (2015), those in the cognitive reappraisal group were protected against the increase in negative emotions that is often associated with recalling and writing about stressful events. Although there was no support found for decreased physiological arousal in the cognitive reappraisal group, they did experience a significant reduction in depression symptoms, which was not seen in the expressive writing group. This suggests that cognitive reappraisal training through a daily writing paradigm like the one used here could potentially be used to treat depressive symptoms, and could serve as a cost-effective supplement or alternative to traditional therapies such as CBT, which already incorporate the principles of cognitive reappraisal in their practice. Clearly more research would be needed before it could be recommended to clinical populations, however the potential for clinical applications is promising. One could envision an online cognitive reappraisal diary as a form of continued treatment for patients in recovery, or even as a preventative measure for those at risk for psychopathology or in anticipation of stressful

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life events. In conclusion, using an expressive writing paradigm to encourage cognitive reappraisal in the context of real-life stressful situations can positively influence perceptions of emotional well-being.

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Table 1. Overview of Study Procedure

| | Day 1 | Day 2 | Day 3 | Day 4 |
|--------------------|---|---|---|--------------------------|
| In the Lab: | - Informed Consent | | | -Well-Being Survey (BDI) |
| | -Well-Being Survey (BDI) | | | -Return armband |
| | -Armband training & application | | | -Debrief & Payment |
| At Home: | -Wear armband | -Wear armband | -Wear armband | |
| | -Writing Survey 1 (Pre & Post mood ratings) | -Writing Survey 2 (Pre & Post mood ratings) | -Writing Survey 3 (Pre & Post mood ratings) | |

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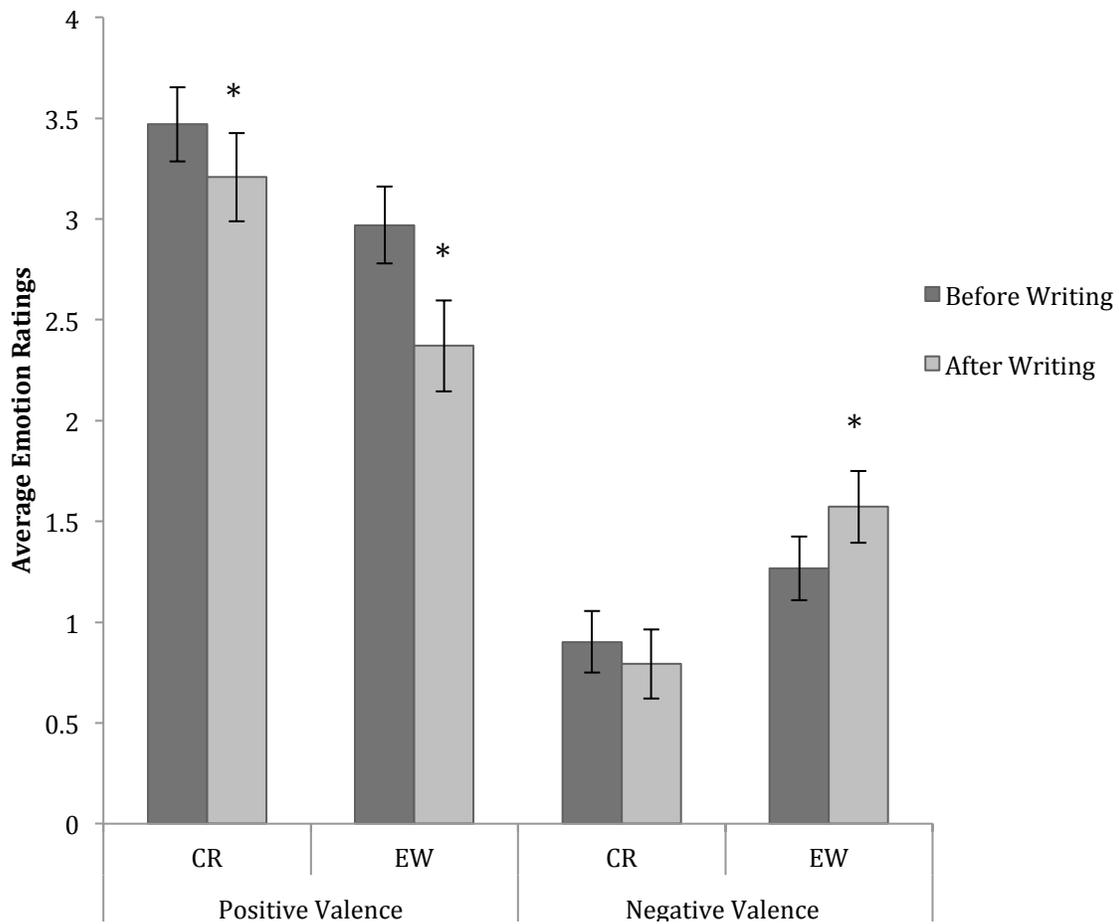


Figure 1. Mean Positive and Negative Mood from Pre to Post Writing. Error bars represent +/- one standard error. Both groups experienced significant decreases in positive mood from before to after writing, $F(1, 58) = 8.289, p = 0.006$ for CR group and $F(1, 58) = 40.444, p < 0.001$ for EW group. Only the EW group showed a significant increase in negative mood after writing, $F(1, 58) = 13.428, p = 0.001$. No change in negative mood was seen in the CR group, $F(1, 58) = 1.838, p = 0.180$.

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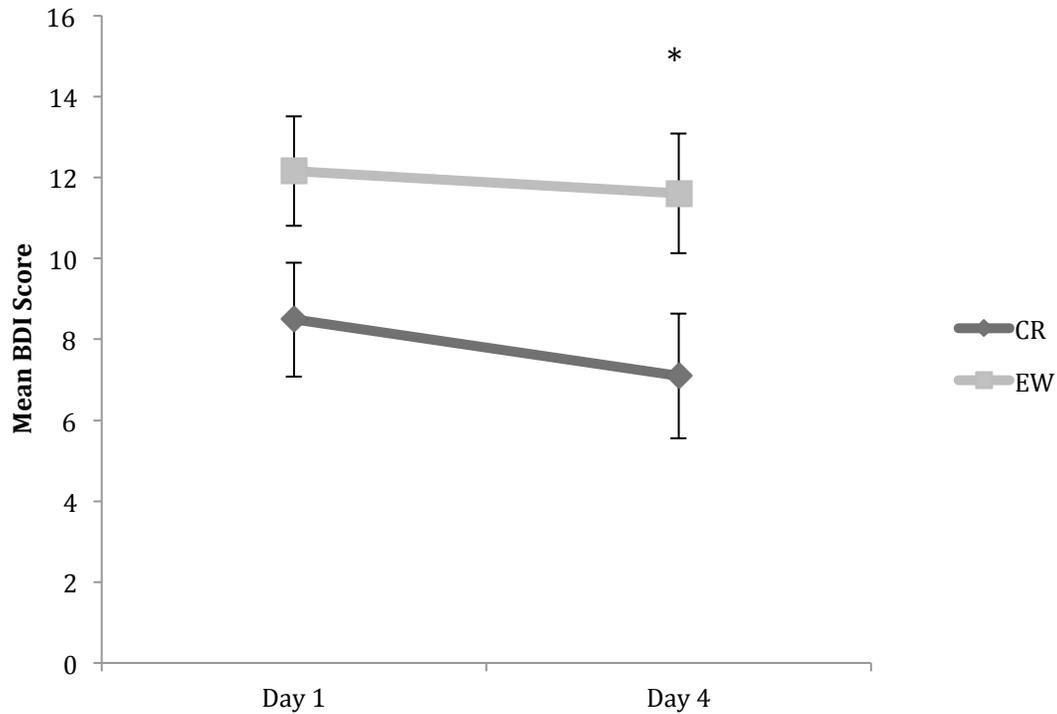


Figure 2. Mean BDI scores on Days 1 and 4. Error bars represent +/- one standard error. Scores decreased significantly in the CR group from Day 1 to Day 4, $F(1, 55) = 6.424$, $p = 0.014$, and did not change in the EW group, $F(1, 55) = 0.872$, $p = 0.355$. There was a trend for the EW group to have higher BDI scores on Day 1, $F(1, 55) = 3.073$, $p = 0.085$, however the between-groups difference was only statistically significant on Day 4, $F(1, 55) = 5.048$, $p = 0.029$, indicated by the asterisk.

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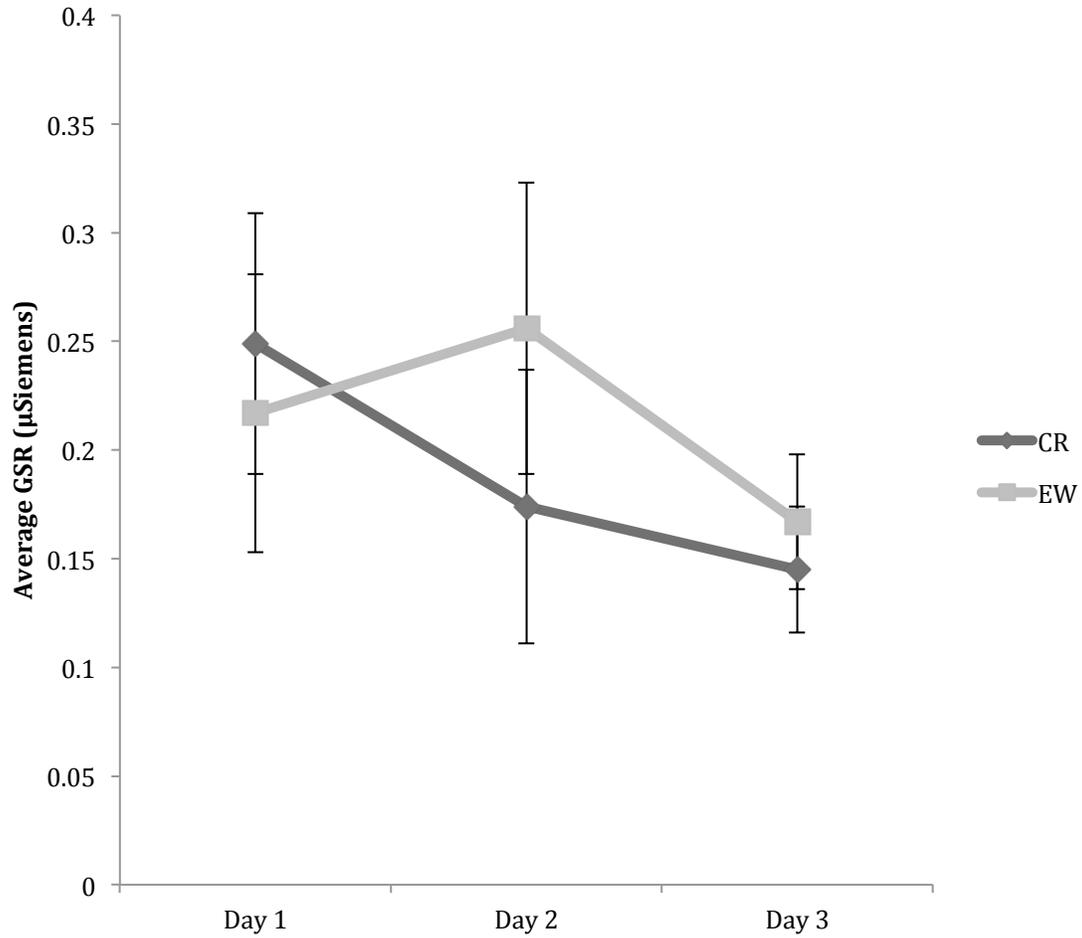


Figure 3. Average GSR from 7:00pm-12:00am on Days 1, 2, & 3. Error bars represent +/- one standard error. There were no main effects of day or group, and no significant between-groups differences on any of the three writing days.

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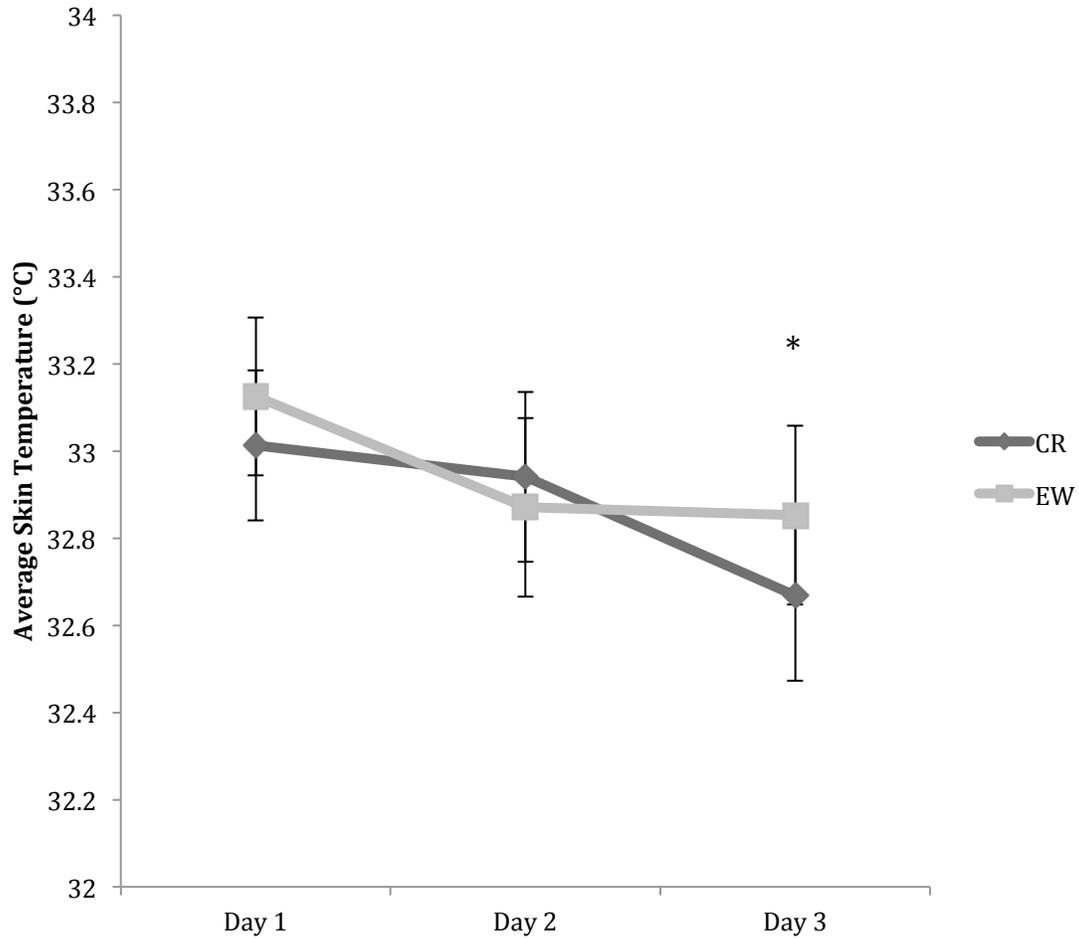


Figure 4. Average skin temperature from 7:00pm-12:00am on Days 1, 2, & 3. Error bars represent +/- one standard error. A main effect of day was seen, reflecting that skin temperatures appeared to decrease in a linear fashion from Day 1 to Day 3, $F(2, 58) = 3.584$, $p = 0.034$. Contrary to the hypothesis, average skin temperatures in the CR group were significantly lower on Day 3 than on Day 1, $p = 0.034$, as indicated by the asterisk.

Appendix

Additional Well-Being Survey Measures:

FFERQ. The first measure of the Well-Being survey is the Five Families Emotion Regulation Questionnaire (FFERQ), which consists of 24 statements scored on a 7-point Likert scale ranging from 0 (Strongly Disagree) to 7 (Strongly Agree), as well as a “Decline to Answer” option. This scale is meant to assess subject’s use of the five major families of the emotion regulation strategies according to the process model of emotion regulation. These are: situation selection, situation modification, attentional deployment, cognitive change, and response modulation (Gross & Thompson, 2007). The FFERQ includes statements such as “I seek out situations that might make me feel positive emotions,” and “I control my emotions by blocking them or not letting myself feel them” tapping into situation selection and response modulation respectively.

BAS/BIS. The second measure is the Behavioral Inhibition & Activation Scales (BAS/BIS), which assesses tendencies towards approach and avoidance motivational systems (Carver & White, 1994). This scale consists of 24 statements scored on a 4-point Likert scale ranging from 1 (Very true for me) to 4 (Very false for me), and a “Decline to Answer” option. The BAS/BIS includes statements such as “When I get something I want, I feel excited and energized” and “I feel worried when I think I have done poorly at something.”

Sleep. This section of the survey contains six questions about how well the participant slept the night before, including what time they got into bed, how long it took them to fall asleep, how many times they woke up during the night, and what time they

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got out of bed in the morning. It also asks subjects to rate their quality of sleep, and how rested they felt upon waking.

Health. Participants were asked to rate their overall health compared to others their own age on a five-point scale ranging from “excellent” to “poor.” Subjects were also asked to rate their overall quality of life on the same scale. The next four questions ask about the amount of exercise, caffeine, cigarettes, and alcohol consumed in the last 3 hours. Participants are then asked if they have been seen or are currently being seen by a mental health professional, and if so, for what.

LES. The Life Events Scale (LES) asks whether or not the participant experienced any of sixty-eight presumably stressful life events within the last four months, and if so what impact the event had on them ranging from -3 (Extremely Negative) to +3 (Extremely Positive). The scale includes events such as death of a friend or family member, major award or accomplishment, law violations, and break-ups among others. This version of the LES also included items specifically relevant to a collegiate sample, failing a course being one example.