Effect of Cognitive Reappraisal on Interoceptive Awareness and Symptoms of Anxiety and Depression

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Abstract

The emotion regulation strategy of cognitive reappraisal (CR) has been shown to facilitate greater well-being; specifically, cognitive reappraisal has been shown to lessen depression and anxiety. Interoceptive awareness (IA) is defined as consciously perceiving internal bodily signals that relate to emotions, such as heart beat. Because emotion regulation processes such as cognitive reappraisal are linked to attention to and awareness of the state of the body, it is possible that there is a link between use of cognitive reappraisal and interoceptive awareness. Interoceptive awareness has also been linked to depression and anxiety, representing another avenue by which cognitive reappraisal and interoceptive awareness might be related. The present study aimed to gather more research that would elucidate the link between cognitive reappraisal and interoceptive awareness, depression, and anxiety. In order to further examine the relationship between these variables, the researchers manipulated the presence of CR instructions in a writing paradigm. The expressive writing group (EW) and the cognitive reappraisal writing (CRW) groups participated in daily writing exercises about stressful events, and the CRW group was instructed to use cognitive reappraisal in their writing. The control group did not participate in any writing exercises. The researchers assessed depressive and anxious symptoms at the beginning and the end of the study, and evaluated interoceptive awareness on the last day of the study, for participants in all groups. The results of the present study showed no significant effect of cognitive reappraisal writing on interoceptive awareness, nor on changes in anxious and depressive symptoms.

Keywords: cognitive reappraisal, interoceptive awareness, anxiety, depression

Effect of Cognitive Reappraisal on Interoceptive Awareness and Symptoms of Anxiety and Depression

Cognitive reappraisal is an emotion regulation strategy that is antecedent focused, meaning that it aims to redirect an emotional response before that response is active, rather than after (John & Gross, 2004). Specifically, cognitive reappraisal is an emotion regulation strategy that focuses on changing the meaning of an emotional stimulus. Cognitive reappraisal can be used to more positively frame an emotional stimulus, in the hopes of eliciting a more positive response. The use of cognitive reappraisal in this manner has been shown to have an impact on mental state. For example, John and Gross (2004) found that the use of cognitive reappraisal facilitated greater well-being and enhanced interpersonal functioning, and Haga, Kraft and Corby (2007) found that increased use of cognitive reappraisal predicted increased levels of positive well-being outcomes across cultures, even when controlling for extraversion and neuroticism. Even more specifically, cognitive reappraisal has been shown to be associated with changes in depression and anxiety. A study by Troy, Wilhelm, Shallcross, and Mauss (2012) found that at high levels of stress, women with high cognitive reappraisal ability exhibited fewer depressive symptoms than those with low cognitive reappraisal ability. Moore, Zoellner and Mollenhelt (2009), showed that cognitive reappraisal was associated with lower self-reported stress related symptoms, and Hofman, Heering, Sawyer, and Asnaani (2009) showed that cognitive reappraisal more successfully down-regulated heart rate and lowered reported anxiety as compared to suppression.

There are a number of ways to experimentally manipulate cognitive reappraisal so that it might have effects on anxiety and depression, and one such way is through writing. A seven day study by Ng and Diener (2013) induced cognitive reappraisal via a writing manipulation; participants were assigned to a control group, a reappraisal group, or a focusing group, and were instructed to rate emotions and write about daily stressful events according to instructions dependent on their condition. The manipulation was successful and results indicated that reappraisal reduced negative emotions to daily stressful events. A study by Lu and Stanton (2009) supports these findings; in a writing paradigm for groups of emotional disclosure, cognitive reappraisal, a combination of emotional disclosure and cognitive reappraisal (self-regulation), and a control condition (no writing), participants in the self-regulation group experienced the most positive benefits, where positive affect and physical health increased, and the cognitive reappraisal group experienced physical health benefits. Cameron and Nicholls (1998) also found that expressive writing—writing about how one feels—coupled with formulating coping plans (self-regulation condition), compared to just an expressive writing condition and a control condition (writing about a trivial topic), improved overall mood and adjustment in college students, and reduced illness-related clinic visits.

Research conducted in the Emotion, Brain and Behavior Laboratory (EBBL) at Tufts University has produced results similar to previous literature. Raskin, Floerke, Vujović and Urry (2015) found significant results indicating that cognitive reappraisal induced via a writing instruction manipulation over a week-long period successfully reduced depressive symptoms and writing-induced negative emotions, as compared to a purely expressive writing condition. Another study in the EBBL at Tufts University replicated those results; after a period of four

days, participants in a cognitive reappraisal writing condition had lower depressive symptoms compared to participants in the expressive writing condition (Cochran, 2015). The present honors thesis builds on these two studies to assess the effect of the cognitive reappraisal writing manipulation on not only depressive symptoms, but on anxiety symptoms as well. As previous literature has indicated that cognitive reappraisal is associated with a decrease in negative emotions when writing about anxiety-inducing events (Cochran, 2015; Raskin et. al, 2015), the current study aimed to investigate cognitive reappraisal's relationship to both depressive and anxious symptoms individually.

While the present study investigates the relationship between cognitive reappraisal's effects on anxious and depressive symptoms, it is also interested in any possible effect of CR on interoceptive awareness. Interoceptive awareness is defined as "the conscious perception of sensations from inside the body that create the sense of the physiological condition of the body, such as heart beat, respiration, satiety, and the autonomic nervous system sensations related to emotions," (Mehling et. al, 2012, p. 2). Successful emotion regulation requires an awareness of emotional states, and various theories of emotion associate awareness of bodily signals to awareness of emotional states (Füstös, Gramann, Herbert & Pollatos, 2013). Because emotion regulation processes—such as cognitive reappraisal—are therefore linked to attention to and awareness of the state of the body, it is possible that there is a link between use of cognitive reappraisal and interoceptive awareness. Interoceptive awareness has also been linked to depression and anxiety, and cognitive reappraisal has an impact on the experienced symptoms of those two states, representing another avenue by which cognitive reappraisal and interoceptive awareness could be related.

Interoceptive awareness can be broken down into two subcategories: interoceptive accuracy and interoceptive sensitivity (Garfinkel, Seth, Barrett, Suzuki & Critchley, 2015). Interoceptive accuracy is the objective ability to perceive internal bodily signals, such as heart beat. This measure is assessed via specific tasks that allow researchers to compare participants' perception of internal bodily signals to the actual execution of those bodily signals. Interoceptive sensitivity is how well one perceives themselves to be attuned to their internal bodily signals. This is measured via subjective self-reports that aim to extract perceived aptitude of detection of internal bodily signals. Interoceptive awareness is a combination of the above two subcategories; it is a combination between how sensitive one thinks they are and how accurate they actually are. To assess interoceptive awareness, objective body signal measuring tests are required, along with self-report measures, and, often, confidence assessments.

Many studies show links between interoceptive awareness and depression and/or anxiety. A study by Furman, Waugh, Bhattacharjee, Thompson and Gotlib (2013), showed that women who were clinically diagnosed with Major Depressive Disorder were worse at detecting their own heartbeats as compared to control participants, and that the MDD group also experienced reduced positive affect and trouble making decisions. A study by Herbert, Herbert and Pollatos (2011) produced similar results, showing that interoceptive awareness was negatively correlated with depression (based on BDI scores). However, Dunn, Dalgleish, Ogilvie and Lawrence (2007) assessed interoceptive awareness in participants with varying levels of depression and found different results than the above two studies. They found that among three groups—a healthy control group of community volunteers, a moderately depressed group, and a severely depressed group—the moderately depressed group had the lowest interoceptive accuracy, and both the

control group and the severely depressed group had equivalent levels of interoceptive accuracy. This finding was noteworthy because, contrary to the researcher's hypothesis, interoceptive awareness did not negatively correlate with increased depression, yet lower interoceptive accuracy was associated with moderate depressive symptoms, indicating that the relationship between interoceptive awareness and depressive symptoms is complex.

According to the literature thus far, the link between interoceptive awareness and anxiety appears to be more clear cut. Many studies have shown that a higher level of interoceptive awareness is associated with higher levels of anxiety in a variety of forms. In a study by Schandry (1981), participants who were categorized as good heartbeat perceivers had significantly higher scores on State Anxiety and Emotional Lability. In a series of studies by Ehlers and Breuer (1992), patients with panic disorder showed a higher level of interoceptive awareness than patients with other specific phobias, and patients with depression. While patients with panic disorder performed the best at the interoceptive task as compared to the other groups, infrequent panickers also had higher interoceptive accuracy than the other groups. In their third study, results indicated that patients with generalized anxiety disorder did not differ from panic disorder patients in terms of interoceptive awareness. A study by Zoellner and Craske (1999) further examined group differences in interoceptive awareness. At baseline, they found that infrequent panickers were significantly more accurate than were control participants in accurately detecting their heartbeats. The infrequent panickers also self-reported more anxiety and panic symptoms than did the control group, though only panic symptoms were significantly negatively correlated with error in heartbeat detection. This particular study also introduced manipulations of caffeine ingestion and safety/no safety information. However, when controlling

for the above manipulations, post-hoc analyses replicated the baseline findings, showing that there was a significant effect of group on interoceptive accuracy: infrequent panickers had a lower percentage of error for heartbeat detection than did control participants.

However, as anxiety and depression have a complex and often comorbid relationship, the interaction of these two traits has led to conflicting results regarding their effect on interoceptive awareness. In a study by Pollatos, Traut-Mattausch, and Schandry (2009), the negative correlation between depression and interoceptive awareness was only significant in participants with high anxiety. Dunn et. al (2010) found that interoceptive awareness was positively associated with anxiety-arousal symptoms, however, they also found that this effect was moderated by depressive symptoms: when depression-specific anhedonia symptoms increased in severity, the positive association between anxiety-specific arousal and interoceptive accuracy became less strong. Because of the interdependent nature of anxiety and depression, analyzing each's relationship to interoceptive awareness becomes more complicated.

In discussing why interoceptive awareness might be associated with increased levels of anxiety, some researchers have hypothesized that the link stems from the perception of bodily signals, and a resulting interpretation of these bodily signals as more dangerous. According to a review by Domschke, Stevens, Pfleiderer and Gerlach (2010), interoceptive sensitivity may "increase the vulnerability to anxiety disorders by increasing the perceptual base for catastrophic interpretations of cardiac symptoms" (p. 7). Another explanation is that those with higher interoceptive awareness experience emotions more intensely. As the study by Schandry (1981) showed, good heart beat perceivers scored higher on Emotional Lability scales. Moreover, researchers in a study by Pollatos, Traut-Mattausch, Schroeder and Schandry (2007) found that

interoceptive awareness was the mediating factor between anxiety and the intensity of unpleasant feelings, and therefore that interoceptive awareness might have a role in the development of anxiety disorders. If it is correct that those with higher interoceptive awareness experience emotions more intensely and that this is the reason they have higher levels of anxiety, it would also explain why lower interoceptive awareness would be associated with depression (as depressive symptoms exclude intense feelings of positive affect). It does not, however, explain why those with lower interoceptive awareness might experience intense feelings of depressed mood; perhaps in the absence of intense positive affect, those low in interoceptive awareness do not experience intense sadness, rather, they might experience apathy, which is associated with depression (Marin, Firinciogullari & Biedrzycki, 1993).

Based on all of this information regarding the links between interoceptive awareness and depression and anxiety, is would be reasonable to expect that cognitive reappraisal might reduce interoceptive awareness. Because cognitive reappraisal reduces anxious and depressive symptoms, and anxiety is associated with higher interoceptive awareness and depression's relationship with interoceptive awareness is not yet clear, a manipulation that enhances cognitive reappraisal could very likely reduce interoceptive awareness in participants. Interestingly, however, other studies have shown that the use of cognitive reappraisal is positively associated with interoceptive awareness, and that interoceptive awareness might facilitate cognitive reappraisal. Because cognitive reappraisal is associated with attention to and awareness of bodily signals in order to regulate one's emotional status, it is also possible that those with higher interoceptive awareness will be more likely to use—and be better at using—cognitive reappraisal. Füstös et al. (2013) found that higher interoceptive awareness in participants

facilitated the down-regulation of negative affect via reappraisal. According to this study, interoceptive awareness facilitates cognitive reappraisal by providing feedback of the emotional state, allowing someone to manipulate it accordingly. Kever, Pollatos, Vermeulen and Grynberg (2015) also found that interoceptive awareness facilitated cognitive reappraisal. Participants with higher interoceptive sensitivity showed more use of cognitive reappraisal habitually compared to those of lower interoceptive sensitivity, supporting the idea that better perception of one's bodily signals facilitates the selection and use of antecedent- and response-focused emotion regulation strategies, including, in particular, cognitive reappraisal.

Acknowledging all of the above literature, the present study aimed to further examine and clarify the relationship between cognitive reappraisal, depression, anxiety, and interoceptive awareness. In this four-day study, the researchers manipulated the presence of CR instructions in a writing paradigm. An expressive writing group (EW) and a cognitive reappraisal writing group (CRW) participated in daily writing exercises about stressful events. The CRW group was instructed to use cognitive reappraisal in their writing, while the EW group did not receive any such cognitive reappraisal instructions. The control group did not participate in any writing exercises. For participants in all groups, the researchers both assessed depressive and anxious symptoms at the beginning and the end of the study, and evaluated interoceptive awareness on the last day of the study. Interoceptive accuracy was assessed via a heartbeat tracking task, interoceptive sensitivity via the self-report Multidimensional Assessment of Interoceptive Awareness (MAIA), and interoceptive awareness via the combination of the above two measures.

Due to the conflicting literature, the researchers hypothesized that the use of cognitive reappraisal might either enhance or diminish interoceptive awareness. We further hypothesized that the group using cognitive reappraisal in their writing would have lower depression and anxiety symptoms as compared to both the expressive writing group and the control group.

Method

Participants

Participants for this study were 33 Tufts University undergraduate students or graduate students (23 women, 10 men, M_{age} = 20.2 years, age range = 18-32). Participants were recruited on both the paid and non-paid version of the Psychology Research Credits System, SONA. On the first day of the study, each participant indicated their informed consent to the study procedures in the lab. The study procedures were approved by the Social, Behavioral and Educational Research Institutional Review Board at Tufts University. The participants who took part in this study for compensation received $65 for completing all parts of the study. Other participants took part in the study for course credit for psychology classes, and they earned a total of 4 credits for completing all parts of the study.

Materials

Well-Being Survey. The Well-Being Survey was administered to participants on the first day of the study (Day 1) in order to get a baseline of psychological and physical well-being. The Well-Being Survey was then administered again when the participants returned to the lab (Day 4), after completing three days of the writing protocol for the CRW and EW groups; no writing

was done in the interim for the Control group. The Well-Being Survey was administered via Qualtrics (Provo, UT) on one of the laboratory computers, and it took approximately 30 minutes to complete. The following measures in the Well-Being Survey are reported on in this study. Additional measures were assessed in the Well-Being Survey, including measures of demographics, debriefing questions, estimates of resting heart rate, perception of time intervals without counting, emotion regulation strategy use, approach and avoidance tactics, physical health, sleep, and life events; these measures are not reported on in the interest of focusing on the primary hypotheses (See Appendix for a description of the additional measures included in the Well-Being Survey).

Anxiety Depression Stress Inventory (ADDI-27). The ADDI-27 is a shortened version of the Mood and Anxiety Symptom Questionnaire-90. It is an empirically-validated measure of the tripartite model of affect, including reliable measures of the Absence of Positive Affect, Somatic Anxiety, and General Distress (Osman et. al, 2011). Each of the three scales are made up of nine items, making a total of 27 statements. Participants were asked to respond to each item while thinking about the previous two weeks, indicating how often they felt the item applied to them during that time period. Each item was scored on a 5-point Likert Scale, giving participants the option to choose responses ranging from “not at all” to “extremely.” Internal consistency reliability was acceptable for all three subscales in this sample on both days (all Cronbach’s alpha > .70).

Multidimensional Assessment of Interoceptive Awareness (MAIA). The MAIA is a 32-item multidimensional self-report measure of interoceptive body awareness that assesses eight concepts (Mehling et al., 2012). The eight concepts are: Noticing—awareness of uncomfortable,

comfortable and neutral body sensations; Not Distracting—tendency not to ignore or distract oneself from sensations of pain or discomfort; Not Worrying— tendency not to worry or experience emotional distress with sensations of pain or discomfort; Attention Regulation—ability to sustain and control attention to body sensations; Emotional Awareness—awareness of the connection between body sensations and emotional states; Self Regulation—ability to regulate distress by attention to body sensations; Body Listening—active listening to the body for insight; and Trusting—experience of one's body as safe and trustworthy (Mehling et al., 2012). Participant were asked to respond to the items based on how often each statement applied to them in daily life. Participants were able to choose responses from a 6 point Likert Scale, where 0 represented "never," and 6 represented "always."

To score the MAIA, each of the eight concepts were scored independently. Each question of the MAIA corresponds to one of the eight concepts. The mean score was then calculated across items for each subscale. Items 5, 6, and 7, which related to the "Not Distracting" category, and items 8 and 9, which related to the "Not Worrying" category, were reverse scored. Internal consistency reliability was acceptable for most subscales in this sample on both days (all Cronbach's alpha > .70 with the exception of Not Worrying on Day 1, and Not Distracting on Day 1 and Day 4.

Writing Survey. The Writing Survey was administered to participants in the Cognitive Reappraisal Writing (CRW) and Expressive Writing (EW) groups. The survey link was sent out to participants at 6:00PM EST on three consecutive days, starting on Day 1 of the study. If the participants did not complete the survey by 9:00PM, they were sent a reminder email to do so.

The first page of the Writing Survey reaffirmed each participants' consent to participate in the study if they clicked "continue."

Before Writing. Participants were instructed to rate their overall level of happiness and stress level for that particular day. Participants were then given a list of 17 mood triplets that included emotion related words (i.e. "anxious/worried/fearful") and were asked to indicate using sliders how much they were feeling that mood at the current moment. Participants were then instructed to press the gray button on an armband they were wearing that measures physical activity and sweat (SenseWear armband), in order to submit a time marker for this part of the procedure. Next, participants were instructed to write one sentence that described the most stressful situation of their day. They were then asked to indicate approximately what time this event began and ended, who they were with during that event, and what category that stressful event best fit under (for example, "My job" or "Relationship with my family," etc.). Participants then rated how stressed they were during that specific event, on a scale ranging from 0-7 (Not at all stressed - Very stressed).

Writing Protocol. Participants in both the CRW and EW conditions received instructions to write for 5-15 minutes about their deepest thoughts and feelings related to the stressful event that they indicated in the previous section. Participants in the CRW condition were additionally asked to reappraise the stressful situation in a positive light, by thinking and writing about it in a way that would make them feel less stressed.

Specifically, EW group received the following 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 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."

The CRW group received the following 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

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."

After Writing. After completing the writing, participants were then instructed to complete the mood triplets questionnaire a second time. After responding to these 17 statements, participants were instructed to press the gray button on their armband in order to submit a time marker for this part of the procedure. Next, participants were asked to respond to nine statements about how they felt about that day's writing. They were asked to indicate how much they agreed with each statement by moving a slider on a scale of 0-7 (Not at all - Extremely). The statements included sentiments such as "I did not like having to write today" and "The writing task was difficult. After completing this section of the survey, participants were shown a page thanking them for their participation.

Cognitive Reappraisal in the Writing Samples. In order to determine that the CRW writing instruction manipulation actually led to more cognitive reappraisal use, all writing samples were coded for CR use by two independent raters who were blind to each participant's condition. Both raters coded every writing sample from Day 1, Day 2 and Day 3 for participants in the EW and CRW groups (as the Control group did not participate in the Writing Surveys) on a scale of 0 - 3 (CR definitely absent - CR definitely present). Presence of CR was defined as whenever the participant did any of the following to feel better about the stressful event they were writing about: generating an interpretation, explanation, insight, or finding meaning;

finding some higher meaning in the situation; 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; and/or finding that consequences are actually less negative than imagined. Overall, 22 participant's writing data (CRW n = 11, EW n = 11) were coded, making for a total of 66 writing samples that were coded for presence of CR. An average measure of intraclass correlation of .84 established that the coding achieved acceptable levels of interrater reliability. Additionally, for later analyses, each individual participant's CR scores across the three days of writing were averaged, in order to get an average score of CR use for each participant over the course of the study.

Heartbeat Tracking Task (HTT). A modified version of the Schandry Mental Tracking Task (Schandry, 1981) was used on Day 4 of the experiment. In the first heartbeat tracking task, participants were instructed that they were going to mentally count their heartbeats for a specific interval of time, the length of which they would not know the duration. They were instructed that they should try to count their heartbeats by focusing internally on their chest, and to not hold their breath or use the chair or other objects to allow them to feel their pulse. The researchers presented participants with two consecutive rounds of three intervals of different second lengths (25s, 35s, 45s) for a total of six intervals. The order of the three intervals were randomized for each participant. For the duration of the task, participants wore noise-reducing headphones to block out background sound. Participants began counting their heartbeats upon hearing a "ding"

via the headphones, and stopped counting their heartbeats upon hearing a second "ding." Then, prompted by a computer screen, participants recorded on the computer the number of heartbeats they counted for that trial, and answered the following three questions on a Likert scale ranging from 0-7: 1) How confident are you in the number of heartbeats you counted? (0/Not at all confident - 7/Extremely confident), 2) How would you rate the speed of your heartbeat as compared to normal? (0/Much slower - 7/Much faster), and 3) How would you rate the intensity of the pounding of your heartbeat as compared to normal? (0/Much softer - 7/Much harder).

A second iteration of the heartbeat tracking task was performed on Day 4, as well. This second iteration of the task was performed after the participants had completed two other study tasks: a modified version of the Trier Social Stress Task (TSST) and an in-lab writing task. The second iteration of the heartbeat tracking task was the same as described above. However, in the second round of three intervals, the 35s interval (whenever it appeared in the randomization) was modified to have participants physically tap out their heartbeats as they felt them during that time. Participants were instructed to position their non-sensored hand over the keyboard with their pointer finger resting on a specific key and their wrist in the air, and to tap the key each time they felt their heart beat. After they completed this interval, if any trials remained, the participants were instructed to no longer physically tap out their heartbeats. In total, among both the first and the second heartbeat tracking task, participants completed 12 intervals of counting their heartbeats (four 25s, four 35s, four 45s).

Interoceptive Accuracy. In order to calculate interoceptive accuracy based on the data from this task, the researchers took the absolute value of the difference between actual heart rate (beats per minute) of the participant (based on an average of the actual rate during all time

intervals in both the HTT1, and separately, in the HTT 2) and the estimated heart rate (BPM) by the participant (based on an average of the heartbeat estimates given by the participants across all time intervals in HTT 1 and separately, HTT 2). A total of 33 participants data was analyzed, 11 in each group. Initially, the researchers had wanted to calculate interoceptive accuracy based on the difference between actual heart rate and estimated heart rate for each specific time interval, but, due to equipment malfunction, this was not possible at the end of data collection.

Autonomic Physiology. Physiological measures were collected on the Day 4 laboratory session. The measures that were collected were electrocardiography and electrodermal activity, collected using Biopac technology in a MP150 system (Biopac, Goleta, CA). The data collected was processed in ANSLAB (Wilhelm & Peyk, 2005). Additional physiological measures were collected throughout this study, including skin conductance level both in the laboratory and via BodyMedia SenseWear armbands; these events are not reported on in the interest of focusing on the primary hypotheses (See Appendix for a description of the additional physiological measures captured in this study).

Electrocardiography (ECG). ECG was used to measures the heart rate of each participant. In order to collect this data, two Ag/AgCl electrodes were placed on participants, one underneath each collarbone. The electrodes contained 7% chloride gel and had a 1 centimeter curricular contact area. Prior to placing the electrodes on the participants, the areas were cleansed with a 70% isopropyl alcohol wipe. The electrodes used to monitor heartbeat were disposable, and were thrown out after each use.

The ECG signal, monitored on AcqKnowledge software 3.2 (Biopac, Goleta, CA) was downsampled to 400 Hz and bandpass-filtered from 0.5 to 40 Hz. When the data was processed in ANSLAB, algorithms automated R-spike identification and created interbeat intervals (IBI). If ANSLAB missed an R-spike, causing a long period between consecutive R-spikes, that R-spike was interpolated manually. Similarly, if ANSLAB identified an incorrect R-spike, it was removed manually. After artifacts were corrected, the IBI series was converted to heart rate in beats per minute. Following this, the heart rate data was decimated to 10 Hz and then smoothed with a one-second prior moving average filter. Mean heart rate in beats per minute was calculated for each of the heartbeat tracking tasks (1 & 2) during the laboratory session.

Procedure

Each participant was randomly assigned to the Cognitive Reappraisal Writing group, the Expressive Writing group, or the Control group (where $n = 11$ for all three groups). On Day 1 of the experiment, participants came into the laboratory and were guided to a laboratory computer. The participants indicated their informed consent via writing. On the laboratory computer, the Day 1 Well-Being Survey was on the screen. Participants were informed to complete the survey and let the experimenter know when they were done. When participants finished taking the survey, the experimenter collected the participant's height, weight, birthdate and smoking status to calibrate armband data (not reported). The participants were then fitted with a BodyMedia SenseWear Armband on their left arm. They were instructed to wear the armband at all times for the duration of the study, except when bathing, and to wear the armband to their Day 4 session. Participants in the CRW and EW groups were informed that they would receive daily surveys,

starting that same evening, at 6pm. They were told that if they did not complete the surveys by 9pm, they would receive a reminder email. Participants in the Control group were informed that they would receive a reminder of their Day 4 session via email the day before that session was to take place. All participants were then reminded of the date and time of their Day 4 session before leaving the laboratory for on Day 1.

On Days 1, 2 and 3 of the study at 6pm, participants in the EW and CRW groups were sent a link to the Well-Being Survey. If any EW or CRW participants had their initial laboratory session at or after 6pm, they were sent Day 1's survey immediately after their session ended. Starting the evening of the initial laboratory session and for the following two days, all of the participants who received the Well-Being Survey were instructed to complete the entire survey, which included writing for between 5 and 15 minutes about the most stressful event of that day according to the instructions explained in the Materials section.

On Day 4 of the study, all participants came back into the laboratory and were guided to the experiment room. Each participant received a consent form asking for their permission to video record a portion of the study in the lab that day. After indicating or denying their consent, participants completed a second iteration of the Well-Being Survey. Next, ECG sensors were placed beneath the collarbones, and skin conductance SCL sensors were placed on the index and middle fingers of the non-dominant hand and on the back of the neck for grounding. Physiological measures were collected for the duration of the rest of the Day 4 tasks. As a baseline, participants were first asked to look at a fixation cross in the middle of the computer screen for two minutes while physiological measures were recorded, and then they answered a few questions about their current emotional state via the mood triplets. Then, participants

participated in the first iteration of the heartbeat tracking task as described in the Materials section. Participants then took part in a modified version of the TSST, completed emotion rating triplets, and engaged in an in-lab writing task (not reported). Participants then completed the slightly modified second version of the heartbeat tracking task. After, participants watched a short comedic clip designed to help them relax while their sensors were removed. Lastly, participants were debriefed, returned their armband to the experimenters, and received $65 compensation for the completion of the study.

Data Retention and Analysis

Each group (Control, EW and CRW) had a total of 11 participants whose data was used in the final analysis of the study. However, the EW group originally had 13 participants, two whose data was excluded from the study due to participant misunderstanding and issues with the survey distributing website, Qualtrics. One of the participants did not complete the Day 1 Writing Survey as scheduled, and both participants only received two of the three Writing Surveys due to website-wide service issues that Qualtrics was experiencing at that time. Therefore, the data for these two participants were excluded in all final analyses.

Results

Cognitive Reappraisal Use Manipulation Check

A one-way ANOVA confirmed differences that the CRW group (M = 1.71, SD = .74) used CR more than did the EW group (M = .97, SD = .63), $F(1, 20) = 6.42$, p = .020. This

showed that the CRW writing instructions produced the desired manipulation of increased CR use when writing about a daily stressor.

ADDI and MAIA

A Generalized Linear Model (GLM) was used to analyze group differences in ADDI and MAIA scores. For the ADDI, the GLM included factors of group (CRW, EW, and Control), and measures of ADDI subscales: Absence of Positive Affect, Somatic Anxiety, and General Distress. There were no significant effects of group, $F(6, 58) = 1.42$, $p = .223$, day, $F(3, 28) = .69$, $p = .565$, or their interaction, $F(6, 58) = 1.19$, $p = .325$, on ADDI scores.

For the MAIA, the GLM included factors of group (CRW, EW, and Control), and measures of MAIA subscales: Noticing, Not Distracting, Not Worrying, Attention Regulation, Emotional Awareness, Self Regulation, Body Listening, and Trusting. There were no significant effects of group, $F(16, 48) = .98$, $p = .494$, day, $F(8, 23) = 1.09$, $p = .402$, or their interaction, $F(16, 48) = 1.62$, $p = .100$, on MAIA scores.

However, when investigating individual pairwise comparisons of the MAIA subscales and their relation to group and day, a few interesting trends were revealed. From Day 1 to Day 4, the CRW group had a decrease in Noticing, $p = .000$, and an increase in Body Listening, $p = .045$; the Control group had an increase in Self Regulation, $p = .094$, and the EW group had a decrease in Not Distracting, $p = .040$. Aside from these trends, the results demonstrate that in this particular study, cognitive reappraisal did not have a significant effect on self-reported anxiety, depression, general distress, or self-reported interoceptive awareness.

Interoceptive Accuracy via the heartbeat tracking task

A GLM with factors of group (CRW, EW, and Control) and measures of time (HTT 1 and HTT 2) was performed to analyze any effects on interoceptive accuracy. The GLM showed that there was no effect of group, $F(2, 30) = .44$, $p = .651$, time of task, $F(1, 30) = 2.24$, $p = .145$, or the interaction between the two, $F(2, 30) = .49$, $p = .617$, on interoceptive accuracy.

Discussion

Summary of Results

The aim of this study was to examine the effects of cognitive reappraisal writing on interoceptive awareness and depressive and anxious symptoms. The literature thus far has offered multiple possibilities for the directional nature of this relationship. On one hand, since cognitive reappraisal lowers depressive and anxious symptoms, and interoceptive awareness is associated with higher stress and exhibits a complex relationship to depression, it would make sense that cognitive reappraisal use via writing could lower interoceptive awareness. On the other hand, as cognitive reappraisal is based on attention to and awareness of bodily signals in order to modulate emotional responses, it would be reasonable that cognitive reappraisal writing could facilitate interoceptive awareness.

In the present study, participants were randomly assigned to a Control group, an Expressive Writing group, or a Cognitive Reappraisal Writing group in order to test the relationship between cognitive reappraisal use and interoceptive awareness. The writing manipulation successfully produced the desired result of more CR use in the appropriate group.

However, the results of the present study show no significant effect of this manipulation on interoceptive awareness, or anxious or depressive symptoms.

Explanation of Results

Although there were no significant results for the present study, there are a few interesting outcomes to note. First, results from the MAIA from Day 1 to Day 4 suggest that four subscales underwent significant average response changes over the duration of the study. These subscales were the Noticing (awareness of uncomfortable, comfortable and neutral body sensations), Body Listening (active listening to the body for insight), Self Regulation (ability to regulate distress by attention to body sensations), and the Not Distracting (tendency not to ignore or distract oneself from sensations of pain or discomfort) scales. The present study's mean results show that participants in the CRW group became slightly less aware of bodily sensations (Noticing) yet they more readily actively listened to their bodies (Body Listening) at the end of the study as compared to the beginning. These results are fairly contradictory. One possible explanation for an increase in Body Listening for the CRW group is that participants in that condition had to concentrate more on internal bodily signals in order to regulate them through the use of CR in daily writing about stressful events, and they therefore automatically began to pay more attention to their bodies' sensations and how these sensations affected their emotional state. However, if this were the case, it would not explain the decrease in the Noticing scales. Perhaps one explanation is that if the CRW group initially started paying attention to bodily signals when they used CR in their daily writing, that they then became accustomed to certain bodily sensations and began to notice these sensations less. The mean results also show that the

EW group tended to increasingly ignore bodily distress (Not Distracting); perhaps an explanation for this is that purely by writing about their emotions, the EW group became more attuned to what these emotions felt like physiologically, and they therefore became easier to ignore. However, as the reliability for the Not Distracting scale was low (Cronbach's alpha < .70), it is unlikely that the mean change in this subscale provides any accurate indication of results.

Also, estimated marginal means of the ADDI show that participants in the EW group had an increase in mean positive affect from Day 1 to Day 4 of the study. Although this result is not statistically significant, nor could it statistically be considered a trend, had it been significant, it would have been consistent with previous research that has shown that even just expressive writing can decrease depressive symptoms (Gortner, Rude & Pennebaker, 2006).

The data of the present study also suggests non-significant differences between conditions on interoceptive accuracy. According to the results, the CRW group on average had a higher level of mean interoceptive accuracy across both the heartbeat tracking tasks, as compared to the EW and Control group. The EW group had the next highest average of mean interoceptive accuracy, followed by the control group. These findings are neither statistically significant nor close enough to statistical significance to be considered a trend; yet, had they been significant, they could have suggested the potential of a positive correlation between CR use and mean interoceptive accuracy. Had they been significant, it would have been interesting to think about this result in conjunction with the trend of the MAIA Body Listening subscale scores increasing from Day 1 to Day 4 in the CRW group; it could have supported results from previous studies suggesting that cognitive reappraisal can facilitate interoceptive awareness. If future studies can

find results that are statistically significant, it might give some insight as to whether cognitive reappraisal use facilitates interoceptive awareness.

Another interesting outcome of the current study is the difference in estimated marginal means of interoceptive accuracy between iterations of the heartbeat tracking task (1 and 2). Because the second heartbeat tracking task was performed after two other tasks—one of which was designed to induce stress in participants—the researchers were also curious if there were any differences between interoceptive accuracy results from the HTT 1 and HTT 2 (time of task), even though this was not one of the primary hypotheses of interest. While there were no significant results for this analysis, the data suggests that on average, mean interoceptive accuracy declined from the first iteration of the heartbeat tracking task to the second. Again, the results from this analysis are not statistically significant, nor could they statistically even be considered a trend. Nevertheless, had it been significant, this mean change could have indicated that the anxiety induced in the modified TSST and/or from writing about that anxiety, lowered average interoceptive accuracy among all three groups. This possibly could have suggested a negative correlation between anxiety and mean interoceptive accuracy. However, in order to test this idea about the impact of time on interoceptive accuracy, future studies would need to include a group of participants who do not participate in the modified TSST task, yet are tested still on interoceptive accuracy at two different points in the lab session.

Broader Implications

Although the present research did not find any significant effects of the manipulation on interoceptive awareness, depression, or anxiety, had any significant results been found, it would

have had important implications for clinical populations and for theories of emotion. If cognitive reappraisal had successfully diminished symptoms of depression and anxiety via the writing paradigm, it could have promoted the development of a successful clinical intervention for those suffering from those emotional disorders. This intervention could include a specific type of journaling that not only encompasses expressive writing, but also incorporates cognitive reappraisal; an intervention such as this, that can be done at home, would represent a cost-efficient and effective avenue for people suffering from depression or anxiety (or both) to help alleviate negative feelings. Not only would a significant effect in this domain have had an implication for clinical populations, but it could have increased knowledge of how to promote positive well-being for people of the general public, regardless of any clinical diagnosis of anxiety or depression, potentially allowing people to better understand how to handle negative emotionally salient events.

If the use of cognitive reappraisal had been found to have a significant effect on interoceptive awareness, the relationship between emotion regulation strategies and interoceptive awareness would have been further elucidated. Specifically, had cognitive reappraisal increased interoceptive awareness, it could mean that increasing attention to bodily signals could facilitate the manipulation of those bodily signals (i.e. slowing breathing to slow heart rate). In turn, this could lead to a change in emotional state. On the other hand, had cognitive reappraisal diminished interoceptive awareness, it could mean that in order to manipulate emotional state, one would have to disassociate themselves from their bodily sensations. Either scenario would have yielded key information on the relationship between perception of bodily signals and emotional state, providing insight into emotional theory.

Strengths & Limitations

This study possessed certain strengths in terms of its methodology. First, the implementation of the cognitive reappraisal writing instruction manipulation was successful, replicating the successes from previous works by Cochran (2015) and Raskin et al. (2015). This indicated that this manipulation is likely to be a reliable way of inducing the use of cognitive reappraisal in a writing paradigm. This study also added a control group in addition to the EW and CRW groups that previously existed in both Cochran (2015) and Raskin et al. (2015). This addition allowed for not only a comparison of the EW and CRW groups, but for a comparison against a baseline control group as well.

While this study does possess strengths, there are also several limitations to the current research. Overall, the present research had low statistical power due to a small number of participants. Low statistical power reduces the chance of detecting an effect of the manipulation on the dependent variables, and it lowers overall reliability of the experiment. The population of the participants was also relatively homogenous, as all participants were Tufts University students or employees. Because of this, any conclusions drawn from this study are less generalizable to the overall population.

The heartbeat tracking task, based on the Schandry Task (1981), might be subject to influence from external variables, such as beliefs and expectations about heart rate (Phillips et al., 1999). If this were, in fact, the case, it calls into question the effectiveness and accuracy of this method of measuring interoceptive accuracy. In order to attempt to control for this, a measure was included in the first iteration of the Well-Being Survey that asked participants about

existing beliefs about the speed of their heart rate. It also asked participants to estimate the length a time interval without counting the seconds. However, this data has not currently been analyzed and, thus, it is unclear whether the present study's heartbeat tracking tasks were subject to such influence from external variables.

Additionally, the researchers experienced equipment issues with regard to data collection, significantly impacting the validity of the interoceptive accuracy measure. Specific data was missing that would mark each separate interval of seconds where participants counted their heartbeats in the heartbeat tracking task, therefore disabling the researchers from calculating actual heart rate in each time interval. Instead, researchers were required to assess interoceptive accuracy in an alternative manner. This alternative manner was previously described in the results section of this paper, as overall heart rate based on an average for the duration of the time physiological data was recorded, compared to estimated heart rate based on an average of participant's guesses for all time intervals. Calculating interoceptive accuracy using this method also included in the overall averages both the participants estimates of their heart beats and their actual heart beat data during the experimental "tapping" trial. Due to this method of calculating interoceptive accuracy, validity can be assumed to be quite low.

The Writing Surveys that were sent to the CRW and EW groups were also completed by participants outside of the laboratory, in an uncontrolled environment. While participants were told to complete the surveys alone and in a quiet place where they could concentrate, the researchers have no idea what each environment was actually like, how they differed from one another, and what impact, if any, this had on the survey results. Particularly, the environments in which each participant took these surveys could have had an impact on their emotional state or

their ability to concentrate. The latter consequence would be a significant limitation especially for participants in the CRW group, who were given instructions to complete the writing task in a specific way that likely needed focused attention.

Furthermore, as with all self-report data, there are limitations to the validity of the ADDI and MAIA data, as participants might not necessarily be able to accurately assess and report on how they feel. More importantly, however, the ADDI section of the Well-Being Survey on Day 1 and Day 4 included instructions for participants to answer the questions based on how they felt both on that current day and over the past two weeks. The instructions on the Day 4 ADDI section of the Well-Being Survey should have instead asked participants how they felt since Day 1 of the study. Since those instructions did not ask that, the researchers have no way of knowing if they were actually measuring differences in ADDI data corresponding to, specifically, Days 1 and 4 of the study.

Directions for Future Research

The current study presents many opportunities for further research. Some further research should be done to address the limitations of the present study. Namely, the current research could be replicated with a higher level of power, a more even gender and age distribution, modified ADDI instructions on Day 4 of the Well-Being Survey, and with a heartbeat tracking task that allows a more accurate method of calculating interoceptive accuracy to be conducted (where interoceptive accuracy is calculated by the difference between actual heartbeats in a time interval, and a participant's estimate of their heartbeats in that time interval). Future research that

addresses the limitations of the present study could provide more concrete evidence as to whether there exists any significant effects of the manipulation on the dependent variables.

It would also be interesting to conduct a study similar to the current one that uses a within-subjects design, where participants' interoceptive awareness is assessed on Day 1 of the study as well as Day 4, rather than the between-subjects design of the present study. This would allow the researchers to adequately assume that any group differences found could not be attributed to pre-existing differences in interoceptive awareness, and instead are a result of the manipulation at hand.

Future research in this domain could also investigate whether cognitive reappraisal has an effect on interoceptive awareness by means of affecting depressive and anxious symptoms. Previous research has shown that interoceptive awareness has a relationship with both depressive and anxious symptoms in some capacity (Dunn et. al, 2007; Ehlers & Breuer, 1992; Schandry, 1981), and that cognitive reappraisal has an effect on both depressive and anxious symptoms (Haga, Kraft & Corby, 2007; Moore, Zoellner & Mollenhelt, 2009). Therefore, it could be possible that cognitive reappraisal facilitates or diminishes interoceptive awareness via a change in depressive or anxious symptoms. In other words, it would be worthwhile to examine whether cognitive reappraisal has an effect on depressive and anxious symptoms, which in turn could alter interoceptive awareness. In order to examine the relationship between cognitive reappraisal and interoceptive awareness as potentially modulated by a change in depressive and anxiety symptoms, researchers could implement a cognitive reappraisal manipulation that includes both a positive and a negative reappraisal condition. Specifically, one group could be instructed to positively reappraise a situation (i.e. frame it more positively), and another group could be

instructed to negatively reappraise a situation (i.e. increase negative affect). Interoceptive awareness could then be assessed to determine the effects of changes in depressive and anxious symptoms on IA.

Concluding Comments

In sum, this study attempted to further existing research on the links between cognitive reappraisal, interoceptive awareness, and depression and anxiety. The cognitive reappraisal writing manipulation was successful, but no significant results were found for any of the interactions of interest. Although no significant results were discovered, it is possible that the overall nature of the study could be replicated in the future and produce significant results, as the current research contains notable limitations in its methodology. The present findings do warrant further research, as insight into this subject matter could have significant implications for interventions in the anxious and/or depressed communities, and for furthering knowledge of emotional theory.

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Table 1

Estimated Marginal Means of the ADDI, MAIA and Interoceptive Ability Measures

Measure	Subscale	Day	Control Group		EW Group		CRW Group	
			M	*SE*	*M*	*SE*	*M*	*SE*
ADDI	*Positive Affect Absence*	Day 1	26.46	2.66	28.55	2.66	25.55	2.66
		Day 4	26.64	2.39	26.36	2.39	26.73	2.39
	Somatic Anxiety	Day 1	13.27	1.45	11.36	1.45	15.55	1.45
		Day 4	13.00	1.33	11.36	1.33	14.55	1.33
	General Distress	Day 1	18.64	2.18	19.00	2.18	24.27	2.18
		Day 4	17.64	2.66	21.55	2.66	24.73	2.66
MAIA	*Noticing*	Day 1	2.71	0.27	3.11	0.27	3.23	0.27
		Day 4	2.82	0.27	3.02	0.27	2.57	0.27
	Not Distracting	Day 1	2.58	0.17	2.82	0.17	3.03	0.17
		Day 4	2.46	0.26	2.33	0.26	3.15	0.26
	Not Worrying	Day 1	3.00	0.27	2.94	0.27	3.00	0.27
		Day 4	3.03	0.22	3.09	0.22	2.79	0.22
	Attention Regulation	Day 1	3.10	0.27	3.26	0.27	2.73	0.27
		Day 4	3.26	0.22	3.30	0.22	2.56	0.22
	Emotional Awareness	Day 1	3.07	0.25	3.56	0.25	3.29	0.25
		Day 4	2.91	0.28	3.56	0.28	3.20	0.28
	Self Regulation	Day 1	2.59	0.27	2.91	0.27	2.91	0.27
		Day 4	2.86	0.25	3.02	0.25	2.66	0.25
	Body Listening	Day 1	2.73	0.32	2.58	0.32	2.15	0.32
		Day 4	2.70	0.31	2.79	0.31	2.76	0.31
	Trusting	Day 1	4.06	0.29	3.61	0.29	3.27	0.29
		Day 4	3.88	0.27	3.52	0.27	3.09	0.27
Interoceptive Ability	*Heartbeat Tracking Task 1 (Pre-TSST)*	Day 4	20.02	5.01	17.04	5.01	21.35	5.01
	Heartbeat Tracking Task 2 (Post-TSST)	Day 4	16.51	4.24	13.77	4.24	21.20	4.24

Appendix

Well-Being Survey

Demographics. Basic demographic information was collected from each participant during the Well-Being Survey. This information included race, age, gender, education level, marital status, children, and number of people living with the participant. For each question, there was an option to decline to answer.

Debriefing Questions. On Day 4 of the study, participants came into the lab to take the Well-Being Survey a second time. The Day 4 Well-Being Survey included certain debriefing and manipulation check questions. These questions asked the participants what they thought the researchers expected to find in the study, and what effect they thought the writing was intended to have on them. Due to an oversight by the researchers, Control group participants were also asked what effect they thought the writing was intended to have on them, without instructions to ignore or skip this question. If these participants asked the researchers what this question meant, they were instructed to write "N/A." The Day 4 Well-Being Survey also included a question for all participants asking if they thought their data should be included in the final analyses of the study, and if they did not think it should, why they thought this.

Estimates of Resting Heart Rate. On the Day 1 version of the Well-Being Survey, participants were asked how many times they believed their heart beat per minute. This question was included to check to see if participants had a baseline understanding of their resting heart rate. This variable would have been analyzed had the researchers observed any significant effects of group on interoceptive accuracy scores measured in the heartbeat tracking task.

Perception of Time Intervals without Counting. On the Day 1 version of the Well-Being Survey, participants were asked to complete a small task to assess their ability to estimate a length of time without actually counting the seconds. Participants looked at a blank screen with a plus sign (+) for a specific interval, and then were asked to guess how many seconds they believed the screen was there for, without having counted the seconds. Participants did this task three times for three different time intervals. The time intervals were 20, 30 and 40 seconds, as compared to 25, 35, and 45 second intervals of the Day 4 heartbeat tracking task. Combined with the previous question participants were asked on the Well-Being Survey about their perception of how many times their heart beat per minute, this task was designed to assess participants ability to guess their resting heart rate for a certain amount of time. This variable also would have been analyzed had the researchers observed any significant effects of group on interoceptive accuracy scores measured in the heartbeat tracking task.

Five Families Emotion Regulation Questionnaire (FFERQ). This measure of the Well-Being Survey consists of 24 statements scored on a 7-point Likert scale ranging from 0-7 (Strongly Disagree - 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.

Behavioral Inhibition and Activation Scales (BAS/BIS). This measure of the Well-Being Survey 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 1-4 (Very true for me - 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 Well-Being 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 got out of bed in the morning. It also asks subjects to a rate their quality of sleep, and how rested they felt upon waking.

Health. In this section of the Well-Being Survey, 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.

Life Events Scale (LES). This measure of the Well-Being Survey 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.

Physiological Measures

BodyMedia SenseWear Armband. Participants in all three conditions were given a BodyMedia SenseWear armband model MF-SW (Pittsburgh, PA) to wear for the duration of the experiment. The BodyMedia SenseWear armband is a small, wearable ambulatory monitoring device that is worn on the back of the upper arm, secured by a velcro strap. Each participant wore the armband on their left arm. Participants were instructed to wear the armband for approximately 23 hours a day, removing it for bathing. They were also instructed to gently wipe the inside of the armband with a moistened paper towel once daily. The armband contains multiple sensors for measuring 3-axis accelerometry, heat flux, skin temperature, near body temperature, and galvanic skin response (GSR). The GSR sensor's calibrated range is 56k Ohms to 20 MOhms (50.0 nSiemens - 17.0 μSiemens), two-standard-deviation of error of +/-9.0 nSiemen, 50 to 225 nSiemens, two-standard-deviation error of +/-4.0% otherwise. The skin temperature sensor has a calibrated range of 20.0ºC to 40.0ºC, with a minimum resolution of 0.05ºC and two standard deviation accuracy of +/-0.8ºC. Average GSR and skin temperature were sampled at a rate of 1 Hz. The data is uploaded to the SenseWear Professional 8.0 Software in order to calculate energy expenditure, activity level, and sleep duration and quality. When participants returned the armband at the end of the final laboratory session, the armbands were disinfected between participant uses with 70% isopropyl alcohol wipes, and the straps were washed with detergent.

Skin Conductance Level (SCL). Skin conductance level was measured to monitor the activation of the sympathetic nervous system. In order to collect this data, two Ag/AgCl electrodes were placed on the pads of the index and middle fingers of the participant's non-dominant hand. Another electrode was placed on the back of the participants neck as a ground. The electrodes contained .5% chloride isotonic gel and had a 1 centimeter circular contact area. SCL activity was recorded with DC coupling and constant voltage electrode excitation at 31.25 Hz (sensitivity =0.7 nS). Following this, the SCL data was decimated to 10 Hz and then smoothed with a one Hz low-pass filter.

Modified TSST

The TSST is a tool implemented as a stress-task to induce anxiety (Kirschbaum et al., 1993). In this study, it was used during the Day 4 session in the laboratory. In the TSST, participants are asked to perform a speech task. Participants learn that they will be assessed and video recorded (if they previously gave consent to be video recorded) as they speak for five minutes about their organizational skills and their ability to accomplish deadlines under pressure. They are given three minutes of preparation time in which they are allowed to take notes, but the notes are taken away before the speech performance begins. When the speech begins, participants are able to see their faces being video recorded on the screen before them. If participants do not give video recording consent, they would only see their face on the screen before them, without the record button being pressed. The speech lasts for five minutes, and if participants get quiet before the five-minute mark, the experimenter tells them how much time is remaining and that they should continue speaking. In a typical TSST, a math task usually begins

immediately after. However, in this particular study, a modified version of the TSST was used, and the math task was excluded. Therefore, participants only engaged in the speech aspect of the TSST.

In-Lab Writing Task

After the TSST, participants were asked to write about the stressful event that they just experienced. They were asked to use the first person perspective ("I," "me," "my") and to address how they felt during the task and how they feel at the present moment. The participants were not given any instructions relating to cognitive reappraisal writing. The goal of this task was to allow researchers to assess group differences in the use of cognitive reappraisal without specific prompting, if they chose to analyze this data.