# THE INFLUENCE OF EMOTION REGULATION ON PSYCHOLOGICAL DISTRESS AND PHYSIOLOGICAL FUNCTIONING FOLLOWING A ROMANTIC BREAKUP

by

Lydia Genevieve Roos

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Approved by:

_____
Dr. Jeanette M. Bennett

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Dr. Amy Canevello

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Dr. Reuben Howden

# ABSTRACT

LYDIA GENEVIEVE ROOS. The influence of emotion regulation on psychological distress and physiological functioning following a romantic breakup. (Under the direction of DR. JEANETTE M. BENNETT)

Being in a romantic relationship confers better psychological wellbeing and physical health than being single; however, relationship dissolution can be psychologically stressful, and separation and divorce have been linked to an array of poor health outcomes. Nonetheless, there has been no known research to date regarding the health effects of nonmarital breakups. Additionally, recent research has implicated distress as a possible cause for the health effects of relationship dissolution. Individual factors, such as the tendency to regulate emotions using rumination or avoidance, may also magnify the negative effects of breakups on health via increased distress. The current research project examined 1) whether nonmarital breakups compromise physiological functioning, 2) whether physiological dysregulation is associated with breakup distress, and 3) whether these effects are driven by the tendency to use ruminative or avoidant emotion regulation strategies. No significant differences were found between participants who experienced a recent breakup and those who were continuously in a relationship on stress-related health outcomes, nor was breakup distress associated with any physical health marker. Emotional avoidance was directly and positively associated with diastolic blood pressure in those who experienced a recent breakup ($p < .05$), suggesting that the tendency to avoid negative emotions following a stressor can place strain on the cardiovascular system. Rumination was directly and inversely associated with inflammation in participants with a recent breakup ($p < .05$). Results suggest that

although nonmarital breakups alone may not be related to poorer health, ways of regulating emotions following a breakup may impact health. More research is needed to fully understand how healthy emerging adults physically respond to the stress of a breakup.

# DEDICATION

This thesis is dedicated to my mother, Dr. Susan Roos. Your dedication to education and devotion to lifelong learning, as well as your persistent strength in the face of adversity has made you an exemplary role model for me in this journey. Thank you for always encouraging me to pursue my intellectual interests with enthusiasm and gumption, to seek the education needed to pursue a career in science, and for inspiring me to use my work to help improve the lives of others. You have been a continuous source of support and motivation for me to expand my understanding of what is possible. I truly could not have done this without you.

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| | |
|---|---|
| BDS | breakup distress scale |
| BMI | body mass index |
| BP | blood pressure |
| CRP | C-reactive protein |
| CV | coefficient of variation |
| DBP | diastolic blood pressure |
| EAQ | emotional avoidance questionnaire |
| ELISA | enzyme-linked immunosorbent assay |
| ICG | inventory of complicated grief |
| I-RS | inhibition-rumination scale |
| IL-6 | interleukin-6 |
| HMR | hierarchical multiple regression |
| HPA | hypothalamic-pituitary-adrenal |
| HR | heart rate |
| LSD | lysergic acid diethylamide |
| RA | research assistant |
| SAM | sympathetic-adrenal-medullary |
| sCRP | salivary C-reactive protein |
| SE | standard error of the mean |
| SNS | sympathetic nervous system |
| SSRI | selective serotonin reuptake inhibitor |

| | |
|---|---|
| NK | natural killer |
| UNC Charlotte | University of North Carolina at Charlotte |

## Introduction

Romantic relationships play a key role in health. Research throughout the past three decades have consistently found that being married confers profound positive effects on psychological health, such as lower levels of depression and anxiety (Horwitz, White, & Howell-White, 1996; Kim & McKenry, 2002; Reneflot & Mamelund, 2012), and greater happiness and life satisfaction (Mastekaasa, 1994). Although partly due to selection effects in which psychologically and physically healthier individuals are more likely to become and stay married (Mastekaasa, 1992), the evidence suggests that the effects of marriage on mental health are primarily explained by the beneficial effects of the relationship itself (Horowitz, White, & Howell-White, 1996; Lamb, Lee, & DeMaris, 2003; Wu, Penning, Pollard, & Hart, 2003). Similar effects have been found for nonmarital relationships; college students in relationships have fewer mental health problems than their single counterparts, such as lower levels of depression, anxiety, and perceived stress (Braithwaite, Delevi, & Fincham, 2010).

Relationship dissolution, however, is related to poorer psychological health. Divorce has been associated with depression and anxiety (Kiecolt-Glaser et al., 1987; Knopfli, Morselli, & Perrig-Chiello, 2016), with the increased prevalence of depression symptoms lasting for years after the dissolution (Aseltine & Kessler, 1993). Other measures of psychological wellbeing decrease in response to divorce as well; global happiness, feelings of purpose in life, self-acceptance, positive relations with others, and personal and environmental mastery decline in separated or divorced individuals compared with those who remain continuously married (Marks & Lambert, 1998). The psychological effects of nonmarital romantic relationship dissolution parallel that of

divorce; romantic breakups have been related to increased depression symptoms, psychological distress, and decreased life satisfaction, exhibited in both cross-sectional and within-person longitudinal studies (Simon & Barrett, 2010; Rhoades et al., 2011).

Echoing the impact of relationships on mental health, marriage confers positive physical health effects (for a review, see Kiecolt-Glaser & Newton, 2001; Loving & Slatcher, 2013), and divorce is associated with poorer health outcomes. Increased sleep disturbances (Hale, 2005), worse self-reported physical health (Hughes & Waite, 2009; Williams & Umberson, 2004), and greater amounts of chronic conditions such as heart disease, diabetes, and cancer (Hughes & Waite, 2009) have all been uniquely associated with divorce. According to the *crisis model* (Booth & Amato, 1991; Williams & Umberson, 2004), the health disparity between married and separated/divorced individuals is primarily due to the stress of marital dissolution rather than a decrease in resources, although specific mechanisms are currently unknown.

Prolonged psychological stress has detrimental effects on physical health, partly through dysregulation in the sympathetic-adrenal-medullary (SAM) and hypothalamic-pituitary-adrenal (HPA) axes (Glei, Goldman, Chuang, & Weinstein, 2007; Segerstrom & Miller, 2004). Physiological activation from psychological stress, while adaptive in the short term in response to acute stressors, can damage health when the SAM and HPA axes are continually stimulated. Over time, physiological systems within the body, such as the cardiovascular and immune systems, become dysregulated from repeated autonomic, neuroendocrine, and immune activation, and can negatively impact health in the long term (Glei, Goldman, Chuang, & Weinstein, 2007).

Constant sympathetic nervous system (SNS) activation from stress raises resting blood pressure and can promote hypertension as well as atherosclerotic plaque growth (Miller, Chen, & Cole, 2009). Indeed, longitudinal studies have associated psychological stress with cardiovascular disease morbidity and mortality (Rozanksi, Blumenthal, & Kaplan, 1999; Krantz & McCeney, 2002), and individuals who have experienced a marital loss have higher incidence of cardiovascular disease than their continually married counterparts (Zhang & Hayward, 2006).

Similarly, a dysregulated immune system from long-term psychological stress can thwart proper immunological responses in the future, resulting in increased susceptibility to upper-respiratory infections (Cohen, Tyrrell, & Smith, 1991), reduced immune response to vaccines (Kiecolt-Glaser, Glaser, Gravenstein, Malarkey, & Sheridan, 1996), slowed wound healing (Kiecolt-Glaser, Marucha, Malarkey, Mercado, & Glaser, 1995), and suppressed cellular immunity (Lupien & McEwen, 1997; Sheridan, 1998). Immune system dysfunction also has the potential to increase risk of cardiovascular disease and metabolic syndrome (Hansson, 2005; Hotamisligil, 2006; Nabipour, Vahdat, Jafari, Pazoki, & Sanjdideh, 2006). Marital separation, in particular, has been linked to poorer immune functioning, including lower percentages of Natural Killer (NK) and helper T cells, higher antibody titers to Epstein-Barr Virus, and poorer proliferation in response to mitogens compared to socio-demographically matched married individuals (Kiecolt-Glaser et al., 1987).

Although the adverse health effects of divorce are widespread and well-known, few studies have investigated possible mechanisms by which marital dissolution impacts physical health. The majority of studies exploring the health effects of divorce often do

so using secondary datasets that offer large, diverse samples and longitudinal data on health events, but little detail from which to extract reasons for the health impacts of divorce. Of the current data, most studies employ a single item regarding marital status (e.g., status as married, separated/divorced, widowed, or never married), with no further information on marital dissolution or the challenges and changes that were incurred as a result of divorce (e.g., Hale, 2005; Hughes & Waite, 2009; Williams & Umberson, 2004).

Only two investigations thus far have examined possible mechanisms between marital dissolution and physical health; Kiecolt-Glaser and colleagues (1987) found that continued attachment to the former spouse and a shorter separation period resulted in poorer immune functioning. Over two decades later, Sbarra, Law, Lee, and Mason (2009) sought to determine whether separation- or divorce-related distress accounted for changes in cardiovascular functioning. Among men, those who reported higher event-related emotional intrusion-hyperarousal had elevated resting blood pressure, and those who expressed greater emotional difficulty related to the divorce had greater blood pressure reactivity completing a stress task (Sbarra et al., 2009). Although only one study has explored distress as a possible mechanism for physiological changes following marital relationship dissolution, breakup distress has been widely studied as a predictor for psychological health among nonmarital relationship breakups.

Breakup distress is a type of stress caused by grief following the ending of a romantic relationship (Field, Diego, Pelaez, Deeds, & Delgado, 2009). It is characterized by intrusive and distressing thoughts related to the former partner or the relationship ending, lack of breakup acceptance, changes in feelings of closeness and trust in others, and sadness, anger, and bitterness related to the breakup (Field, Diego, Pelaez, Deeds, &

Delgado, 2010). Breakup distress has been associated with greater sleep disturbances (Field et al., 2009), increased feelings of anger (Sbarra, 2006; Field et al., 2009) and anxiety (Davis, Shaver, & Vernon, 2003; Field et al., 2009), and initial depressive episode onset (Monroe, Rohde, Seeley, & Lewinsohn, 1999), all of which are simultaneously related to poorer physical health (Irwin, 2015; Chida & Steptoe, 2009; Ironson & Fitch, 2016; Moussavi et al., 2007).

Despite these links and the similarities between the psychological effects of romantic relationship dissolution in both married and unmarried individuals, no known research has explored whether the dissolution of a nonmarital romantic relationship, or the distress associated with it, is connected with markers of physical health. Research is needed to determine whether relationship dissolution has negative health impacts in nonmarital relationships, or if the physical health effects are limited to marital separation and divorce. Additionally, distress should be included as a possible mechanism for relationship dissolution impacting health, given its similarity to the distress implicated as a possible cause for raised blood pressure in the study by Sbarra and colleagues (2009) and its association with other psychological variables that impact health.

While the physical health impacts of romantic breakups and breakup distress are unknown, breakup distress has nonetheless become a meaningful subject among nonmarital relationship researchers in regards to psychological health, and some have started to investigate predictors of this distress. Emotion regulation, in particular, has garnered attention as a strong predictor of breakup distress. In a study exploring the association between breakup distress and various emotional coping mechanisms (i.e., rumination, avoidance, emotional processing, and emotional expression), Wrape, Jenkins,

Callahan, and Nowlin (2016) found that use of either rumination or avoidance in response to stressful situations heightened distress following a nonmarital romantic breakup. Rumination and emotional avoidance, then, may be key facilitators in the development of breakup distress.

Rumination is a trait-like, self-focused way of engaging with emotions that includes repetitive thinking about negative inferences following stressful events (Robinson & Alloy, 2003) and could be a precursor to psychological distress. It is strongly associated with depression (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008) and has been related to greater anxiety and poorer sleep quality (Zawadzki, 2015). Needles and Abramson (1992) suggest that psychological wellbeing is compromised not only by negative cognitive thoughts, but the degree to which these thoughts are activated and recursively rehearsed. Thus, constant activation and rehearsal of negative thoughts in response to an emotionally stressful event may be a cause of heightened distress following a romantic breakup.

Emotional avoidance, contrary to rumination, encompasses negative beliefs about experiencing emotions and attempts to ignore or distract oneself from distressing feelings associated with an event or situation (Taylor, Laposa, & Alden, 2004). The concepts of suppressing expressions and unwanted thoughts, both of which may be related to emotional avoidance due to their shared reluctance to engage with feelings, have been widely studied (Aldao, Nolen-Hoeksema, & Schweizer, 2010; Gross, 1998; Gross & John, 2003; Hu et al., 2014; Wenzlaff & Wegner, 2000). Collectively, emotionally avoidant behaviors have been linked to harmful effects on mental and physical health; expressive suppression has been associated with exaggerated cortisol responses to

psychosocial stress (Lam, Dickerson, Zoccola, & Zaldivar, 2009), greater negative emotion, and lesser positive emotion (Gross & John, 2003), and suppression of unwanted thoughts has been linked to increased risk of depression (Wenzlaff & Wegner, 2000), panic disorder (Lissek et al., 2009), and posttraumatic stress disorder (Foa & Kozak 1986). Considering the links between emotional avoidance and various psychological health problems, it is unsurprising that avoidance of emotions should also be linked to breakup distress (Wrape et al., 2016).

Prior research has indicated a strong link between psychological stress and cardiovascular and immune system functioning, and marital dissolution has been shown to have damaging effects on physical health (Kiecolt-Glaser et al., 1987; Sbarra, Law, & Portley, 2011). Research by Sbarra and colleagues (2009), although limited in scope, demonstrates distress as a possible link between relationship dissolution and health outcomes. Thus, it behooves researchers to determine whether a nonmarital relationship dissolution confers similar cardiovascular and immune system consequences (i.e., greater cardiovascular and immune system activation) and if these effects are driven by the amount of distress experienced. Additionally, both the tendency to ruminate on emotions and avoid them are linked to psychological distress following the ending of a romantic relationship (Wrape et al., 2016). It is possible that the tendency to participate in certain emotion regulation strategies (i.e., rumination and avoidance) following a romantic breakup could increase the amount of psychological distress experienced, which may then increase the likelihood of poorer health outcomes via dysregulated physiological systems.

## Specific Aims

The current research expands upon the current literature and addresses three major gaps in the literature by determining 1) whether individuals who have experienced a recent nonmarital romantic breakup exhibit dysregulated physiological functioning compared to individuals in a relationship, 2) among those who have experienced a recent breakup, whether ongoing distress related to the romantic breakup impacts physiological functioning, and 3) whether the effect of breakup distress on physiological functioning is driven by the tendency to either ruminate on or avoid emotions in response to emotionally upsetting events.

### Hypotheses.

**Hypothesis 1:** Individuals who have experienced a recent breakup will exhibit poorer cardiovascular functioning and higher systemic inflammation than their counterparts currently in a relationship, as shown by higher resting heart rate (HR), systolic and diastolic blood pressure (BP), and salivary C-reactive protein (sCRP).

**Hypothesis 2:** Among those who have recently experienced a romantic breakup, breakup distress will be directly associated with cardiovascular functioning and inflammation, such that greater breakup distress will be associated with higher levels of HR, BP, and sCRP.

**Hypothesis 3:** The impact of rumination and avoidance on HR, BP, and sCRP will be mediational in nature; HR, BP, and sCRP will be directly influenced by breakup distress, which will be driven by tendency to use a ruminative or avoidant emotion regulation strategy, such that greater tendency to either ruminate on or avoid emotions

will be associated with increased breakup distress, which will in turn be associated with higher HR, BP, and levels of sCRP.

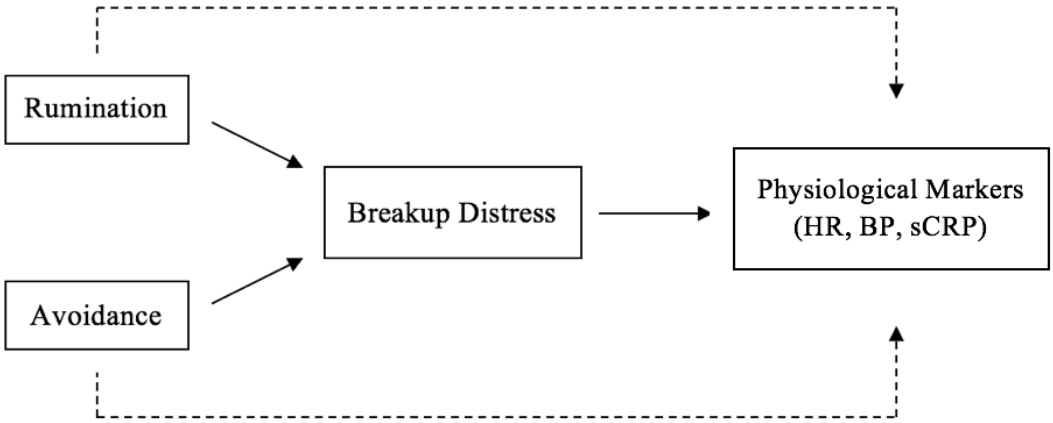


*Figure 1*. Proposed mediation model (H3) for the effects of rumination and avoidance on breakup distress and downstream effects on physiological markers (i.e., resting HR, systolic BP, diastolic BP, and sCRP). Dashed lines in this model represent possible direct effects of rumination and avoidance on physiological markers that will be tested, but expected to be non-significant.

# Method

## Participants

Participants (*N*=106) who have either experienced a recent breakup (i.e., within the past 12 months) from a serious relationship and are not in a new relationship, or who endorse being in a committed relationship were asked to participate in this study. Due to inconsistencies in the literature of when breakup distress is examined (e.g., within 3 to 24 months; Field et al., 2010; Chung et al., 2003), no clear timeframes are known regarding when distress should be assessed following a romantic breakup. Given the focus on physiological outcomes, the shorter time frame of 0 to 12 months was chosen to qualify a breakup as "recent." Consistent with prior research comparing individuals in relationships with single individuals, to be categorized as in a relationship, potential participants were dichotomously asked whether they are currently in a committed relationship, however time in the relationship will not be an inclusionary or exclusionary factor (Braithwaite, Delevi, & Fincham, 2010; Simon & Barrett, 2010).

Participants were recruited using a targeted email service offered through University of North Carolina (UNC) Charlotte's Office for Institutional Research as well as through other electronic avenues (e.g., using social media and Sona Systems, a UNC Charlotte subject pool management software) and print advertisements (i.e., flyers, paper advertisements) on campus.

**Screening.** Screening took place during Part I of the study; participants completed both the screening and the self-report measures via Qualtrics before they were scheduled for the in-person laboratory visit. Screening questions concerning demographics, physical and mental health history, and medication and dietary supplement use (i.e., vitamins,

minerals, herbs, probiotics and/or prebiotics, and any other over-the-counter or prescription supplements) were asked. Participants were carefully screened for factors that may affect cardiovascular or immune system functioning (i.e., medications, acute illness or infection) as well as current diagnoses or prescription medication used to treat cardiovascular or chronic inflammatory diseases (i.e., cardiovascular disease, diabetes, obesity, autoimmune disorders, asthma, etc.) to limit possible confounds. Further, possible confounding variables (e.g., age, sex, race, BMI, time since breakup) that are found to be significantly associated with the outcome variables will be included in analyses.

Participants were also asked about their current relationship status and whether they have experienced a breakup from a serious relationship within the past 12 months. A "serious" relationship was subjective to the participant. Participants currently in a relationship must not have experienced a breakup from a serious relationship in the past 3 years and must have endorsed being in a "committed" relationship. "Committed" will also be subjective to the participant.

**Inclusion Criteria.**

- Healthy males and non-pregnant or non-breast-feeding females aged 18-26 years.
- Must be able to read and provide informed consent.
- Must speak English; Participants must be able to complete questionnaires in English.
- Must have experienced a breakup from a serious relationship within the past 12 months and not in a new relationship, or currently be in a committed

relationship and endorse not experiencing a breakup within the past three years.

**Exclusion Criteria.**

- Age: Under 18 or over 26; CRP naturally rises with age. As such, 26 was the age cut-off to keep the group homogenous.
- Obesity (i.e., BMI >30); Obesity disrupts stress hormones and elevates CRP levels.
- Tobacco and marijuana smokers as well as use of illicit drugs like heroin, cocaine, methamphetamine, ecstasy, LSD, hallucinogens or their derivatives or abused prescription drugs in the past 12 months.
- Currently experiencing an acute illness or infection; A current illness or infection would raise levels of inflammation assessed as a body temperature at visit of 99.6 F or higher.
- Currently taking medications for psychiatric disorders that may influence the production of CRP (i.e., depression, anxiety, bipolar disorder, schizophrenia).
- Currently taking medications or supplements that may affect CRP production (i.e., high dose non-steroidal anti-inflammatory drugs, steroid medications, SSRIs, allergy desensitization immunizations, and psychoactive medications).
- Current diagnosis or personal history of significant cardiovascular concerns (i.e., hypertension, congenital heart disease or disorders, cardiovascular disease such as heart attack or stroke), or current use of blood pressure lowering medications.

- Current diagnosis of any inflammation-related disease (i.e., asthma, diabetes, obesity, autoimmune disorders, cancer, major depression, celiac's disease)
- Surgery in the past three months.
- Any currently pregnant females, females who have had a child in the last year or are currently breastfeeding.

**Sample**

Participants (*N*=106) completed the study. Of those, nine were excluded because their relationship status was unclear or they were in an on-off relationship, seven were excluded because they were mistakenly deemed eligible, four were excluded because of incomplete data, three had a fever and/or were sick the day of their in-person visit, one was excluded because they were not at least moderately happy in their current relationship, and one was excluded because they did not give quality answers to the survey. The final sample consisted of 81 participants, of whom 53 experienced a recent breakup (i.e., within the past 12 months) from a serious relationship and are not in a new relationship, and 29 who endorsed being in a committed relationship and had not experienced a breakup in the past three years.

**Procedures**

The current study was divided into two parts: Part I was an online survey including all questionnaires and screening information, while Part II involved a laboratory visit in which participants' physiological measures are assessed. Individuals interested in participating in the study completed Part I via Qualtrics.com, an online survey platform. Individuals with access to UNC Charlotte's Psychology's Sona System were able to access the survey link directly. Non-Sona recruited individuals received an

email with a link to the survey. The survey link took participants to the electronic consent, in which consented to Part I of the study and provided contact information. Following the completion of their contact information, participants were given a link that directed them to a second survey containing the self-report measures and screening questions. A unique identification number was randomly generated by Qualtrics which linked the two Qualtrics surveys; this link was the only connection between identifying information and sensitive data. This identification number was used by study personnel to grant Sona Systems credit, remove repeat participation, and to contact individuals for Part II regarding their eligibility.

After a research assistant (RA) determined eligibility for Part II of the study via the screening questions within Part I, eligible individuals were contacted via email and asked to participate in Part II of the study by providing the link and password to schedule for Part II between 7:30am and 11:30am at a time and date convenient for them via Sona. Alternatively, participants, especially non-Sona recruited, were given the option to call or reply via email to be manually scheduled by study personnel. Participants were asked to schedule Part II within 7-10 days of completing Part I and were given instructions to not eat or drink anything (other than water) the morning of their visit. Morning fasting visits occurred to allow for the most accurate assessment of CRP.

During the in-person laboratory visit (Part II), a trained RA guided the participant through a second, physical consent form, reviewed the laboratory visit procedures, and answered any questions. After the informed consent was obtained, the RA reviewed the initial screen to confirm answers to questions that assess inclusionary and exclusionary criteria. The RA then assessed participants' biological measures, including temperature

(to ensure the participant is not acutely ill), resting heart rate and blood pressure, and a saliva sample for C-reactive protein analysis using a Salivette (Sarstedt, Cary, NC).

**Informed Consent.** During the informed consent for both Part I and Part II, participants were told the purpose of the study, a short description of the measures included in Part I, and estimated time it would take to complete Parts I and II. They were informed of the sensitive nature of the study and given resources for on- and off-campus counseling and therapy services should they wish to seek support following the study. Participants were given the opportunity to ask questions and were informed that they could stop participation at any time.

**Psychological Measures.** In addition to capturing details regarding the individual (i.e., gender, sexuality, current relationship status) and the relationship (i.e., length of relationship, initiator status for those who have experienced a breakup, level of commitment to the former partner, and time since dissolution), the following measures were administered to participants.

***Breakup Distress.*** The Breakup Distress Scale (BDS) was adapted from the Inventory of Complicated Grief (ICG) for use in university students in another study (Field et al., 2010). The BDS is a 15-item self-report measure used to assess feelings of grief following relationship dissolution. Specifically, wording was altered from the ICG by referring to the former partner instead of the deceased person, and 15 of the 19 items from the ICG were included as not all items were appropriate. Respondents indicate on a 4-point Likert scale from 1 (not at all) to 4 (very much so), and items are summed to find the total score. Example items included in the final scale include “Memories of the person upset me,” “I feel stunned or dazed over what happened,” and “I feel bitter over

this breakup." Internal consistency was excellent in this sample (Cronbach's α = 0.93). The BDS was only be displayed to participants who endorse experiencing a breakup.

***Rumination.*** To assess rumination, the Inhibition-Rumination Scale (I-RS; Roger, de Scremin, Borril, & Forbes, 2011) was used. The I-RS is a 39-item self-report scale used to measure emotional control (i.e., ways of regulating emotions) and includes two factors: Inhibition and rumination. Items are scored as False = 0 and True = 1. Emotional inhibition and rumination are scored separately by summing answers to their respective items. The rumination factor of the I-RS will be used to assess the tendency to ruminate over emotionally upsetting events (e.g., "I often find myself thinking over and over about things that make me angry."). The rumination factor demonstrated acceptable internal consistency in the present sample (Cronbach's α = .76).

***Emotional Avoidance.*** The Emotional Avoidance Questionnaire (EAQ; Taylor, Laposa, & Alden, 2004) is a 20-item self-report scale used to assess four aspects of emotional avoidance: 1) Avoidance of positive emotions (e.g., "If I start to feel strong positive emotions, I prefer to leave the situation); 2) Avoidance of negative emotions (e.g., "When I feel anxious or worried about something, I try to ignore it as much as I can"; 3) Negative beliefs about emotions (e.g., "I cannot handle feeling anxious or worried about things"); and 4) Social concerns about displaying emotion (e.g., "I try to keep feelings of anxiety or worry to myself so that other people don't think less of me"). Items are scored on a 5-point Likert scale from 1 (not true of me) to 5 (very true of me). Scores can be used as a total or separately by subscale. For the purposes of this study, the full scale was used to assess overall emotional avoidance. The EAQ exhibited good internal consistency in our data (Cronbach's α = .87)

**Physiological Measures.**

***Blood pressure, heart rate, and body temperature.*** Resting systolic and diastolic blood pressure and heart rate was captured at the start of the laboratory visit using a GE Carescape Dinamap V100. Body temperature was also assessed to rule out the possibility of increased inflammation due to acute illness; participants with a temperature above 99.6 were removed from analyses.

***Salivary C-reactive protein.*** C-reactive protein is produced by the liver in response to inflammation, thus serving as an indicator of immune system activation (Loucks et al., 2006). Levels of salivary C-reactive protein (sCRP) were assessed using saliva via a synthetic swab (Salivette, Sarstedt). The saliva sample was immediately frozen in -80°C freezer until sCRP was assessed using a commercially available Enzyme-Linked Immunosorbent Assay (ELISA) kit (Salimetrics, State College, PA). The lowest level of detection for this type of assay is 10 pg/mL. Intra-assay precision for the high and low control are 1.9% and 5.9%, respectively. Inter-assay precision for the high and low control are 3.7% and 11.2%, respectively. All samples with a coefficient of variation (CV) higher than 10% were re-run to obtain more reliable values.

**Analytic Plan**

Analyses were conducted using SPSS Version 23 and a two-tailed significance level of $\alpha = 0.05$. Due to differing metrics among measures, all categorical variables were dummy coded and continuous independent variables were z-scored to reduce non-essential multicollinearity and aid interpretation (Cohen, Cohen, West, & Aiken, 2003). Due to the inherent non-normal distribution introduced by the ELISA, sCRP values were natural log transformed to reduce skewness in the data. Saliva samples were collected

using two different salivette lots, thus, a dummy code for salivette lot was used to control for the lot differences in the analyses.

The sample was summarized using frequencies for categorical variables (e.g., sex, race) and descriptive statistics (mean and standard error of the mean [SE]) for continuous variables (e.g., age, breakup distress, etc.). Chi-square analyses and t-tests were used to examine group differences for categorical and continuous variables, respectively. Possible confounding factors (i.e., sex, age, race, BMI, time since breakup, salivette lot number) and their association with outcome variables were first examined via zero-order correlations; only sex, age, BMI, and time since breakup were associated with outcomes, thus they were included as covariates in Stage 1 of all analyses. As salivette lot number was additionally associated with salivary CRP (sCRP), it was also included as a covariate in sCRP analyses.

To compare differences in physiological outcomes (i.e., resting HR, BP, and sCRP) by relationship status (H1), relationship status was dummy coded (in a relationship = 0, had a recent breakup = 1). Separate hierarchical multiple regression (HMR) analyses were conducted to test the associations between HR, systolic BP, diastolic BP, and sCRP with relationship status. Among participants who experienced a breakup in the past 12 months, HMR analyses were then conducted to test whether breakup distress influenced health outcomes (H2).

To examine whether rumination and emotional avoidance influenced physiological markers directly, or indirectly through breakup distress (H3), PROCESS macro model 4 in SPSS (Hayes, 2013) was used. We determined the significance of

indirect effects in mediation models using bootstrap estimates and bias-corrected confidence intervals (Preacher & Hayes, 2008).

# Results

## Participants

The final sample consisted of 81 participants; 53 experienced a recent breakup (i.e., within the past 12 months) from a serious relationship and were not in a new relationship, and 29 endorsed being in a committed relationship and had not experienced a breakup from a committed relationship in the past three years. The sample was between the ages of 18 and 26 ($M$ = 19.44, $SE$ = 0.20). The majority was female ($N$ = 62; 76.5%) and white ($N$ = 51; 63.0%). Table 1 shows descriptive statistics for total sample characteristics and characteristics by group. Chi-square analyses revealed no significant differences between the subsets of the sample for sex, or race, and t-tests showed no significant differences between groups on age, BMI, or trait rumination or emotional avoidance. Zero order correlations among all sociodemographic, psychological, and physiological outcomes appear in Table 2.

Table 1

*Descriptive Statistics of Sample*

| | Overall sample<br>*N* = 81 | In a relationship<br>*N* = 29 | Breakup<br>*N* = 53 |
|---|---|---|---|
| Variable | *M* ± *SE*/n (%) | *M* ± *SE*/n (%) | *M* ± *SE*/n (%) |
| 1. Age in years | 19.44 ± 0.20 | 19.41 ± .32 | 19.45 ± .25 |
| 2. Sex (female) | 62 (76.5%) | 23 (82.1%) | 39 (73.6%) |
| 3. Race (White) | 51 (63.0%) | 18 (64.3%) | 33 (62.3%) |
| 4. BMI | 22.47 ± 0.41 | 22.43 ± .51 | 22.49 ± 0.57 |
| 5. Rumination | 8.88 ± 0.48 | 8.16 ± 1.00 | 9.22 ± 0.52 |
| 6. Avoidance | 50.58 ± 1.50 | 49.08 ± 2.90 | 51.32 ± 1.72 |
| 7. Breakup Distress | -- | -- | 23.77 ± 1.90 |
| 8. Heartrate | 76.02 ± 1.22 | 76.71 ± 2.22 | 75.65 ± 1.46 |
| 9. Systolic BP | 109.22 ± 1.09 | 108.64 ± 1.52 | 109.53 ± 1.46 |
| 10. Diastolic BP | 63.60 ± 0.71 | 63.39 ± 1.12 | 63.71 ± 0.91 |
| 11. sCRP | 7.31 ± 1.15 | 9.02 ± 2.61 | 6.43 ± 1.13 |

*Note.* BMI = Body Mass Index. BP = Blood Pressure. sCRP = Salivary C-reactive Protein. Raw sCRP values are shown here, however natural log-transformed sCRP values were used in analyses.

Table 2

*Zero-Order Correlations*

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Age (years) | -- | | | | | | | | | | | |
| 2. Sex (female) | -.13 | -- | | | | | | | | | | |
| 3. Race (White) | .20 | .12 | -- | | | | | | | | | |
| 4. BMI | .16 | -.39** | .21 | -- | | | | | | | | |
| 5. Relationship Status (breakup) | .01 | -.10 | .02 | .01 | -- | | | | | | | |
| 6. Time Since Breakup | .10 | -.07 | .10 | .24 | -.33* | -- | | | | | | |
| 7. Rumination | .12 | .00 | -.17 | .01 | .12 | -.03 | -- | | | | | |
| 8. Avoidance | .24* | .00 | .08 | .30** | .08 | .19 | .40** | -- | | | | |
| 9. Breakup Distress | -.17 | .31* | -.12 | -.06 | .02 | -.24 | .31* | .20 | -- | | | |
| 10. Heartrate | -.16 | .25* | -.01 | -.05 | -.05 | .24 | -.04 | -.02 | .05 | -- | | |
| 11. Systolic BP | .17 | -.61** | .04 | .55** | .04 | .11 | -.07 | .19 | -.17 | -.12 | -- | |
| 12. Diastolic BP | .24* | -.21 | .11 | .30** | .02 | .03 | .02 | .34** | .00 | .12 | .55** | -- |
| 13. sCRP | -.07 | -.07 | .06 | .15 | -.03 | .30* | -.21 | .09 | -.10 | .21 | .08 | .10 |

Note. $N = 81$. *p < .05; **p < .01. BMI = Body Mass Index. BP = Blood Pressure. sCRP = Salivary C-reactive Protein. Relationship Status was dummy coded such that participant's relationship status was either in a relationship or had a recent breakup (in a relationship = 0, had a recent breakup = 1). Time Since Breakup was only asked of those who had experienced a recent breakup ($N = 59$).

Of the participants who were in a relationship, the majority reported being very happy in their relationship ($M = 4.00$, $SE = 0.15$ on a scale of 1 [Not at all happy] to 5 [Extremely happy]). Of the participants who had experienced a breakup, the average length of the relationship prior to the breakup was 19.6 months ($SE = 2.48$). The majority of these participants reported their partner as the initiator of the breakup ($N = 27$; 50.9%), nearly a quarter said they initiated ($N = 13$; 24.5%), and nearly a quarter reported the breakup as a mutual decision ($N = 13$; 24.5%). The breakup occurred within the past month for 16 participants (30.2%), within the past 6 months for 22 participants (41.5%), and within the past 12 months for 15 participants (28.3%). Regarding their feelings related to the breakup, most participants reported not wanting to breakup at the time ($M = 2.38$, $SE = 0.18$ on a scale of 1 [Not at all] to 5 [Very much]) and feeling moderately bad about the breakup ($M = 4.79$, $SE = 0.18$ on a scale of 1 [Very good] to 6 [Very bad]).

**Relationship Status and Health Outcomes**

Separate hierarchical multiple regression (HMR) analyses were conducted to compare differences in physiological outcomes (i.e., resting HR, systolic and diastolic BP, and sCRP) by relationship status (H1). None of the associations were significant (*n.s.*).

**Breakup Distress and Health Outcomes**

We then tested whether breakup distress influenced health outcomes among participants who experienced a breakup in the past 12 months using HMR analyses (H2). Breakup distress was not significantly associated with any health outcomes (*n.s.*).

Using PROCESS macro model 4 in SPSS (Hayes, 2013), I then examined whether rumination and emotional avoidance influence physiological markers directly, or indirectly through breakup distress. Analyses revealed that while a negative association was trending between rumination and sCRP (total effects $b$ = -.24, $\Delta R^2$ = .06, 95% CI [-.51, .03] $p$ = .08), the association was significant only when assessed directly (effect = -.29, 95% CI [-.57, -.01], $p < .05$); breakup distress was not a significant mediator (effect = .05, 95% CI [-.05, .18]). (See Figure 2 and Table 3.) Rumination was not associated with resting blood pressure or heart rate directly or indirectly (*n.s.*).

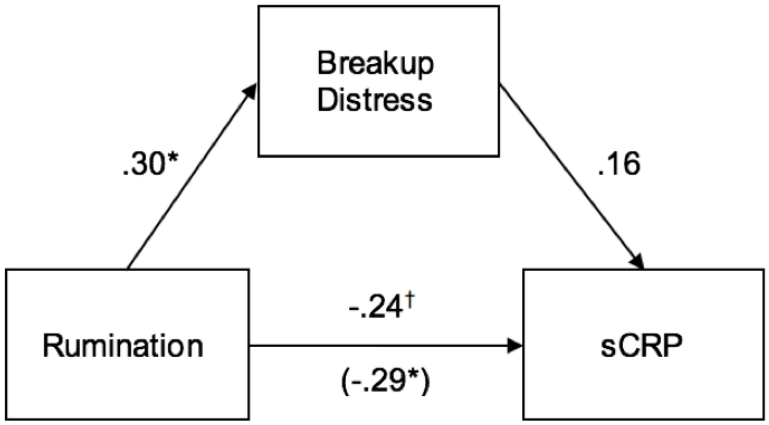


*Figure 2.* N = 53. *$p < .05$; †$p < .10$. Mediational model showing the direct effect of rumination on sCRP; breakup distress was not a significant mediator. All predictor variables were z-scored prior to analyses. The regression coefficient for the effect of rumination on sCRP, controlling for breakup distress, is in parentheses. sCRP = Salivary C-reactive Protein.

Table 3

*Direct and Indirect Effects of Rumination on sCRP with Breakup Distress as a Mediator, Controlling for Sex, Age, BMI, Time Since Breakup, and Salivette Lot*

| Mediator and Dependent Variables | Coefficient between IV (Rumination) and Mediator (Breakup Distress) | Coefficient between Mediator (Breakup Distress) and DV (sCRP) | Coefficient between IV (Rumination) and DV (sCRP) | Indirect Effect [95% CI] |
|---|---|---|---|---|
| Breakup Distress | .30* | | | |
| Rumination | | .16 | -.29* | .05 [-.06, .18] |

*Note.* $N = 53$. *$p < .05$. The independent variable and mediator were standardized prior to analysis. sCRP = Salivary C-reactive Protein. BMI = Body Mass Index.

When examining emotional avoidance, analyses demonstrated that while avoidance was positively associated with diastolic blood pressure (total effects $b = 2.24$, $\Delta R^2 = .09$, 95% CI [.44, 4.05], $p = .02$), breakup distress did not mediate the association; it was direct in nature (effect = 2.25, 95% CI [.35, 4.14], $p = .02$). (See Figure 3 and Table 4.) Emotional avoidance was not associated with resting heart rate, systolic blood pressure, or sCRP either directly or indirectly in this subsample.

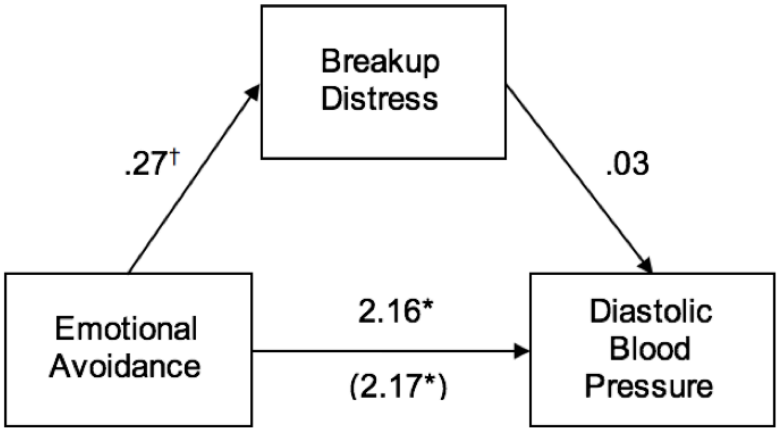


*Figure 3.* N = 53. *$p < .05$; †$p < .10$. Mediational model showing the direct effect of emotional avoidance on diastolic blood pressure; breakup distress was not a significant mediator. All predictor variables were z-scored prior to analyses. The regression coefficient for the effect of emotional avoidance on diastolic blood pressure, controlling for breakup distress, is in parentheses.

Table 4

*Direct and Indirect Effects of Emotional Avoidance on Diastolic Blood Pressure with Breakup Distress as a Mediator, Controlling for Sex, Age, BMI, and Time Since Breakup*

| Mediator and Dependent Variables | Coefficient between IV (Avoidance) and Mediator (Breakup Distress) | Coefficient between Mediator (Breakup Distress) and DV (DBP) | Coefficient between IV (Avoidance) and DV (DBP) | Indirect Effect [95% CI] |
|---|---|---|---|---|
| Breakup Distress | .27$^{\dagger}$ | | | |
| Rumination | | -.03 | 2.17* | -.01 [-.73, .51] |

*Note.* $N = 53$. *$p < .05$; $^{\dagger}p < .10$. The independent variable and mediator were standardized prior to analysis. DBP = Diastolic Blood Pressure. BMI = Body Mass Index.

## Discussion

Although a fair amount of research has been conducted regarding the health effects of marital separation and divorce, the physical health effects of nonmarital breakups has received little attention thus far. Further, the possible role of emotion regulation strategies, such as rumination or avoidance, on breakup-related distress and physical health is unknown. The current research used cross-sectional data to determine 1) if nonmarital breakups can compromise physiological functioning, 2) whether physiological dysregulation is associated with breakup distress, and 3) whether these effects are driven by the tendency to use ruminative or avoidant emotion regulation strategies.

No significant differences were found on health markers (i.e., resting heart rate, blood pressure, salivary C-reactive protein; sCRP) when comparing young adults who had experienced a breakup in the past 12 months with those who had continuously been in a relationship. There were also no significant associations between breakup distress and health markers when examining only the group that experienced a breakup; the lack of a significant association with the health markers additionally precludes any significant indirect effects of breakup distress on the association between emotion regulation strategies and health markers. These results suggest that breakups during emerging adulthood may not contribute to worsened health in the same way as separation and divorce among married couples.

Marital separation and divorce bring with it other factors that can contribute to worsened health past the stress of the relationship dissolution. Although the *crisis model* (Booth & Amato, 1991; Williams & Umberson, 2004) adheres to the belief that health

disparities between married and separated/divorced individuals is due to the stress of marital dissolution rather than a decrease in resources, the stress of a separation or divorce can be amplified beyond relationship dissolution by several aspects unique to marriage. Because marriage is a legally binding contract, dissolution of the contract is effortful, financially and emotionally costly, and time-consuming. Despite the prevalence of divorce in western societies, it also continues to be stigmatized and any stigma or perception of stigma may lead to real and/or felt isolation.

Conversely, breakups from romantic relationships, although not positive, are more socially acceptable, particularly in young adulthood. Relationships in young adulthood also do not typically last as long as a marriage or carry the same commitment, reducing the potential for shock for either partner or upheaval of one's life as may occur in the wake of a divorce. Additionally, depending on their level of integration, separating and divorcing couples may have to deal with the potential loss of friendships as those friends or couples "pick sides," reducing potential social support and integration within the community. More research is needed to delineate the effects of both nonmarital and marital breakups fully, but the current research suggests nonmarital breakups during emerging adulthood may not contribute to worsened health as do marital separation and divorce.

Although there were no indirect effects of breakup distress, results showed a significant direct effect of emotional avoidance on diastolic blood pressure, such that more avoidance led to higher diastolic blood pressure values. The results suggest that every one standard deviation difference in negative beliefs about emotions, social concerns about displaying them, and behavioral avoidance of negative emotions equated

to a 2.25 mmHg difference in diastolic blood pressure. No associations with other health markers were significant. In young adults, elevated diastolic blood pressure (DBP) may represent longer term adjustments of the cardiovascular system to stress, as opposed to systolic blood pressure that is typically more influenced by current sympathetic nervous system activity and responsive to current transient states or situations (Spruill, 2010). Thus, elevated resting DBP or isolated diastolic hypertension suggests more chronic strain on the cardiovascular system. Isolated diastolic hypertension and elevated resting DBP are not uncommon among stressed young adults, however they are linked to cardiovascular disease risk in this population (Li, Wei, Wang, Cheng, & Wang, 2014; Pickering, 2003). The present results suggest that emotional avoidance may negatively impact heart health, even if the person is not currently in a reactive state.

Counter to the hypothesis, greater tendency to ruminate was associated with lower sCRP levels. Previous research suggests that engaging in rumination following a laboratory stressor is linked with higher HPA axis reactivity and delayed recovery, as well as higher inflammation (Zoccola & Dickerson, 2012; Zoccola, Figueroa, Rabideau, Woody, & Benencia, 2014). Thus, following acute stress, rumination appears to heighten or exacerbate stress reactivity, but little research exists regarding trait rumination and stress-related basal health markers or chronic inflammation.

Given the well-established positive association between rumination and depression (e.g., Rood et al., 2009), and that depression is linked to chronic inflammation via dysregulated cortisol signaling and/or glucocorticoid insensitivity (Cohen et al., 2012; Miller, Cohen, & Ritchey, 2002), rumination was expected to be positively associated with greater inflammation. Nonetheless, rumination and sCRP were inversely associated

in the current data. Recent research has found that although rumination exacerbates and prolongs the stress response in the lab, rumination's effect on basal levels of inflammation is less consistent.

A recent study by Segerstrom, Reed, and Scott (2017) found that repetitive thought was linked with lower interleukin (IL)-6 in healthy adults. Another study by Boren and Veksler (2018) found that higher levels of co-rumination with a partner had differential effects on inflammatory markers in healthy, young adults: co-rumination was positively associated with CRP, but negatively associated with IL-6. The authors were not able to fully delineate the reasons for the differential effects, but suggested rumination may prolong participants' exposure to stress, leading to immunosuppression for IL-6.

Therefore, it is possible that the unexpected direction of rumination on CRP in these data may be due to differences in the ways that well-regulated and dysregulated neuroendocrine-immune communication responds to prolonged psychological stress. Given our young sample ($M_{age}$ = 19.44) and employment of strict inclusion criteria, we potentially selected for people with the healthiest, most well-regulated stress systems. It appears that because of their healthy systems, their immune cells may still be sensitive to glucocorticoids, such as cortisol, dampening inflammatory processes in well-regulated systems. Thus, engaging in rumination and thereby consistently activating their HPA axes may have resulted in less inflammation in these participants. Capturing data with both cortisol and inflammatory markers could help researchers understand whether less inflammation is happening in young adults because of greater cortisol output in people who tend to ruminate, or if both are lower than their counterparts. Additionally, a

longitudinal study capturing data closer to the breakup (e.g., 1-3 months) and later (e.g., 6-12 months) may provide a more well-rounded picture concerning how healthy emerging adults physically respond to the stress of a breakup.

It is also possible that if we were to assess an older population with more physiological wear and tear, we would see greater allostatic load, causing a shift into a dysregulated state in which they would show higher levels of glucocorticoids *and* inflammation. More research determining the point at which stress systems move from well-regulated to dysregulated could help shed light on inconsistencies in the data and how rumination impacts health over time. Future research should also consider less restrictive inclusion criteria (e.g., not restricting participation of those with chronic diseases such as Type 2 diabetes, obesity, or depression). Individuals who have a chronic condition often have a taxed physiological system and may be more vulnerable to the negative effects of stressful events. Widening the inclusion criteria to include people with chronic conditions may enable the detection of the breakup distress on physiological functioning for at-risk populations.

Another promising avenue that may provide additional information is the assessment of health behaviors over time. Rumination is related to health behaviors such as poorer sleep (e.g., Guastella & Moulds, 2007; Takano, Iijima, & Tanno, 2012), and both rumination and avoidance are related to increased alcohol intake (e.g., Caselli et al., 2009; Simon et al., 2017; Stewart, Zvolensky, & Eifert, 2002). Health behaviors such as sleep and alcohol use may impact stress system and cardiovascular functioning, and thus could serve as moderators in the association between emotion regulation strategies and health. Further, following their findings with repetitive thought and lower IL-6,

Segerstrom et al. (2017) suggested that repetitive thought may actually foster positive health behaviors because it can promote processing, planning, and coping following a stressor. Thus, although rumination is typically regarded as conferring negative health effects, some types of rumination may encourage engagement in positive health behaviors, and may be another reason for our data showing less inflammation in those who ruminate more. Research considering health behaviors is needed to examine whether some types of rumination may be healthy.

A major limitation of the study includes a smaller sample size than anticipated, which may have led to the lack of significant associations with other physical health markers and between breakup distress and physical health. Because of difficulty in recruiting, our data may not be adequately powered, potentially leading to a high risk of type II error. More research including adequate power would alleviate concerns about whether type II errors occurred in these data.

Additional limitations of the proposed research include a cross-sectional design, disallowing for causal interpretations regarding emotion regulation strategies and health markers. For example, prior research has shown that inflammation may aid in the development of both depression (Valkanova, Ebmeier, & Allan, 2013) and posttraumatic stress disorder symptoms (Eraly et al., 2014). Thus, it is possible that ongoing stress system activation in the body may lead to greater tendency to ruminate or that the effects of stress system activation and rumination are bidirectional. Further, greater intrusive rumination brought on by activated stress systems may also elicit fear of emotions and subsequent attempts to avoid them.

Although the use of particular emotion regulation strategies is typically regarded as a trait-like characteristic, it is also possible that distress resulting from the breakup could induce the desire to ruminate on or avoid emotions even if the trait was not present before the breakup. Similarly, the tendency to ruminate on or avoid emotions may confer negative effects more so during and following a breakup than before. For example, people may tend to avoid emotions or ruminate if confronted with emotional stressors, but neither strategy may be used if the person does not perceive negative emotions that must be regulated. Thus, the strategies may only confer negative effects when in an emotionally stressful situation. Longitudinal studies are needed to causally infer the effects of rumination and avoidance on cardiovascular functioning and inflammation in various states of stress.

Despite the limitations of the current study, these findings provide novel information suggesting that tendency to regulate emotions using rumination or avoidance following a breakup may influence resting physiological functioning. Further, because breakup distress was not associated with health outcomes, the direct associations reveal the impact of emotion regulation on health need not function through breakup distress. Results reveal a need for more research regarding how maladaptive emotion regulation strategies impact health, and whether increasing the use of more appropriate emotion regulation strategies (e.g., distraction for individuals who tend to ruminate) or therapies (e.g., Acceptance and Commitment Therapy for individuals who tend to avoid emotions) can result in healthier physiological outcomes.

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