Cardiovascular Benefits of Forgiveness in Women: A Psychophysiological Study

Research Thesis

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by

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Abstract

The perseverative cognition hypothesis posits that psychological stress (e.g., sustained mental representations of past events) contributes to somatic disease through prolonged activation of cardiovascular and other biomechanisms. In the current study, we examined the effects of forgiveness compared to unforgiveness states, the latter conceptualized as a form of perseveration, on cardiovascular function. Ruminating about a hurtful event has been associated with higher heart rate, blood pressure, and muscle tension compared to forgiving. Specific aims of the current study are to examine the impact of forgiveness on vagal function—indexed by heart rate variability (HRV)—using an electrocardiogram. Healthy female participants' (N = 60) HR data was continuously measured during a 5-minute baseline period, a 5-minute negative emotion induction, and 5 minutes of a randomized recovery manipulation. During the negative emotion induction, participants were instructed to think about a transgressor with whom they were feeling frustrated. Participants were then randomized into one of three recovery conditions: forgiveness (imagine forgiving the transgressor), extended frustration (continue thinking about the transgressor), and distraction (read neutral, thorough laundry instructions). After controlling for baseline and task HRV, participants in the forgiveness phase had higher HRV than those in both the extended frustration and distraction phases. Results suggest that: a) forgiveness may influence somatic health through mechanisms of cardiac autonomic control, b) lower HRV during unforgiveness is analogous to perseverative states such as worry and rumination, and c) among women, forgiveness of a transgressor may be a beneficial coping strategy. Overall, the findings support the perseverative cognition hypothesis, and suggest a link between forgiveness and cardiovascular health.

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Many researchers have explored the link between health and emotion. As humans, we experience a whole multitude of emotions, ranging from positive to negative. A large body of research has drawn a link between emotional states and physical health (Thayer, Hansen, Saus-Rose & Johnsen, 2009). Moreover, gender differences present in cardiovascular health warrant further investigation into the immediate effects of particular emotion-health connections, through biological indices of cardiovascular health (Horsten, Ericson, Perski, Wamala, Schenck-Gustafsson, & Orth-Gomér, 1999).

The importance of the emotion-health connection is especially relevant in light of research suggesting that men and women express and cope with emotions differently (Kring & Gordon, 1998). For example, men tend to focus on one problem at a time and simultaneously let go of the emotion invoked by a situation. In contrast, women tend to consistently 'over-think' when dealing with emotional situations by thinking about the stressor continually (McRae, Ochsner, Mauss, Gabrieli, & Gross, 2008). These different responses characterize emotion regulation (ER), defined as the process in which one is able to regulate or manage their emotions mentally (Gross, 2002). ER incorporates feelings, emotion-related cognitions, behaviors, and physiological processes (Gross, 2002). All of these factors can be influential on physical well-being and health, as research has shown that holding on to negative emotions can have a negative impact on cardiovascular function (Friedman & Thayer, 1998; Booth-Kewley & Friedman, 1987). Gender differences in ER may also contribute to known differences in the prevalence of cardiovascular disease and to the well-documented gender differences in depression diagnoses (Chonody & Siebert, 2008; McSweeney, Pettey, Souder, & Rhoads, 2011).

A large body of research has focused on one ER strategy, in particular, rumination, which is a way of responding to distress by consistently focusing on the symptoms, causes, and consequences of the distressful situation (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). Studies have shown that women ruminate more frequently compared to men, and that rumination is an important factor in maintaining depression and other psychopathology (Nolen-Hoeksema et al., 2008). These studies have further indicated differences between males and females that stems from their individual processes of regulating emotions.

The extensive work of gender differences in ER and cardiovascular health further supports the link between emotional experiences and physical well-being (McCraty, Atkinson, Tiller, Rein, & Watkins, 1995). Anger has been of particular interest in this regard. For example, previous studies have shown that a reduction in anger leads to increased cardiovascular function (Horsten et al., 1999). The relationship between other emotions, such as sadness, fear, and panic, in relation to heart function, has also been evaluated with notable results (Friedman & Thayer, 1998). Specifically, this study has demonstrated that in patients with panic disorder, increased fear and panic may lead to a reduction in heart function (Friedman & Thayer, 1998). However, previous studies conducted on the effects of sadness have revealed that some moderate symptoms of depression are associated with higher heart function, especially in women (Thayer, Rossy, Ruiz-Padial, & Johnsen, 2003).

This interplay between negative affective states (i.e. worry, etc.) and health disparities provided the basis for the perseverative cognition hypothesis (Brosschot, Gerin & Thayer, 2006). The perseverative cognition hypothesis states that psychological stress, which can be sustained as mental representations of past events or other likewise transgressors, contributes to somatic disease through prolonged activation of cardiovascular and other biomechanics (Brosschot et al.,

2006). This research highlighted similarities, particularly repetitive and consistent thoughts, evidenced between studies conducted on rumination, worry, and health. Furthermore, this review illustrated that the primary focus of the perseverative cognition hypothesis is the chronic activation of physiological and psychological responses to one or more transgressors (Brosschot et al., 2006).

Moreover, research has shown that perseverative cognition, in addition to other negative affective states (i.e. anger, stress, depression, etc.), can have a detrimental impact on cardiovascular health by reducing heart rate variability (Thayer & Lane, 2007). Heart rate variability (HRV) is utilized as a measure of cardiac function and autonomic balance (Thayer, Åhs, Fredrickson, Sollers & Wager, 2012; Thayer & Lane, 2000). Autonomic balance is the stability or instability (i.e. autonomic imbalance) present between the parasympathetic nervous system (PNS) and the sympathetic nervous system (SNS) of the autonomic nervous system (ANS). Autonomic imbalance is characterized by a hyperactive SNS and hypoactive PNS at rest. The PNS is considered the "rest or digest" branch of the ANS, whereas the SNS is considered the "fight or flight" branch of the ANS. Thus, the SNS becomes active when there are stressors present, and the PNS regulates the body's peripheral organs (i.e. heart) to a homeostatic state following the removal of the stressor (Thayer & Lane, 2000; Thayer, J.F., Yamamoto, S.S., Brosschot, J.F., 2010). For example, when the body attempts to adapt to an imminent threat, SNS activation occurs, resulting in an increase of blood pressure (BP) and heart rate (HR), while HRV (i.e. PNS tonus) decreases. Objectively, once the threat has passed, the PNS allows the body to stabilize. However, subjectively, the threat may not have been removed; cognitive representations of the stressor may still be present, causing a prolonged recovery of the heart and other peripheral organs. The perseverative cognition hypothesis focuses on the cognitive

representation of a stressor, which seems to account for slower recovery following the stressful experience (Brosschot et al., 2006). Thus, stability between both the PNS and the SNS allows for maximum adaptability in terms of lifetime progression.

Considering the importance of autonomic balance, methods to alleviate tensions following a deleterious situation would be beneficial. One such method to relieve oneself of negative emotions, particularly as they relate to someone else, is forgiveness. Forgiveness is conceptualized as a series of mental changes that an individual performs, following a personal injury, where negative emotions are relinquished and the individual begins to feel increased positivity towards the transgressor (McCullough, 2001). People tend to hold on to negative emotions, such as frustration or hatred, in forms of grudges. When consistently keeping these emotions close to them, they tend to expel energy in maintaining the frustration, in turn, may prolong the physiological experience of the negative emotion (i.e. longer elevations in HR and blood pressure) and result in a negative impact on health. Along these lines, letting go of this hatred or frustration could lead to positive health outcomes. Previous research supports this notion, as studies have shown that participants who expressed forgiveness toward someone against whom they held a grudge had lower HR, and, in turn, a more positive physiological response (Oyen, Ludwig, & Laan, 2001). In this study, participants were instructed to alternate between remembering someone that they held a grudge against and to focus on forgiving this person over a two-hour period. These researchers found that forgiving thoughts exhibited decreases in heart rate following the stressor (Oyen et al., 2001).

A recent study focused on trait forgiveness and cardiovascular health (Friedberg, Suchday & Shelov, 2007). Within the study, participants were asked several questions about forgiveness techniques through a series of questionnaires, and later interviewed about a negative

event (anger-recall) within the past 6-months. A cognitive task was also included. Findings suggested that those individuals with higher scores in trait forgiveness depicted lower resting BP during baseline, with increases in BP during the recovery phase. However, the researchers did suggest that no connection between forgiveness and cardiovascular reactivity was found through the course of the anger recall phase (Friedberg et al., 2007).

Furthermore, another study focused specifically on forgiveness, distraction, and anger (Larsen, Darby, Harris, Nelkin, Mikam, & Christenfeld, 2012). Participants in the experiment were randomized into three conditions and subsequently asked to think about the transgressor in a forgiving mentality, an anger mentality, or were distracted. Results from HR data and blood pressure (BP) showed that those who were instructed to think about a negative event in a forgiving mindset had less elevated BP in comparison to those individuals instructed to think about a negative event in an angry mindset (Larson et al., 2012).

Considering the more recent interest in forgiveness research pertaining to cardiovascular health outcomes, the current study aimed to evaluate the physiological impact of forgiveness, with a focus on women, a more emotion-driven group. Furthermore, the present investigation incorporated the use of self-report data designed to focus on emotion regulation processes and behaviors; specifically the Difficulties in Emotion Regulation Scale (DERS), the Behavioral Inhibition Scale and the Behavioral Activation Scale (BIS/BAS), and the Ruminative Responses Scale (RRS). These scales provided access to data about an individual's resting state, prior to the beginning of the study (Gratz & Roemer, 2004; Carver & White, 1994; Treynor, Gonzalez & Nolen-Hoeksema, 2003).

Overall, the purpose of this study was to further evaluate the hypothesis that letting go of negative emotions, such as frustration or grudge holding, can have a positive and immediate

impact on cardiovascular function in women. Previous findings suggest that individuals who are able to let go of their negative frustrations/grudges should exhibit higher HRV, whereas those who hold on to their negative frustrations/grudges will have lower HRV. The present study explored this possibility, with a focus on women, a traditionally understudied population, as substantiated by the gender disparities, in terms of emotion regulation processes and cardiovascular health outcomes (Chonody & Siebert, 2008; McSweeney et al., 2011). Furthermore, the study also addressed the larger questions of how both mental health and physical health might be linked.

Method

Participants

Sixty healthy female participants (N = 60) were recruited over the course of a year. Women were recruited from an introductory psychology course at The Ohio State University, for which they received research credit for participation, and from surrounding campus areas, for which they received paid compensation for participation. Participants ranged in age between 18 - 40 years old.

Measures

Continuous heart rate (HR) data were collected utilizing an electrocardiogram (EKG) monitor and Biolab 1.11 computer software (Biolab 1.11, 2007). HRV is conceptualized as the beat-to-beat interval present between R spikes on a QRS wave complex (Thayer & Lane, 2007). The inner-beat-intervals (IBIs) were extracted through the HRV 2.51 computer program (HRV 2.51, 2007). Kubious HRV Analysis Software was used to remove outliers, provide time and

frequency domain indices for HRV, and calculate absolute high frequency (HF) HRV using high frequency power (HF-HRV; 0.15-.40 Hz, ms2) (Tarviainen, Niskanen, Lipponen, Ranta-aho, & Karjalainen, 2008). The natural log (ln) of the absolute HF was taken to homogenize the scores (Task Force Guidelines, 1996). LnHF was the final measure used for analyses of the resulting data.

Procedure

Participants were brought into the laboratory, given informed consent forms, and provided with a basic explanation of the study without revealing the hypothesis. Subjects were then connected to a three lead electrocardiogram (EKG). HR data was measured throughout the experiment. At the start, participants were asked to fill out a set of self-report scales. These scales included: The Behavioral Inhibition System (BIS) and Behavioral Activation System (BAS) (Carver & White, 1994), The Difficulties in Emotion Regulation Scale (DERS) (Gratz & Roemer, 2004), and The Ruminative Responses Scale (RRS) (Treynor et al., 2003). Participants then completed three stages of the experiment: (1) Baseline, (2) Negative Emotion Induction, and (3) Recovery Manipulation. Each stage was five minutes in length. During the baseline period, participants sat for a five-minute long baseline stage. During this period, the computer monitor displayed a blank screen, and individuals are asked to sit quietly. Following baseline, the negative emotion induction was employed. At this time, a prompt was displayed on the computer screen stating, "Now, I want you to recall a time when you felt very frustrated toward another person. This should be someone that still frustrates you when you think about them now". Participants are asked to think about this individual for five minutes. Succeeding the negative emotion induction,

participants were randomized into one of three recovery manipulations: a forgiveness manipulation, a distraction manipulation, or an extended frustration manipulation.

Participants who completed the forgiveness manipulation condition were prompted with a screen stating "In the next part of the experiment we would like you to think about forgiving this person with whom you hold a frustration and letting go of this frustration". Participants were asked to do this for a total of five minutes. Participants who completed the distraction manipulation condition were prompted with a screen asking them to read through neutral stimuli. These stimuli consisted of thorough directions about how to do laundry. Participants who completed the extended frustration manipulation condition were prompted with a screen instructing them to "In the next part of the experiment we would like you to continue thinking about with whom you are frustrated". Upon completion of the experiment, the EKG was disconnected and the participants were given a verbal and written debriefing of the study. The entirety of the study was completed within one hour of time.

Questionnaires

The Difficulties in Emotion Regulation Scale (DERS) consists of a 36-item scale that is designed to identify an individual's system of emotion regulation (Gratz & Roemer, 2004). It has six subscales: Non-acceptance of emotional responses, difficulties engaging in goal directed behavior, impulse control difficulties, lack of emotional awareness, limited access to emotion regulation strategies, and lack of emotional clarity. This scale was used to gauge trait mental states, and detect any frequencies of emotion dysregulation present among the participants (Gratz & Roemer, 2004).

The Ruminative Responses Scale (RRS) contains 22- items in which individuals supply answers to questions seeking information about how sad or depressed an individual feels at that particular moment (Treynor et al., 2003). Participants in studies that use this self-report questionnaire are asked questions in which the participant must respond on a four-point scale, with the number one corresponding to Never and the number four corresponding to Always (Treynor et al., 2003). The use of RRS in the current study allowed valuable data to be collected regarding the participant's mental and emotional state, with particular focus on depression and sadness (Treynor et al., 2003).

The Behavioral Inhibition Scale and Behavioral Activation Scale (BIS/BAS) is a 20-item scale that is designed to gauge the level of an individual's behavioral inhibition system and their behavioral activation system, as the literature suggests that both systems play a role in behavior (Carver & White, 1994). The BAS is geared towards a positive perspective, looking more discretely into reward and affirmative action seeking behaviors (Carver & White, 1994). It has three subscales, including the Reward-Seeking Subscale, the Drive Subscale, and the Fun-Seeking Subscale, whereas the BIS portion is focused on negative behavioral actions with no subscales (Carver & White, 1994).

Results

Physiological Data

Descriptives were performed to take into account any significant differences present between all three conditions, prior to the manipulated recovery period. Furthermore, frequency

analyses of absolute high frequency (HF) HRV at baseline, task, and recovery showed a positively skewed distribution in all three stages. Due to this discrepancy amongst participants for further analyses, natural log transformed absolute HF HRV were utilized (Task Force Guidelines, 1996).

No significant differences were evident when checking natural log (ln) high frequency (HF) HRV by condition during the baseline period. However, a significant difference ($F(2,57) = 3.50$, $p = 0.037$) [Figure 1] was evident between conditions during the negative emotion induction period. In order to evaluate the effects of the manipulation, while constraining the physiological differences present amongst individual participants, both baseline and the negative emotion induction stages were covaried. This ensured that individual differences in HRV and between groups were not influencing the final analyses. Thus, we performed an analysis of covariance (ANCOVA) to evaluate group differences between the three recovery manipulation conditions (forgiveness, distraction, and extended frustration). LnHF at recovery was utilized as the determining factor for HRV. The ANCOVA test showed a significant main effect by condition for lnHF ($F(2,52) = 3.64$, $p = 0.033$). To further investigate the effect by condition, planned contrast analyses were conducted. Contrasts revealed that individuals in the forgiveness condition had higher HRV in comparison to both the distraction condition and the extended frustration condition ($p = 0.056$, CI 95% [-0.657, 0.009] | $p = 0.013$, CI 95% [- 0.690, -0.085]). Furthermore, contrasts showed that individuals in the distraction condition did not exhibit significant differences in LnHF HRV at recovery to those in the extended frustration condition ($p = 0.696$, CI 95% [-0.262, 0.389] [Figure 1 | Table 2].

Questionnaire Data

A comparison between conditions on the DERS depicted several marginally significant results in some subscales including the "Limited Access to Emotion Regulation Strategies" ($F(2,59) = 2.285$, $p = 0.111$), and the "Lack of Emotional Clarity" subscale, ($F(2,59) = 2.308$, $p = 0.109$). Within both subscales, those in the forgiveness recovery condition exhibited higher scores than the other two recovery conditions. Furthermore, the BIS/BAS depicted several significant results in terms of subscales including the "Drive" subscale, ($F(2,59) = 3.177$, $p = 0.049$), and the "Fun-Seeking" subscale ($F(2,59) = 3.944$, $p = 0.025$). Within both these subscales, those in the distraction recovery condition exhibited higher scores than the other two recovery conditions. No other scale or subscale differed significantly between groups (all p's > 0.2).

Discussion

The trends depicted in the data were consistent with the original hypothesis. Overall, those randomized into the forgiveness recovery condition displayed better cardiovascular functioning immediately following a transgressor than those in the extended frustration condition and those in the distraction condition.

Furthermore, this study provides evidence that forgiveness may influence somatic health through mechanisms of cardiac autonomic control. Lower HRV during the extended frustration condition, in which individuals were instructed to continue ruminating over the transgressor, is analogous to that during perseverative states such as worry and rumination. Overall, the findings support the perseverative cognition hypothesis and suggest a link between forgiving responses and cardiovascular health.

Additionally, the results are consistent with previous research showing that forgiveness may be related to better cardiovascular outcomes (Larson et al., 2012). Similar studies conducted along a similar construct, employing forgiveness, distraction, and anger states, found that individuals who were able to think of a negative transgressor in a forgiving mindset had minimal increases in blood pressure, compared to other subjects who were asked to think about a negative transgressor in an angry mindset (Larson et al., 2012). Furthermore, these researchers found that individuals asked to think about a neutral event, in comparison to a negative one, had similar blood pressure to those in the forgiveness condition (Larson et al., 2012). However, during a subsequent stage, individuals were allowed to engage in a free thought period, and those in the distraction condition showed elevated blood pressure more similar to those in the anger condition (Larson et al., 2012). As such, findings in the present results are in line with Larson et al (2012) findings. In the present study, forgiveness yielded the highest HRV values *following* the emotion induction, whereas the Larson et al (2012) study found that forgiveness *during* the negative emotion induction yielded low blood pressure values following the induction. Thus, the present study extends previous work by demonstrating that beyond how an individual recalls a frustrating event, forgiveness (following the thoughts of the frustrating individual) can increase cardiovascular function. Overall forgiveness was most attributable to immediate increases in HRV, suggesting that forgiveness allowed for a more positive, overall cardiovascular health outcome immediately following a transgressor in women subjects.

The use of several emotion-based questionnaires prior to beginning the experiment allowed for evaluation of individual emotion-coping strategies. Individuals who were randomized into the forgiveness recovery condition presented with higher scores on the DERS "Limited Access to Emotion Regulation Strategies" than those in the distraction or extended

frustration recovery conditions. Furthermore, these same individuals also exhibited the highest scores, on average, in the DERS "Lack of Emotional Clarity" subscale. These results suggest that subjects in the forgiveness recovery condition naturally had poorer emotion regulation strategies available than those in the other two recovery conditions. Additionally, analyses of the BIS/BAS subscales of "Drive" and "Fun-Seeking" revealed that those in the forgiveness and extended frustration conditions had difficulty thinking in terms of motivational and positive behaviors versus those in the distraction condition. Other research has suggested that HRV is a measure of emotion regulation (Thayer & Lane 2007; Thayer et al 2012). Thus, covarying for baseline HRV effectively covaries for individual's emotion regulation at both the baseline and the emotion induction stages.

Previous research included both male and female subjects, although, there is extensive literature demonstrating the differences prevalent between genders on these measures (Thayer et al, 2003; Nolen-Hoeksena et al, 2008). Differences are generally highlighted in emotion regulation, however, gender differences in health, with particular emphasis on the prevalence and onset of cardiovascular disease is also important for researchers to continue to investigate. Thus, the present study examined the impact of forgiveness in the short term in women only. The results support previous results, showing that individuals who are able to forgive have higher cardiovascular activity. The present investigation extended this research by providing evidence that forgiveness can be beneficial, no matter the individual's recall methods. Furthermore, the implications of the study are important for individuals who habitually hold grudges, as well as individuals who have difficulty in letting go of negative emotions, as this may be detrimental to overall health, especially for women.

Limitations and Future Direction

Future studies can address the limitations of the current experiment. The study performed by Oyen, Ludwig & Laan (2001) focused on the cardiovascular benefits of forgiveness, and implemented a self-report emotion rating following each individual trial of the study (Oyen et al., 2001). However, the latter approach was not used in the present study. An emotion scale prior to the beginning the study, and following completion of the study, would have allowed us to see if participants were impacted by the emotion induction and recovery manipulations. Furthermore, the recovery manipulation could have potentially influenced individual performance. Within the experiment, all stages were employed through use of a television monitor. Participants within the forgiveness condition and the extended frustration condition were instructed to "think" about a situation, whereas the distraction condition provided visual neutral stimuli (i.e. laundry instructions) to read. As the latter was a lexical task, it could have contributed in some way to discrepancies between the distraction condition and the other two recovery conditions. Moreover, as the entire study was completed within an hour, with the experimental portion taking a total of fifteen minutes, an extended recovery period would be interesting for investigation in the future. This would allow the examination of a possible prolonged impact of the forgiveness manipulation on participants.

Numerous future directions have been inspired by the current investigation. Of most interest is the employment of an emotion scale prior to, and following, completion of the experiment. This would allow for a manipulation check outside the supporting physiological data. In addition, the incorporation of a brief questionnaire that would include several questions addressing the individual's transgressor (i.e. significant other, friend, family member, etc.) and details about the situation they recalled. This could potentially be very beneficial to the overall

findings, and would allow for the incorporation of a unique set of data that could open the discussion to other topics, including romantic influence and emotional attachments.

Conclusion

In conclusion, research conducted on the topic of forgiveness of negative emotions is a contemporary, evolving field. This current study will contribute to the literature demonstrating that forgiveness, though only in the short term, is suggestive of having a beneficial impact on women's cardiovascular function and subsequent health. Additionally, these results are in support of the perseverative cognition hypothesis, suggesting that forgiveness may decrease the prevalence of negative mindset. Finally, this study provides insight into possible gender differences when evaluating forgiveness – which could assist in the study of cardiovascular disease, specifically as it relates to women.

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Figures

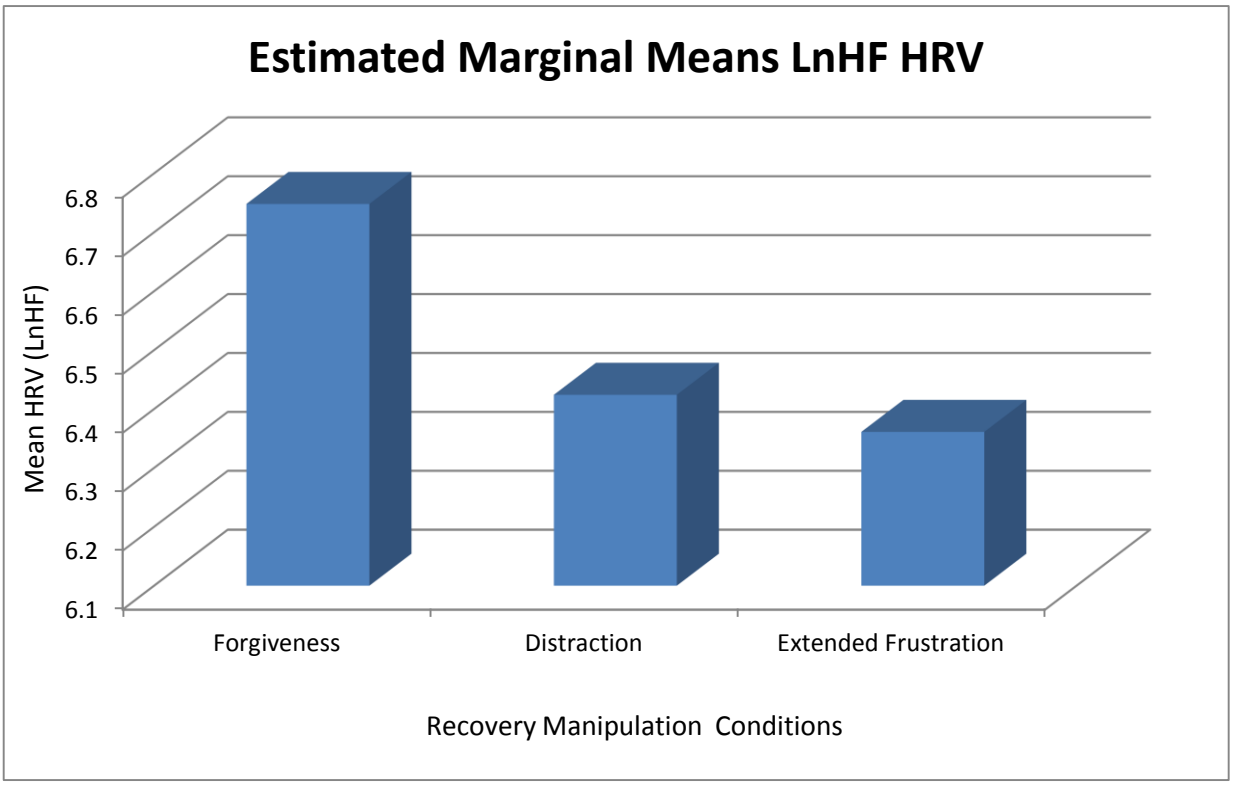

Figure 1. Bar graph showing LnHF HRV during recovery manipulation condition for each group once both baseline HRV and task HRV have been covaried.

Table 1

Recovery Manipulation Conditions Prior to Covarying

Recovery Condition	Mean HRV Recovery (LnHF)	Standard Deviaion	N
Forgiveness	6.36557912	1.41673265	20
Distraction	7.00953872	1.21740116	18
Extended Frustration	6.216463	0.944712611	20
Total	6.5140093	1.23486602	58

Note. This is descriptive information by condition including mean, standard deviation, and total participants within each condition. Distraction condition did not have two qualifying baseline periods due to equipment malfunction. This is prior to covarying HF HRV at task and recovery.

Table 2

Recovery Manipulation Conditions After Covarying

Recovery Condition	Estimated Marginal Mean HRV Recovery (LnHF)	Standard Error	N
Forgiveness	6.748	0.108	20
Distraction	6.424	0.118	18
Extended Frustration	6.361	0.106	20

Note. This is descriptive information of each condition at the recovery stage after covarying at baseline and task HF HRV. The table provides the estimated marginal means.

Appendix A

Difficulties in Emotion Regulation Scale (DERS)

Response categories:

1 Almost never (0-10%)
2 Sometimes (11-35%)
3 About half the time (36-65%)
4 Most of the time (66 – 90%)
5 Almost always (91-100%)

1. I am clear about my feelings.
2. I pay attention to how I feel.
3. I experience my emotions as overwhelming and out of control.
4. I have no idea how I am feeling.
5. I have difficulty making sense out of my feelings.
6. I am attentive to my feelings.
7. I know exactly how I am feeling.
8. I care about what I am feeling.
9. I am confused about how I feel.
10. When I'm upset, I acknowledge my emotions.
11. When I'm upset, I become angry with myself for feeling that way.
12. When I'm upset, I become embarrassed for feeling that way.
13. When I'm upset, I have difficulty getting work done.
14. When I'm upset, I become out of control.
15. When I'm upset, I believe that I will remain that way for a long time.
16. When I'm upset, I believe that I'll end up feeling very depressed.
17. When I'm upset, I believe that my feelings are valid and important.
18. When I'm upset, I have difficulty focusing on other things.
19. When I'm upset, I feel out of control..
20. When I'm upset, I can still get things done.
21. When I'm upset, I feel ashamed with myself for feeling that way.
22. When I'm upset, I know that I can find a way to eventually feel better.
23. When I'm upset, I feel like I am weak.
24. When I'm upset, I feel like I can remain in control of my behaviors.
25. When I'm upset, I feel guilty for feeling that way.
26. When I'm upset, I have difficulty concentrating.
27. When I'm upset, I have difficulty controlling my behaviors.
28. When I'm upset, I believe there is nothing I can do to make myself feel better.
29. When I'm upset, I become irritated with myself for feeling that way.
30. When I'm upset, I start to feel very bad about myself.
31. When I'm upset, I believe that wallowing in it is all I can do.
32. When I'm upset, I lose control over my behaviors.
33. When I'm upset, I have difficulty thinking about anything else.
34. When I'm upset, I take time to figure out what I'm really feeling.

35. When I'm upset, it takes me a long time to feel better.
36. When I'm upset, my emotions feel overwhelming

Appendix B

Ruminative Responses Scale

People think and do many different things when they feel depressed. Please read each of the items below and indicate whether you almost never, sometimes, often, or almost always think or do each one when you feel down, sad, or depressed. Please indicate what you *generally* do, not what you think you should do.

1 almost never 2 sometimes 3 often 4 almost always

1. Think about how alone you feel
2. Think "I won't be able to do my job if I don't snap out of this"
3. Think about your feelings of fatigue and achiness
4. Think about how hard it is to concentrate
5. Think "What am I doing to deserve this?"
6. Think about how passive and unmotivated you feel.
7. Analyze recent events to try to understand why you are depressed
8. Think about how you don't seem to feel anything anymore
9. Think "Why can't I get going?"
10. Think "Why do I always react this way?"
11. Go away by yourself and think about why you feel this way
12. Write down what you are thinking about and analyze it
13. Think about a recent situation, wishing it had gone better
14. Think "I won't be able to concentrate if I keep feeling this way."
15. Think "Why do I have problems other people don't have?"
16. Think "Why can't I handle things better?"
17. Think about how sad you feel.
18. Think about all your shortcomings, failings, faults, mistakes
19. Think about how you don't feel up to doing anything
20. Analyze your personality to try to understand why you are depressed
21. Go someplace alone to think about your feelings
22. think about how angry you are with yourself

Appendix C

Behavioral Inhibition Scale and Behavioral Activation Scale

Each item of this questionnaire is a statement that a person may either agree with or disagree with. For each item, indicate how much you agree or disagree with what the item says. Please respond to all the items; do not leave any blank. Choose only one response to each statement. Please be as accurate and honest as you can be. Respond to each item as if it were the only item. That is, don't worry about being "consistent" in your responses. Choose from the following four response options:

1 = very true for me
2 = somewhat true for me
3 = somewhat false for me
4 = very false for me

1. A person's family is the most important thing in life.
2. Even if something bad is about to happen to me, I rarely experience fear or nervousness.
3. I go out of my way to get things I want.
4. When I'm doing well at something I love to keep at it.
5. I'm always willing to try something new if I think it will be fun.
6. How I dress is important to me.
7. When I get something I want, I feel excited and energized.
8. Criticism or scolding hurts me quite a bit.
9. When I want something I usually go all-out to get it.
10. I will often do things for no other reason than that they might be fun.

11. It's hard for me to find the time to do things such as get a haircut.
12. If I see a chance to get something I want I move on it right away.
13. I feel pretty worried or upset when I think or know somebody is angry at me.
14. When I see an opportunity for something I like I get excited right away.
15. I often act on the spur of the moment.
16. If I think something unpleasant is going to happen I usually get pretty "worked up."
17. I often wonder why people act the way they do.
18. When good things happen to me, it affects me strongly.
19. I feel worried when I think I have done poorly at something important.
20. I crave excitement and new sensations.

21. When I go after something I use a "no holds barred" approach.
22. I have very few fears compared to my friends.
23. It would excite me to win a contest.
24. I worry about making mistakes.

Appendix D

Neutral Stimuli "Laundry Instructions"

1. Collect all your dirty clothes from the bathroom floor, or wherever you keep them. Keep in mind that your socks may be in the living room or under your desk. Make sure you find everything.

2. Sort the clothes into piles. There are two important considerations here: what material your clothes are, and what color.

3. Read all the labels, and pick out the clothes that: (a) cannot be washed (dry clean only items), (b) all clothes that say delicate (i.e. wool, silk).

4. Remember delicates may have to be washed by hand. This means using a sink or a bucket, and adding water. Read labels to verify the temperature and detergent. The water should feel slippery.

5. Sort the remaining clothes according to color. All whites should go with only whites. Put all the reds, pinks & oranges in a separate pile. Depending on how much more you have left, put the other colors together, possibly into a lighter (i.e. greys) and a darker (blacks, blues, browns) pile.

6. Know that, each pile is its own load. It is recommended to start with the highest priority pile, usually the socks/underwear pile.

7. Put the first pile into the washer. Add detergent (the package should say how much to use).

8. Read all instructions on the washer carefully. Examine all the knobs to make sure that the machine is set to the proper temperature. Whites usually go on hot temperatures. Colors and sheets usually go on warm or cold.

9. Close the door and push the on button.

10. Come back when the washer is done. Take the clothes out, shake them gently and either put into a dryer or hang them up to dry!

Appendix E

Debriefing: Perseverative cognition and cardiovascular activity

People often think about events or problems that cause stress, even when the stress or problem is no longer present. Such prolonged cognitive processing is called perseverative cognition, and in particular, researchers are beginning to study the effects of worry and rumination or prolonged anger.
Normal responses to stress may involve increased heart rate and other changes in cardiovascular activity. During perseverative cognition, the mental representation of the stressor is prolonged, and this may result in changes in cardiovascular functioning even in the absence of the stressor. One index of cardiac activity in which these changes may be seen is heart rate variability. Heart rate variability refers to the beat-to-beat fluctuations in heart rate that occur normally in healthy individuals. Generally, no two intervals between each heartbeat are exactly the same, and these variations differ from person to person.

In addition, changes in cognitive processing may be associated with perseverative cognition. You were asked to do a psychological task, such as writing down a source of worry on a sheet of paper and worrying about it as you normally do, or recalling an event in the past that made you intensely angry and verbalizing it in detail. Subsequently, you completed a cognitive task such as correctly identifying facial visual stimuli, colors, or letters. We hypothesized that there would be individual differences in the speed and accuracy of the cognitive task based on low or high heart rate variability and trait psychological characteristics such as worry.

If you have any questions about this study, please contact Dixie Hu at hu.277@osu.edu or at 614-688-3895, or Dr. Thayer at Thayer.39@osu.edu..