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# A Daily Diary Study of Rumination and Health Behaviors: Modeling Moderators and Mediators

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A Daily Diary Study of Rumination and Health Behaviors:

Modeling Moderators and Mediators

Kristen E. Riley, Ph.D.

University of Connecticut, 2016

Engaging in maladaptive health behaviors such as excessive alcohol intake and sexual risk taking behavior and avoiding adaptive health behaviors such as a healthy diet and exercise contribute to the development of a number of chronic illnesses. Rumination, thinking about things negatively over and over again, is a common cognitive process among college students that may impact health behavior engagement or avoidance. However, very little research has examined the relationship between rumination and health behaviors, and none to our knowledge has studied possible moderators and mediators. This study examined these relationships using an 11-day online daily diary design. Outcomes included fruit intake, vegetable intake, exercise, alcohol intake, sexual risk taking behavior, and cigarette smoking. Using multivariate modeling in Mplus, we found that significant Level 2 moderators included intention for all health behavior and perceived behavioral control and neuroticism for alcohol only. Emotional intelligence and mindfulness were surprisingly not significant moderators. Significant Level 1 mediators included impulsivity and using health behaviors as coping for most health behaviors, but motivation was a significant mediator for exercise only and self control was only a significant mediator for vegetable intake. We also found that individuals with anxiety symptoms may ruminate and then act impulsively and individuals with depressive symptoms may ruminate and then not act at all. We discuss implications of this research and application to interventions, including the potential limits of mindfulness and the potential importance of cognitive behavioral therapy and stress management focused interventions on college campuses.

A Daily Diary Study of Rumination and Health Behaviors:

Modeling Moderators and Mediators

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B.S., University of Delaware, 2010

M.A., University of Connecticut, 2012

A Dissertation

Submitted in Partial Fulfillment of the

Requirements for the Degree of

Doctor of Philosophy

at the

University of Connecticut

2016

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2016

APPROVAL PAGE

Doctor of Philosophy Dissertation

A Daily Diary Study of Rumination and Health Behaviors:

Modeling Moderators and Mediators

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In memory of mentor Larry H. Cohen and grandma Joan R. Carrick

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**Rumination and health behaviors: A model of moderators and mediators**

Maladaptive lifestyle factors such as poor diet, lack of exercise, excessive alcohol intake, cigarette smoking, and sexual risk taking, are among the biggest threats to future health of the US population. Poor health behaviors are epidemic, and can contribute to myriad health issues, including obesity, heart disease, diabetes, and cancer (Enwald & Huotari, 2010; Ginsburg et al., 2012).

College student population health is strongly related to public health in the US because college students represent a broad swath of the population of young adults in the US, and over half of the US population attends college (Educational Attainment, 2006). Making an impact on college student health has the potential to substantially improve US public health in both the short- and long-term (Sallis, Owen & Fisher, 2008). If these young adults adopt, increase, or maintain use of adaptive health behaviors and reduce engagement in maladaptive health behaviors, their long-term prospects for avoiding or postponing chronic disease (e.g., metabolic syndrome, diabetes) are bettered (Sallis et al., 2008). Many variables have been examined as factors in health behavior engagement in college students, yet the need for exploration of additional variables remains, as rates of obesity and other health issues among college students are on the rise (Braithwaite, 2010; Greene et al., 2011).

It is important to identify lesser-studied variables that may affect health behavior engagement and the ways through which these variables operate in order to learn how to improve health behaviors and thereby increase public health. Rumination, or thinking about a negative mood or event passively and repetitively (Nolen-Hoeksema, 1991; Smith & Alloy, 2009), is one such variable, and is described in further detail below. Rumination, as well as a set of proposed moderators and mediators focused on in the present study, have been shown to be related to physical and mental health (Azjen, 1991; Coleman, 2008; Denson et al., 2011; Deyo et al., 2009; Smith & Alloy, 2009) but have not been thoroughly studied in the context of health behaviors. Proposed

mediators and moderators in this study have been related to both rumination and health behaviors in previous literature, but have never been studied as mediators or moderators of the rumination to health behavior relationship, as detailed below.

### **Rumination is common and may impact health behaviors**

Rumination is a common cognitive process that has been studied extensively; its deleterious effects on mental and physical health have been documented by numerous researchers (see Smith & Alloy, 2009, for a review). Rumination refers to passively and repetitively thinking about a negative mood, negative thoughts, or negative events (Nolen-Hoeksema, 1991; Smith & Alloy, 2009). It is important to note this traditional conceptualization of rumination as depressive rumination has been recently supplemented with a conceptualization and measures that have expanded to measure both depressive (or brooding) and reflection rumination. While brooding aligns with the previously defined depressive rumination, reflection rumination is a turning inward to engage in cognitive problem solving to alleviate depressive symptoms (Treynor, Gonzales, & Nolen-Hoeksema, 2003; Smith & Alloy, 2009). Because depressive or brooding rumination specifically has been related to health and health behaviors, and because we are interested in the effect of the traditionally-defined depressive or brooding rumination theoretically, and its maladaptive effects, we focus on brooding rumination in this manuscript, and rumination henceforth will refer to brooding or depressive rumination.

Rumination has been negatively related to self-reported physical health; rumination likely affects physical health through health behavior engagement (Thomsen et al., 2004). However, only a few studies have studied the link between rumination and health behaviors (See Table 1). A few studies have posited why rumination may impact health or health behaviors. Rumination has been empirically linked to impulsivity (Smith & Alloy, 2010), decreased motivation (Dickson, Ciesla & Reilly, 2013), decreased self control (Denson, 2011), and use of poor health behaviors to cope

(Nolen-Hoeksema & Harrell, 2002). Therefore, rumination may impact health behaviors through causing people to act too quickly (impulsivity, low self control), inhibit action (low motivation, low self control), or attempt to use maladaptive health behaviors as a means to cope with distress resulting from the ruminative thoughts.

To our knowledge, only eleven studies have examined rumination in the context of any specific health behavior (See Table 1). Preliminary evidence suggests a moderately strong positive correlation between rumination and engagement in deleterious health behavior patterns.

More specifically, two studies examined rumination's impact on eating behaviors (Nolen-Hoeksema et al., 2007; Rawal et al., 2010), two studies examined rumination's relationship with smoking (Dvorak et al., 2011; Richmond et al., 2001), one study examined healthcare utilization (Thomsen et al., 2004), one looked at sleep (Zawadzki, Graham & Gerin, 2013), and four studies included rumination in predicting drinking behavior (Caselli et al., 2008; Caselli et al., 2010; Ciesla et al., 2011; Nolen-Hoeksema & Harrell, 2002). Additionally, one study examined rumination's role in sexual risk taking behavior (Eich-Hochli et al., 2001; See Table 1).

Again, these studies found a moderately strong positive correlation between rumination and maladaptive health behaviors, and moderately strong negative correlations between rumination and adaptive health behaviors. No studies to our knowledge have empirically studied how or under what conditions rumination may impact health behaviors. In this study, we examined possible moderators and mediators of the relationship between rumination and health behaviors.

### **Moderators and mediators**

Some moderators and mediators have been proposed as existing between rumination and health behaviors (see Table 1), and between rumination and behaviors in general (see Table 2), but none have been empirically tested using established moderation or mediation analytic techniques. Nolen-Hoeksema (2002) suggested that maladaptive health behaviors serve as coping mechanisms to

avoid or deal with the distress that depressive rumination often causes. Other potential moderators and mechanisms, and the variables of focus in this study, are discussed below. All moderators besides intention are measured at baseline, Level 2, and all mediators are measured in daily surveys, at Level 1.

### **Moderators**

A moderator variable is one that influences the strength of a relationship between two other variables. A moderator may increase the strength of a relationship, decrease the strength of a relationship, or change the direction of a relationship between an independent or predictor variable and a dependent or criterion variable (Baron & Kenny, 1986; Fairchild & MacKinnon, 2009). Moderators also tend to be stable within-person descriptive or personality variables. Specifically within a correlational analysis framework, a moderator is a third variable that affects the zero-order correlation between two other variables (Baron & Kenny, 1986). For example, mindfulness may buffer the effects of rumination on health behaviors, so was therefore tested as a moderator.

We examined a number of moderators of the rumination to health behaviors relationship in order to develop a comprehensive model. However, there are two primary potential moderators of interest: intention and mindfulness.

First, intention has been shown to be an important construct theoretically and in previous research (Riley & Park, unpublished dataset) as well as in the well-supported theory of planned behavior (Ajzen, 1991, 2011), but has not been included as a moderator in any study of rumination and health behaviors or any behaviors in general, and is not even included in much of the health behavior literature (Ajzen, 2011). We hypothesized that intention is a very important variable missing from much of the current study of health behaviors, and the present study could provide evidence for further inclusion of this important variable in future research.

Additionally, because the most important implication of this research is the ability to develop better interventions for healthier lifestyles among college students, and because mindfulness interventions have been shown to be powerful interventions for decreasing rumination (e.g., Deyo, Wilson, Ong, & Koopman, 2009; Jain et al., 2007), a second focal moderator in this study is mindfulness.

We also examine perceived behavioral control, neuroticism, and emotional intelligence, constructs that have been linked to rumination and health behaviors previously, that may serve as moderators of this relationship.

**Intention.** The Theory of Planned Behavior details that intention is the most important predictor of behavior (See Figure 1; Azjen, 1991). Additionally, theoretically, if we are hypothesizing that rumination causes a person to be impulsive or not act at all with health behaviors, that it interferes with what one would otherwise do, it is important to know about participants' intentions. For example, if a person eats unhealthily, but has no intention to eat healthfully, there would not be a process for rumination to disrupt. However, if a person eats unhealthily, but had intended to eat healthily, rumination may have been involved in that person's not following through on that intended behavior, through various mechanisms. It is therefore reasonable to posit that the relationship between rumination and health behaviors is strengthened, or only exists, when intention is present. This hypothesis was borne out in a pilot study conducted in 2013, in which rumination only had minimal bivariate correlations with health behaviors, but when intention was included as a moderator in linear regressions, more relationships between rumination and health behaviors emerged (Riley & Park, unpublished dataset).

Additionally, because intention is an important theoretical moderator of the rumination to health behavior relationship, such that there would likely not be a relationship without it, we included intention as a moderator for the mediation relationships as well. Intention is proposed to



moderate the rumination to mediator relationship such that the rumination to mediator (impulsivity, amotivation, low self control, using health behaviors as coping) link will be stronger should there be intention to engage in an adaptive health behavior and less strong should there be no intention to engage in maladaptive health behaviors. If a person has an intention to engage in a healthy behavior, that may decrease the rumination to maladaptive mediator relationship, such that rumination's effect on the mediator would be weaker. If a person has an intention to engage in an unhealthy behavior, that may increase the rumination to mediator outcome relationship. Additionally, intention is proposed to strengthen the relationship between the mediator and the outcome, such that without intention to engage in the health behavior, there is no process upon which for the mediator (e.g., impulsivity) to impact health behavior outcomes.

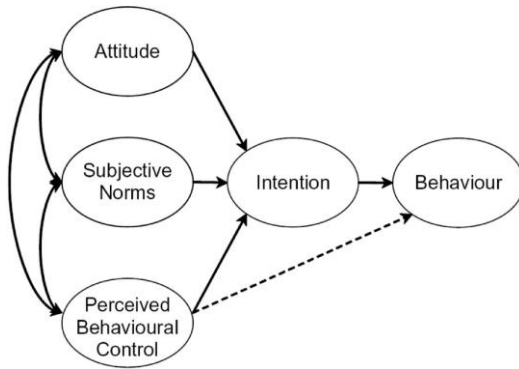
**Mindfulness.** Mindfulness and mindfulness interventions have consistently been shown to combat rumination and ruminative responses to stress (e.g., Deyo et al., 2009; Jain et al., 2007), and has also been linked to engaging in more adaptive health behavior patterns (e.g., Black, Johnson, Sussman, & Milam, 2012; see Grossman, Niemann, Schmidt, & Walach, 2004, for a review). Because rumination appears to have a harmful impact on health behaviors, it will be important to think about how to reduce rumination to increase adaptive health behavior adherence and decrease maladaptive health behavior engagement. We would expect trait mindfulness to buffer, or decrease, the harmful relationship between rumination and health behaviors.

Other possible moderators that have been linked to both rumination and health behaviors are outlined below.

**Perceived behavioral control.** Perceived behavioral control refers to an individual's perceived ease or difficulty in performing a particular behavior. This construct also has some direct impact on behavior engagement in the Theory of Planned Behavior that has been empirically validated by a number of studies (e.g. Azjen, 1991). This relationship is not as strong as the

relationship between intention and behavior, as intention has been shown to be a partial mediator of the relationship between perceived control and behavior, but is still important to measure as a potential moderator in the relationship between rumination and health behaviors.

**Figure 1. Theory of Planned Behavior**



**Neuroticism.** Neuroticism is a personality trait characterized by emotional instability, anxiety, pessimism, stress, and difficulty regulating emotions (Costa & McCrae, 1987). Evidence for a significant relationship between neuroticism and rumination has been demonstrated (Nolen-Hoeksema & Davis, 1999; Nolen-Hoeksema et al., 1994; Roberts, Gilboa, & Gotlib, 1998; Trapnell & Campbell, 1999; Smith & Alloy, 2009). Some research has conceptualized rumination as a cognitive and behavioral expression of trait neuroticism (Smith & Alloy, 2009). However, rumination relates to depression above and beyond neuroticism (Nolan, Roberts, & Gotlib, 1998; Roberts et al., 1998), indicating that the two constructs are somewhat distinct. Neuroticism is also strongly related to health behaviors (Gallant & Connell, 2003). Smith and Alloy (2009) argue that understanding the relationship of rumination to personality constructs, especially neuroticism, is important.

The interaction between rumination and neuroticism may significantly predict maladaptive health behavior patterns above and beyond rumination alone because the persistent worry component of neuroticism may create more perseverative rumination. Or, perhaps rumination, more related to depression, combined with neuroticism, more related to anxiety, could lead to a distressing

combination of depression and anxiety symptoms, decreasing motivation to engage in good health behaviors and leading to impulsivity. Because neuroticism is not proposed as the reason rumination impacts health behaviors, but rather a condition under which the relationship between rumination and health behaviors is stronger, it is being tested as a moderator.

**Emotional intelligence.** Emotional intelligence is a trait or personality variable that reflects the capacity to understand, interpret, regulate, and express emotions (Goleman, 2006), and has been posited to moderate the relationship between rumination and health behaviors. Emotional intelligence also captures emotion regulation and metacognitive awareness, two results of rumination that have also been posited as a link between rumination and behavior (Smith & Alloy, 2010; See Tables 1 and 2). For example, Mikolaiczak and colleagues (2009) showed that less emotionally intelligent people use more maladaptive coping strategies, including rumination. Because emotional intelligence is a stable trait-like condition under which the relationship between rumination and health behaviors would not be as strong, we tested emotional intelligence as a moderator.

### **Mediators**

A mediator variable is one that explains the relationship between two variables. A given variable may be said to function as a mediator to the extent that it accounts for the relation between the predictor and the criterion, either wholly (direct mediation) or partially (indirect mediation). In the present study, we were interested in those variables that strengthen or weaken the relationship between rumination and health behaviors (moderators), as well as those that may account for how rumination impacts health behaviors, or the paths through which rumination impacts health behaviors (mediators) (Baron & Kenny, 1986; Zhao, Lynch & Chen, 2010). For example, impulsivity may be the pathway through which rumination impacts health behaviors, so was tested as a mediator.

Rumination causes people to get stuck in their head, distracted by and wrapped up in their thoughts, and could cause individuals to either have to make important decisions at the last minute, acting impulsively (Denson et al., 2011; Lucas et al., 2010), or not act at all, due to this distraction. One could also get so caught up in rumination that it saps their motivation to engage in behaviors, also causing them to not act at all. While we tested a number of mediators suggested by previous literature in order to develop a comprehensive model of how rumination impacts health behaviors, our primary variables of interest were impulsivity and not acting at all (operationalized here as lack of motivation), because these two opposing behavioral paths, impulsivity, and not acting at all, may be the primary overarching mediators of how this cognitive process of rumination impacts engaging in maladaptive health behaviors or not engaging in adaptive behaviors, respectively. Not acting at all is operationalized as lack of motivation because the construct of motivation is the closest proxy variable we could find for ‘not acting at all’ that was well-operationalized and well-studied, that had well-validated and reliable measures, and that had been linked to rumination in previous literature.

**Impulsivity.** Rumination could lead to more maladaptive health behavior or less adaptive health behavior through leading an individual to act too quickly, or being impulsive. Much research connects rumination to impulsivity (Denson et al., 2011; Lucas et al., 2010), and impulsivity has also been linked to maladaptive health behaviors (Grano et al., 2004; Stoltenberg, Batien & Birgenheir, 2008). One study determined that impulsivity was a link between rumination and depression in a population of cigarette smokers (Herrera & McChargue, 2011). Another study demonstrated that impulsivity moderated the association between a sample of smokers’ depressive rumination and number of failures to quit (Dvorak, Simons, and Wray, 2011; See Table 1), but no studies have examined impulsivity as a mediator of the relationship between rumination and health behaviors.

**Motivation (Amotivation).** Alternately, rumination can sap individuals’ motivation and initiative. Rumination maintains one’s focus on one’s depressive or sad thoughts, which may distract

individuals from their desire to engage in constructive behavior (Lyubomirsky & Tkach, as cited in Papageorgiou & Vells, 2004). Several studies suggest that people who focus on negative feelings show reduced motivation. For example, Lyubomirsky et al. (1999) asked students to report their biggest problems and then come up with solutions to them; trait ruminators were less likely than non-ruminators to follow through with their planned solution. Another study showed that although ruminators believed that pleasant activities would lift their mood, they did not do them (Lyubomirsky & Nolen-Hoeksema, 1993). Shockingly, one study even demonstrated that, because they suffer heightened distress upon discovering health symptoms, ruminators delay seeking a diagnosis for medical issues: Women with breast cancer with a tendency to ruminate reported having delayed a doctor's appointment, and therefore diagnosis of cancer, for an average of 2 months later than non-ruminators (Lyubomirsky, Kasri & Chang, 2003).

A lack of motivation as a result of rumination is distinct from intention to engage in specific health behaviors, one of the proposed moderators. Intention implies a specific plan, while motivation speaks to a general desire to engage in the health behavior, which fluctuates more often (Russell, Ruppap, & Matteson, 2011). Motivation has not yet been studied as a mediator between rumination and behaviors.

**Self control.** While motivation captures the *desire* to engage in a behavior, self control captures the *ability* to override incipient responses and regulate one's behavior towards one's goals. It may provide additional willpower to overcome temptation (either to not do something or to do something; Tangney, Baumeister, & Boone, 2004). Low self control has been shown to mediate the rumination-aggressive behavior relationship (Denson et al., 2011). Therefore, low self control may mediate the relationship between rumination and health behaviors.

**Health behaviors as coping.** Nolen-Hoeksema and Harrell (2002) posited that maladaptive health behaviors result from wanting to distract oneself from one's distress, or cope with the distress

of the repetitive negative thoughts involved in ruminative processes, yet this relationship has not thus far been tested empirically, so we measured the use of health behaviors as coping as a mediator in the relationship between rumination and health behavior (Nolen-Hoeksema, 2002; See Table 1).

### **Study overview**

Health behaviors and rumination are ongoing daily processes. Because of this ongoing nature, we conducted a daily diary study

**Benefits of a daily diary methodology.** To evaluate the temporal links between rumination and health behaviors, and possible mediators and moderators, we used a daily diary methodology. This methodology involves repeated daily assessment of individuals over multiple days. Diary methods “capture the particulars of experience in a way not possible using traditional designs” (Bolger, 2003, p. 579; Bolger & Laureceau, 2013) and generates summary accounts while avoiding the biases of longer-term retrospection (Bolger, Davis, & Rafaeli, 2003). Shiffman, Stone, and Hufford (2008) discussed the particular threats to validity that result from retrospection in one-shot or cross-sectional measures. Not only is an individual’s recall subject to error due to memory reconstruction and the availability heuristic, it is also subject to bias by the person’s context and mental state at the time of recall. This type of problem is called state-congruent recall, and it can lead to biased reports (Bolger & Laurenceau, 2013; Bower, 1981).

Shiffman et al. (2008) argued that more data collection points, via Ecological Momentary Assessment, or EMA, leads to more accurate data. Particularly, daily diary studies are popular because of their ease of administration and low subject burden. Daily diary surveys can be easily administered online and take only a few minutes to complete, and participants generally have an option within a certain block of time in which to complete the survey (Shiffman et al., 2008).

This type of research design is also referred to as intensive longitudinal modeling, or a study with enough repeated measurements to model a distinct change process for each individual (in this

case, to understand people's feelings, thoughts, and behaviors in situ; Bolger & Laurenceau, 2013). Specifically, with a daily diary design, we can explore whether on days when people ruminate more, or less, they may engage in more or less healthy behaviors, and we can look at moderators and mediators of this relationship.

**Daily health behaviors.** Health behavior engagement occurs on a frequent basis, with multiple instances of engagement in health behaviors, or lack thereof, every day. This is especially true when it comes to eating and exercise behaviors, making a daily diary design particularly appropriate for measuring relationships between variables and temporal patterns, and measuring health behaviors with accuracy. Previous research has demonstrated that measuring health behaviors is most accurate when conducted on a daily basis (Gillmore et al., 2001).

**Daily rumination.** Rumination is a cognitive process that occurs every day, and multiple times per day, much like health behaviors. Very few studies have examined rumination using a daily diary design (Moberly & Watkins, 2008), yet such assessment can yield important information. For example, a study of college students demonstrated the predictive role of rumination in symptom severity of seasonal affective disorder during the winter months (Young & Azam, 2003). The authors cited the benefit of assessing ruminative response style with a daily measure and collecting reports of actual ruminative behavior, not simply assessing general ruminative tendencies. There has been support in previous literature to demonstrate daily fluctuations in both state rumination measures as well as general ruminative trait tendency measures (Moberly & Watkins, 2008). In this study, we included trait rumination, but primarily focused on daily rumination, in order to examine moderators and mediators of daily rumination and health behavior relationships.

## Hypotheses

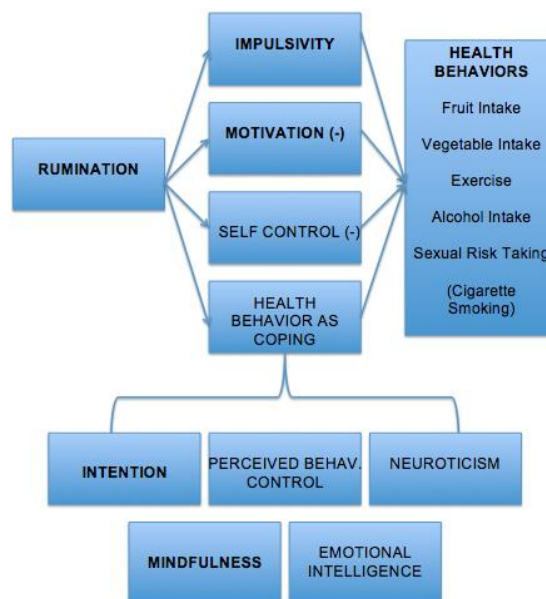
First, as suggested above, and based on previous literature, this study hypothesizes that rumination will be related to health behaviors, with rumination being negatively related to adaptive

health behaviors (fruit intake, vegetable intake, and exercise) and positively related to maladaptive health behaviors (cigarette smoking, alcohol intake, sexual risk taking) in bivariate correlations as well as in multilevel models at both the within-person and between-person levels.

Second, moderators will increase or decrease the strength of the relationship between rumination and health behaviors including intention (increase), perceived behavioral control (decrease), neuroticism (increase), emotional intelligence (decrease), and mindfulness (decrease; See Figure 2). As stated previously, intention and mindfulness are primary moderators of interest.

Third, rumination will be associated with more maladaptive and less adaptive health behaviors through four pathways (mediators): impulsivity, low motivation, low self control, and the use of health behaviors as coping (See Figure 2). As stated previously, we focused on impulsivity and motivation as primary mediators of interest. We also hypothesize that intention will moderate each mediation path (from rumination to mediator and then mediator to outcome) in moderated mediation analyses. We tested moderated mediation models for each mediator, and then removed moderators from the mediation analysis and ran the simpler model when appropriate.

**Figure 2. Proposed model of mediators and moderators**



\*Note. Primary variables of interest are bolded



## **Secondary/Supplementary Hypotheses**

Secondary hypotheses include the following: There are predictors of ruminators who act impulsively and ruminators who don't act at all (low motivation). Specifically, there are subtypes of ruminators: trait anxious people ruminate and then act impulsively and trait depressive people ruminate and then do not act. While there is sparse literature hypothesizing these subtypes, there are questions in previous literature about rumination's lack of specificity to depression and anxiety, and questions about whether there are personality types or third variables that lead to rumination predicting more anxiety symptoms or more depression symptoms (Smith & Alloy, 2009).

## **Method**

### **Participants**

285 participants (mean age=19.3; 76.8% female; 79.4% Caucasian, 6.3% Black/African American, 4.2% Asian, and 3.1% "Other," with 9.3% identifying as Hispanic/Latino) were recruited via the Psychology Department participant pool website at the University of Connecticut in two rounds of data collection in Spring 2014 and Fall 2014. Participants were compensated with credit for an introductory psychology course.

### **Procedure**

Participants completed online questionnaires using the Qualtrics online survey software. Students completed a half-hour long battery of questionnaires at baseline, followed by 11 days of five-minute daily diary assessments, in Spring 2014. At baseline, participants reported demographic information as well as personality variables and tendencies. At each daily diary time point, participants reported daily health behaviors and rumination and other measures outlined below.

In the study description on the Participant Pool portal, participants were informed that they would be sent a link to an online survey via email for baseline on Day 1 at 8am, to be completed that day, and for the daily survey, at 8 pm every day for 11 days, starting the evening of Day 1. They

were directed to a website where they were asked to set aside approximately 30 minutes (baseline) or 5 minutes (daily diary) of uninterrupted time to answer all the questions. Participants were told to complete the daily survey at the end of their day, as close to bedtime as possible, and between 8 pm and 2 am. If they were unable to complete the study at the time they opened the survey, they were able to save their responses and complete the survey at a later time. Participants agreed to an information sheet with terms and conditions of the study, reminding them that they could quit the study at any time, that their responses were confidential, and that they would not be forced to answer any questions, in accordance with the approved IRB protocol. This study was approved by the IRB of the University of Connecticut. A certificate of confidentiality was obtained from NIAAA/NIH in order to protect underage participants' report of alcohol intake. All participants were provided with contact information for mental health resources.

## Measures

**Baseline.** The following measures were collected once on Day 1 of the study.

**Demographics.** We asked the participants to identify their age, year in school, gender, race, and ethnicity with five questions.

**Trait rumination.** The Response Styles Questionnaire, Ruminative Responses Subscale (Brooding subtype; RSQ, RRS; Nolen-Hoeksema & Morrow, 1991) is a 22-item measure that has been extensively used and has been shown to have good internal consistency and moderate to high test-retest reliability over one year ( $r = 0.47$ ,  $p < .001$ ) and validity for predicting depression (Just & Alloy, 1997; Kuehner & Weber, 1999; Nolan, Roberts, & Gotlib, 1998; Nolen-Hoeksema et al., 1994; Nolen-Hoeksema, 2000; Spasojevic & Alloy, 2001). In the present study,  $\alpha = .96$ .

**Perceived Behavioral Control.** Behavioral control, or self efficacy, around health behaviors was measured using the Health Specific Self Efficacy Scales (Schwarzer, 2001). We included two subscales: The Nutrition Self-Efficacy Scale and The Physical Exercise Self Efficacy Scale, with five

questions per subscale, and combined scores for a composite Health Self Efficacy Measure (Schwarzer, 2001). Items include “I can manage to stick to healthful foods even if I need a long time to develop the necessary routines,” and “I can manage to carry out my exercise intentions even when I have worries and problems.” The prompt asks participants to consider “How certain are you that you could overcome the following barriers?” and participants answer each question on a four point Likert scale from “Strongly Disagree” to “Strongly Agree.” Internal consistency is  $\alpha = .90$  for the Nutrition scale, .88 for the Physical Exercise scale, and .61 for both scales combined.

**Neuroticism (NEO).** The Neuroticism-Extroversion-Openness Inventory (NEO; Costa & McCrae, 1980) was used to assess personality variables, with a focus specifically the neuroticism subscale. Items from the neuroticism subscale include “I am a worrier” and “When I’m under a great deal of stress, sometimes I feel like I’m going to pieces,” and are answered with a five point Likert scale from “Rarely/Never” to “Always.” Internal consistency for the neuroticism scale in the present sample is  $\alpha = .86$

**Emotional Intelligence.** The Trait Emotional Intelligence Questionnaire Short Form (TEIQue-SF) is a 30-item questionnaire designed to measure global trait emotional intelligence (trait EI). Items include “expressing my emotions with my words is not a problem for me” and “on the whole, I’m able to deal with stress,” and are rated on a seven point Likert scale from “Completely Disagree” to “Completely Agree.” The TEIQue-SF has been used in a number of studies and has consistently shown good reliability and validity. Internal consistency for this study is  $\alpha = .88$ .

**Trait mindfulness (CAMS-R).** Mindfulness was assessed with the Cognitive and Affective Mindfulness Scale—Revised (CAMS-R). Items are ranked on a Likert scale from “Rarely/Not at All” to “Almost Always.” This is a 12-item scale designed to assess four components of mindfulness: attention, present moment, awareness, and acceptance (Feldman et al., 2007). Example items include “I am able to focus on the present moment,” “I am able to accept the thoughts and

feelings I have,” and “I am preoccupied by the past (reverse scored).” This scale has demonstrated validity and internal consistency. Reliability for this study is  $\alpha = .82$ .

***Depression, Anxiety.*** The depression subscale of the Depression, Anxiety, and Stress Scale (DASS-21; Lovibond & Lovibond, 1995) was used to assess whether rumination impacts health behaviors above and beyond depression. The DASS is an extremely widely used measure that has been used in many college samples (e.g., Mahmoud, 2011). An example of a depression item is “I felt down hearted and blue,” with regards to the last month, on a four point Likert scale from “Did not apply to me at all,” to “Applied to me very much, or most of the time.” This survey has been shown to have good construct validity and normative data in non-clinical samples (Henry & Crawford, 2005). Reliability for this study for the depression subscale is  $\alpha = .91$  and for the anxiety subscale is  $\alpha = .86$ .

**Daily Diary (11 days).** The following measures were collected on each of 11 days.

***Fruit and Vegetable Intake.*** Daily diet was assessed using the Dietary Screener Questionnaire (DSQ), a focused assessment referring to the past week, listed on the NCI website (<http://riskfactor.cancer.gov/studies/nhanes/dietscreen/questionnaires.html>). Questions were modified to inquire for daily intake, a practice used often (e.g., Perrine, 2014). Scoring algorithms produce a single number of average daily fruit and vegetable intake. The DSQ has been used in large-scale and more focused studies and has been shown to have reasonable validity. Internal consistency in our study, or the average alpha across days, is fruit intake  $\alpha = .69$  and vegetable intake  $\alpha = .71$ .

***Exercise.*** Exercise was assessed by the Godin Leisure-Time Exercise Questionnaire (LTEQ), a 4-item measure that assesses leisure-time exercise without the need for detailed review (Godin & Shephard, 1985). The LTEQ assesses frequency per day of strenuous (heart beats rapidly), moderate

(not exhausting), and mild (minimal effort) exercise practiced for at least 15 minutes. A composite score was used for our daily exercise index (Godin & Shephard, 1985).

***Sexual Risk Taking.*** Participants reported occasions on which they had unprotected sex with a monogamous partner (i.e., sex without protection against STDs and pregnancy with an exclusive dating partner) and a nonmonogamous partner (i.e., sex without protection against STDs and pregnancy with a nonexclusive dating partner) (Wetherill, Neal, & Fromme, 2010). The participants endorsed both items on 7-point scales from 0 times to 6+ times. These items have been used and validated in college student samples (Wetherill, Neal, & Fromme, 2010)

***Alcohol.*** Participants reported total alcohol consumption in the previous 24 hours. One drink is defined as one 12-oz bottle of beer, one 4-oz glass of wine, one 12-oz bottle of wine cooler or 1-oz of liquor straight or in a mixed drink. This measure has been used in college student samples (e.g., Park, Armeli, & Tennen, 2003; Park & Levenson, 2002).

***Cigarettes.*** Participants reported how many cigarettes they had smoked in the past 24 hours, a common method of assessing cigarette smoking (Welte et al., 2011).

***Rumination.*** The Ruminative Styles Questionnaire (RRS; Nolen-Hoeksema & Morrow, 1991) is a self-report measure that assesses the tendency to ruminate. Prior research has suggested that the original scale consists of brooding and reflection types of rumination (Treynor, Gonzalez, & Nolen-Hoeksema, 2003). As such, four brooding items, from this scale were included. Items identified by Treynor et al. were adapted for individuals to report their daily levels of ruminative thought. An example item is “Thought: ‘Why can't I handle things better?’ “ on a five point Likert scale. Internal consistency for the brooding subscale is  $\alpha = .79$ .

***Impulsivity.*** Impulsivity was measured with the Barratt Impulsiveness Scale, brief version (BIS-11; Patton, Stanford, & Barratt, 1995; Reise et al., 2013), an eight item measure that assesses trait impulsivity, shown to be reliable and valid and has been tested in college students (Patton et al.,

1995), and has been adapted for use as a state measure, the directions being adapted from “what you usually do” to “what you have done in the past \_\_\_\_\_” (see Stanford et al., 2009 for a review), and we used this adapted state measure in this study. The BIS-11 is a widely used measure of impulsiveness (Patton, Stanford, & Barratt, 1995). Sample items include, “I do things without thinking,” and “I don’t pay attention,” and are scored on a five point Likert scale, from Rarely/Never to Always. Internal consistency  $\alpha = .82$ .

***Motivation.*** The Amotivation subscale from the Global Motivation Scale (GMS-28; Guay, Mageau, & Vallerand, 2003) was used to assess daily lack of motivation around health behaviors. This scale has been shown to have good internal reliability and validity. Example items include “Today I struggled to engage in healthy behaviors because I do not see the benefit in what I’m doing” and “Today I struggled to engage in healthy behaviors because I do not have a good reason for doing them.” Items were reverse scored to denote motivation. Internal consistency for this study was  $\alpha = .61$ .

***Self control .*** The Brief Self Control Measure is a 13-item scale that measures ability to override incipient responses and regulate behavior. It has demonstrated reliability and validity (Tangney, Baumeister, & Boone, 2004), and has been used as a state measure in a number of priming studies (e.g., Ackerman et al., 2009). We used the scale with the modified state self control directions used in other studies, of “Using the scale provided, please indicate how much each of the following statements reflects how you have been today.” Items include “I am good at resisting temptation” and “I am able to work effectively toward long term goals,” and are rated on a 5 point Likert scale from “Not at All” to “Very Much”. Reliability was good for this study  $\alpha = .51$ .

***Health behaviors as coping (HBCS).*** Using health behaviors to cope with rumination was assessed by health behaviors as coping items (Ingledew et al., 1996). Namely, we took the two highest loading items from each of the four health subscales (exercise, eating, self-care, smoking).

These items have been validated, forming a distinct factor from other coping, and were used to assess using health behaviors to cope with distress from ruminative thought “i.e. These items deal with ways you've been coping with the rumination in your day today.” Reliability for this scale was  $\alpha = .55$ .

***Intention to be healthy.*** We asked questions for each health behavior for the next day (i.e., How much do you intend to engage in \_\_\_\_ tomorrow?) based on Azjen’s (2001) recommendations for asking about health behavior intention on a daily level.

### **Power Analysis**

We calculated power for testing individual relationships in our model of moderators and mediators (see Figure 2). In reviewing simulation studies of multilevel power, Kreft and DeLeeuw (1998, p. 125), as well as Bolger and Laurenceau (2013) suggest that the power of multilevel statistical models is affected by both the number of Level 1 (e.g., days) and Level 2 (e.g., persons) units. For example, designs having at least 60 Level 2 units with 25 observations each (2500 total observations) should provide sufficiently high power (i.e.,  $> .80$ ) for detecting small to moderate sized effects, for a certain expected effect size of outcome variables.

We used the software Optimal Design to determine the balance of days to participants based on expected effect sizes for outcome variables (Bolger & Laurenceau, 2013). Expected effect sizes were derived from a previous pilot study dataset. Desired power was set at .8, or 80%, the cutoff for a large effect size and the “magic number” for daily diary studies (Bolger & Laurenceau, 2013). We also accounted for 20% attrition rate, consistent with the average attrition for a daily diary study in college students (Losavio et al., 2011; Swim et al., 2001). Snijders and Bosker (1999) showed that increasing upper-level units (i.e., people) can often result in more power than increasing the number of lower-level units (i.e., days). Our Optimal Design output was consistent with this theory.

We wanted a minimum of 11 observations in order to sample over the course of two

weekends, when healthy behaviors vary more (Gillmore et al., 2001). With 11 observations we required a minimum of 250 participants to power at 80%.

### **Data Analysis Plan**

First, examination of data, cleaning and preparation of data, descriptive analyses, and basic bivariate correlations were performed in SPSS. Then, due to the hierarchical nature of the data, the intensive longitudinal modeling design, and the questions and hypotheses slated for examination, we used Mplus to examine multilevel models of rumination and health behaviors, including moderation, mediation, and moderated mediation (Muthén & Muthén, 2015).

**Normality and missingness of data.** We examined normality of data and made appropriate adjustments in preparation for multilevel modeling, including categorization of outcomes as continuous, count, or categorical outcomes. We marked all missing data as missing. All main models tested used MPLUS to estimate multilevel models, which uses maximum likelihood estimation, a method that accommodates missing data and is particularly useful for analyzing data with a nested structure.

Item- and construct-level ICCs were also examined prior to data analysis. Essentially, ICCs determine the appropriateness of examining items/constructs within a multilevel framework by assessing the amount of variability between items/constructs and the amount of non-independence within items/constructs (Dedrick & Greenbaum, 2010). Cutoff values for ICCs have been reported as ICCs greater than .10 (Dyer, Hanges, & Hall, 2005). Item-level ICC values for rumination ranged from .61-.69, moderators ranged from .20-.45, mediators ranged from .18-.66, and outcomes ranged from .44 to .82, all indicating support for multi-level analysis. Deviance item-level ICCs were lower, with two items having a less than .10 value. Construct-level ICCs were assessed for rumination (ICC = .43) and Level 2 moderators and mediators (ICC range = .54 to .67), indicating support for multi-level analysis.



**Bivariate Correlations.** We conducted basic bivariate correlations in order to note general trends for daily and baseline data. Namely, we examined relationships for three sets of variables: 1. among health behaviors, 2. between rumination & health behaviors, 3. between rumination & moderators/mediators and health behaviors

**Multilevel Modeling Analyses in MPlus.** Diary data collected in this study conforms to a multilevel data structure (Kenny, Kashy & Bolger, 1998; Raudenbush & Bryk, 2002). In the current study, the daily diary ratings of rumination, health behaviors, using health behaviors as coping, self control, and intent were the Level 1 data and were measured for each participant on a daily basis. The Level 2 data were baseline variables, including rumination, neuroticism, motivation, impulsivity, mindfulness, and depression, and were assessed at the beginning of the study for each participant. Note that motivation was measured at both Level 1 and Level 2, and was included in both moderation and mediation analyses.

Multilevel modeling was an ideal choice for the analysis of these data because it estimates between-subject (Level 1 data) and between-subjects (Level 2 data) variation simultaneously, thus allowing for the modeling of each source of the variation while taking into account the statistical characteristics of the other (Bolger & Laurenceau, 2013).

On a practical level, we followed steps to ensure conforming to all best standards and practices for intensive longitudinal modeling (Bolger & Laurenceau, 2013). All data were analyzed at the within-subject level (Level 1) and the between-subject level (Level 2). Each of the predictor variables was group mean centered, meaning that they were centered on each participant's data by subtracting the participant's mean from his or her daily value of each variable. Between subject components of predictor variables were created and included in all models using means of daily items per subject. After dividing predictors into their between and within components, we examined the relationship of 1. Level 1 health behavior outcomes with time (time was included in all models,

as suggested by Bolger and Laurenceau (2013)), 2. relationships of Level 1 health behavior outcomes with Level 1 rumination, 3. proposed moderators of the rumination-health behavior relationship (intention at Level 1, and planned behavior, neuroticism, emotional intelligence, and mindfulness variables at Level 2), 4. moderated mediation of proposed mediators of the rumination-health behavior relationship (impulsivity at Level 2, and motivation, self control, and using health behaviors as coping at Level 1), with Level 1 intention as a moderator. The moderator in the moderated mediation relationships was again Level 1 intention, proposed as a moderator of the rumination to mediator and mediator to outcome relationships. Simple mediation models were run for those mediators that did not demonstrate significant moderation relationships with intention as a moderator when moderated mediation models were initially tested. The simplest models (e.g. mediation vs moderated mediation) are presented. Please note that not all model output are presented in tables for space saving purposes (e.g. randomly varying slopes).

*Moderation.* We estimated both Level 1 and Level 2 moderators for the Level 1 to Level 1 rumination to health behavior relationships. The following regression equation was estimated for each participant in HLM in order to demonstrate moderation, or the within-subject causal process. Time is again included in all models. HealthBehavior specifies one of the five health behavior outcomes and Mod specifies the moderator included in the model

For Level 1 moderators, The Level 1 equation is:

$$HealthBehavior_{ij} = \beta_{0j} + \beta_{1j}(Rum_{ij}) + \beta_{2j}(Mod_{ij}) + \beta_{3j}(Rum \times Mod_{ij}) + r_{ij},$$

Where  $y_{ij}$  is the value of  $y$  for observation  $i$  in group  $j$ ,  $x_{1ij}$ , and  $x_{2ij}$  are the two Level 1 covariates for observation  $i$  in group  $j$ , and  $x_{1ij}x_{2ij}$  is the interaction between the two Level 1 covariates. Further,  $\beta_{0j}$  is the intercept of the regression equation for group  $j$ ,  $\beta_{1j}$  and  $\beta_{2j}$  are the main effects of  $x_{1ij}$  and  $x_{2ij}$ , respectively,  $\beta_{3j}$  is the within-level interaction between  $x_{1ij}$  and  $x_{2ij}$ , and  $r_{ij}$  is the observation- and

group-specific residual. Because the regression parameters are viewed as random variables, these can be expressed in the Level 2 equations as:

$$\begin{aligned}\beta_{0j} &= \gamma_{00} + u_{0j} \\ \beta_{1j} &= \gamma_{10} + u_{1j} \\ \beta_{2j} &= \gamma_{20} + u_{2j} \\ \beta_{3j} &= \gamma_{30} + u_{3j}\end{aligned}$$

where the  $\gamma$ 's represent the fixed regression coefficients and the  $u$ 's represent the group-specific deviations from the fixed effects. This formulation is sometimes referred to as a *random effects regression model* given that the Level 1 regression coefficients vary over the Level 2 units, but are not conditioned on Level 2 covariates. We can substitute the Level 2 equations into the Level 1 equation to result in the reduced form equation such that:

$$y_{ij} = (\gamma_{00} + \gamma_{10}x_{1ij} + \gamma_{20}x_{2ij} + \gamma_{30}x_{1ij}x_{2ij}) + (u_{0j} + u_{1j} + u_{2j} + u_{3j} + r_{ij})$$

For Level 2 moderators,

The Level 1 equation is:  $y_{ij} = \beta_{0j} + r_{ij}$

where  $y_{ij}$  is the observed value of outcome  $y$  for observation  $i$  nested within group  $j$ ,  $\beta_{0j}$  is the intercept for group  $j$ , and  $r_{ij}$  is the person and group specific residual. Because there are no predictors, the intercept represents the model implied mean of  $y$  within group  $j$ . These group means can then be modeled as a function of two Level 2 covariates ( $w_{1j}$  and  $w_{2j}$ ) and their interaction ( $w_{1j}w_{2j}$ ) such  $\beta_{0j} = \gamma_{00} + \gamma_{01}w_{1j} + \gamma_{02}w_{2j} + \gamma_{03}w_{1j}w_{2j} + u_{0j}$  that

where  $\gamma_{00}$  is the fixed intercept,  $\gamma_{01}$ ,  $\gamma_{02}$ , and  $\gamma_{03}$  are the fixed regression coefficients for the two main effects and the interaction, respectively, and  $u_{0j}$  is the Level 2 residual. Finally, the Level 2

equation can be substituted into the Level 1

equation to form the reduced form equation

such that

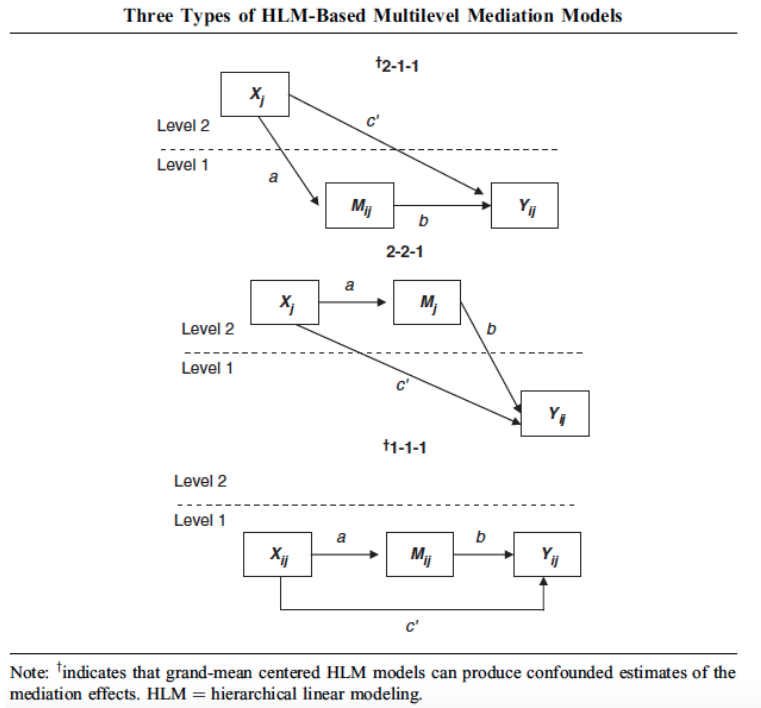
$$y_{ij} = (\gamma_{00} + \gamma_{01}w_{1j} + \gamma_{02}w_{2j} + \gamma_{03}w_{1j}w_{2j}) + (r_{ij} + u_{0j})$$

If the interaction term (i.e.,  $\gamma_{03}$ ) is found to be significant, it is necessary to further probe this effect, with multivariate moderation graphs estimating simple intercepts and simple slopes (Preacher, Curran, & Bauer, 2009; see Figure 6).

In order to explore specific directional relationships in statistically significant moderation models, in accordance with recommendations from previous research (Bauer & Curran, 2005; Bolder & Laurenceau, 2013; Preacher, Curren, & Bauer, 2006), we plotted multilevel moderation effects. We used the simple intercepts, simple slopes, and regions of significance in HLM 2-way interactions calculator, available online at <http://www.quantpsy.org/interact/hlm2.htm>, entering numbers from Mplus output, as well as the program R with the code output from the calculator, in order to plot effects (see Figure 6).

*Moderated mediation and mediation.* Several types of mediation scenarios can exist with multilevel data that come from intensive longitudinal designs because the predictor, mediator, and outcome can vary either within subjects (Level 1) or between subjects (Level 2). However, there are limitations of the combinations of levels for mediation analyses. Krull and MacKinnon (2001) detail three multilevel mediation scenarios: Level 2 to Level 2 to Level 1 (2-2-1), Level 2 to Level 1 to Level 1 (2-1-1), and Level 1 to Level 1 to Level 1 (1-1-1). Zhang, Zyphur, and Preacher (2009) present a visual representation of these combinations in order to explain the limitations in type of level of mediation analyses (see Figure 3).

Figure 3. The three types of multilevel mediation (Zhang, Zyphur, &amp; Preacher, 2009)



This study utilized 1-1-1 mediation. Also, as originally proposed, we included intention as moderation in each mediation analysis, in both the A path between rumination and mediator, as well as the B path between mediator and outcome. We tested these paths in separate models, and then altogether as one large model, for specificity. Again, we hypothesized that without a process to interrupt (intention to be healthy), there would be no ability for a third variable to mediate. The multilevel multivariate statistical models for moderated mediation, presented in Bolger and Laurenceau (2013), was used to assess the specified models below. There are multiple steps associated with testing mediation in a multilevel model; these three steps are detailed below

For L1-L1-L1 mediation:

Mediation effect:  $\gamma_{10}^{(2)} * \gamma_{20}^{(3)}$  or  $\gamma_{10}^{(1)} - \gamma_{10}^{(3)}$  (Level-1 effect confounded with Level-2 effect)

$$L\ 1: Y_{ij} = \beta_{0j}^{(1)} + \beta_{1j}^{(1)} X_{ij} + r_{ij}^{(1)} \quad (16)$$

$$L\ 2: \beta_{0j}^{(1)} = \gamma_{00}^{(1)} + u_{0j}^{(1)} \quad (17)$$

$$\beta_{1j}^{(1)} = \gamma_{10}^{(1)} \quad (18)$$

$$L\ 1: M_{ij} = \beta_{0j}^{(2)} + \beta_{1j}^{(2)} X_{ij} + r_{ij}^{(2)} \quad (19)$$

$$L\ 2: \beta_{0j}^{(2)} = \gamma_{00}^{(2)} + u_{0j}^{(2)} \quad (20)$$

$$\beta_{1j}^{(2)} = \gamma_{10}^{(2)} \quad (21)$$

$$L\ 1: Y_{ij} = \beta_{0j}^{(3)} + \beta_{1j}^{(3)} X_{ij} + \beta_{2j}^{(3)} M_{ij} + r_{ij}^{(3)} \quad (22)$$

$$L\ 2: \beta_{0j}^{(3)} = \gamma_{00}^{(3)} + u_{0j}^{(3)} \quad (23)$$

$$\beta_{1j}^{(3)} = \gamma_{10}^{(3)} \quad (24)$$

$$\beta_{2j}^{(3)} = \gamma_{20}^{(3)} \quad (25)$$

where subscripts  $i$  and  $j$  refer to individuals and Level-2 units, respectively;  $b_{0j}$  is the intercept for firm  $j$ ;  $r_{ij}$  and  $u_{0j}$  are the Level-1 and Level-2 residuals, respectively. The superscript 1 denotes coefficients, parameters, and random variables for the first set of equations. For each mediation analysis that demonstrated significant effects, we calculated direct and indirect effects and created figures for mediation models.

*Secondary analyses.* The secondary hypothesis was about whether there are different types of ruminators, for example people who are depressed who ruminate and then don't act at all, and people who are anxious who ruminate and then are impulsive. We ran four models to this effect. We first ran a multilevel Level 2 depression to Level 2 rumination to Level 1 amotivation mediation model, then a moderation model whereby rumination is tested as a moderator between Level 2 depression and Level 1 amotivation, and then a Level 2 anxiety to Level 2 rumination to Level 1 impulsivity mediation model, followed by a moderation model whereby rumination is tested as a moderator between Level 2 anxiety and Level 1 impulsivity.

*Post hoc analyses.* Because after preliminary data analysis, we wanted to know whether rumination impacted health behaviors above and beyond depression, assessing whether it is a unique and important variable for study, we wanted to further categorize the relationship between depression and rumination and health behaviors with multilevel moderation and mediation analyses. Rumination is linked to the onset and duration of depression, and depression impacts health behaviors (Smith & Alloy, 2009). Because rumination is a much more common cognitive process that is conceptually distinct from depression, we believed that it is important to test on its own, and that it will impact health behaviors above and beyond depression. A hypothesis is that depression may be a partial mediator, but will not fully account for the relationship between rumination and health behaviors; that is, rumination is a unique predictor of maladaptive and adaptive health behaviors. We tested

depression as a Level 2 moderator and a Level 2 mediator of the relationship between Level 1 rumination and Level 1 health behavior outcomes (the mediation model run was a 2-2-1 model).

Similarly, because, surprisingly, mindfulness did not appear to be a moderator in any rumination to health behavior relationships as a between person moderator, we wanted to explore further the relationships between rumination, mindfulness, and health behaviors in multilevel mediation models. While mindfulness was previously tested as a moderator, or a third variable that would just decrease the strength of the rumination to health behaviors relationships, we wondered if perhaps lack of mindfulness functions as a path through which rumination may relate to engaging in maladaptive health behaviors or not engaging in adaptive health behaviors, as mindfulness cultivates awareness to make good decisions, including health behaviors (Kabat-Zinn, 2003).

## Results

### Descriptive Statistics

The 285 college student participants' mean age was 19.3 years old ( $SD = 1.22$ ), consistent with a college student sample. The sample was predominantly female (76.8% female). While this predominantly female sample is not consistent with the average student population, it is consistent with the average psychology major (62.2% female, difference not statistically significant). Consistent with the student body composition at our large public university in New England, our sample consisted of predominantly White participants (79.4% Caucasian, 6.3% Black/African American, 4.2% Asian, and 3.1% "Other," with 9.3% identifying as Hispanic or Latino ethnicity).

**Health behavior frequencies.** On average, per day, participants reported exercising for 23.11 minutes ( $SD = 30.38$ ), eating 1.18 fruits ( $SD = 1.08$ ) and .75 vegetables ( $SD = .93$ ), drinking .81 alcoholic beverages ( $SD = 2.22$ ), and engaging in .06 incidents of sexual risk taking ( $SD = .24$ ). There were low frequencies of reports of cigarette smoking. Only 8 participants reported any smoking incident over the entire study, for a total 60 observations total, or 1.9% of the all daily

observations (11 for 285 participants = 3135 observations). The rates of smoking were so low that this outcome variable was excluded from further analysis (Bolger & Laurenceau, 2013; See Figure 4).

**Normality and missing data.** We examined normality of data and made appropriate adjustments in preparation for multilevel modeling, including categorization of outcomes as continuous (exercise), count (fruit and vegetable), or categorical (alcohol and sexual risk taking). For mediation analyses, in order to more easily interpret effects, we categorized fruit and vegetable intake as continuous outcomes as well. No student withdrew from this study prior to its completion. 28.2% of data was missing. Missing data were examined for any patterns of missingness, (e.g., depression, alcohol use) and data were determined to be missing completely at random (Graham, 2009). Participants completed an average of 9.72 of 11 daily diary days, or 88.3% of the days, an amount that is typical for daily diary completion (e.g., Losavio et al., 2011).

**Intent versus actual health behaviors.** We measured the difference between intended daily health behaviors (reported the previous day) and actual daily health behaviors. On average, participants exercised 16.6 minutes less than intended ( $SD = 11.3$ ), ate .4 less fruits than intended ( $SD = 1.26$ ), ate .8 less vegetables than intended ( $SD = 1.47$ ), drank 1.03 drinks more than intended ( $SD = 2.40$ ), and had .06 more sexual risk taking incidents than intended ( $SD = .04$ ). These findings support the intention-behavior gap literature and are consistent with previous studies (Ajzen, 2011).

### **Bivariate Correlations**

Hypothesis one, that rumination will be related to health behaviors, will be examined below, with bivariate correlations, and in the multilevel modeling section with multilevel models, most appropriate for this daily diary study.

**Health behaviors.** We examined relationships among health behaviors. There were some statistically significant relations between exercise and all other health behaviors ( $p < .05$ ; See Table



3). Surprisingly, exercise was positively correlated with alcohol intake ( $r = .116, p < .001$ ) and sexual risk taking behavior ( $r = .055, p < .01$ ). Fruit and vegetable intake were moderately correlated ( $r = .314, p < .001$ ), and alcohol and sexual risk taking were also significantly correlated ( $r = .224, p < .001$ ). There were no relationships between fruit intake or vegetable intake and alcohol or sexual risk taking.

**Rumination & health behaviors.** Trait rumination (between) was significantly related to exercise ( $r = -.082, p < .001$ ), fruit intake ( $r = -.047, p < .001$ ), and vegetable intake ( $r = -.068, p < .001$ ). Daily rumination (within) was significantly related to fruit intake ( $r = -.040, p < .05$ ), alcohol intake ( $r = .077, p < .001$ ), and sexual risk taking ( $r = .146, p < .001$ ). Simplistic models, visualizing raw data of the relationship of high and low rumination to daily health behaviors, can be seen in Figure 5.

**Rumination & moderators/mediators & depression.** Both trait and daily rumination were significantly correlated with all proposed moderators and mediators at the  $p < .001$  level except for four intention measures. Trait rumination was not related to intention to engage in risky sex and daily rumination was not related to alcohol intake, and only marginally significantly related to fruit intake and sexual risk-taking (See Table 4). Relationships are in the directions predicted except for trait rumination's negative relationship with alcohol intake intentions and daily rumination's negative relationship to intentions to engage in risky sexual behavior.

Trait and daily rumination are significantly related to mindfulness, and mindfulness is only significantly related to exercise ( $r = .053, p < .001$ ) and fruit intake ( $r = .074, p < .001$ ). All measures of rumination, mindfulness, and depression are significantly correlated at the  $p < .001$  level. As expected, rumination is significantly positively related to depression (trait rumination  $r = .489, p < .001$ ; daily rumination  $r = .365, p < .001$ ), and is significantly negatively related to mindfulness (with trait rumination  $r = -.428, p < .001$ ; with daily rumination  $r = -.265, p < .001$ ).

## Multilevel modeling in Mplus

**Relationship with time.** Modeling each health behavior outcome variable with time within and between persons, there is no significant increase or decrease. Fruit decreases at a trending significance level ( $p = .081$ ; See Table 5).

**Hypothesis one: Rumination and health behaviors.** Primary hypothesis one, that rumination will be related to health behaviors at the within and between levels, is tested here with multilevel modeling. Within person, daily rumination is marginally significantly related to fruit ( $\beta = -.085, p = .084$ ), vegetable ( $\beta = -.060, p = .092$ ), and alcohol intake ( $\beta = .252, p = .062$ ), but not exercise or sexual risk taking, when taking time into account time (see Table 5). At the between level, daily rumination is significantly related to vegetable intake ( $\beta = -.092, p = .053$ ) and alcohol intake ( $\beta = .252, p = .041$ ) and is marginally significantly related to fruit intake ( $\beta = -.182, p = .053$ ), and sexual risk taking ( $\beta = .122, p = .092$ ; see Table 5), but not to exercise ( $\beta = -.339, p = .112$ ).

**Hypothesis two: Moderation.** We tested five potential moderators for the rumination to health behavior relationship, according to hypothesis two. Presented in detail are the model results from the main moderators of interest, intention (see Tables 6-10) and mindfulness (see Table 11). Summarized results from all models are summed in the final comprehensive figure (see Figure 12.) Also, because rumination was not related to exercise or sexual risk taking at the within person level in the original base model, it may not be considered a moderator for these variables for any of the following moderators (Baron & Kenny, 1986).

Multilevel moderation model figures for significant models (five intention models, perceived behavioral control for alcohol only, and neuroticism for alcohol only) were created in R using the software created by Preacher, Curran, and Bauer (<http://www.quantpsy.org/interact/hlm2.htm>), and are all presented in Figure 6.

*Intention.* Intention was a significant moderator of the rumination-health behavior relationship for all health behaviors at the within level (see Tables 6-10). We measured intention as specific to each health behavior on the daily level, so we ran five separate moderator analyses for these five separate intention variables. Intention as a within person moderator for fruit was significant, with fruit intake being significantly related to intention ( $\beta = .872, p = .034$ ) as well as the rumination\*intent interaction term ( $\beta = -.199, p = .044$ ). However fruit intake was not significantly related to rumination in this model ( $\beta = .038, p = .489$ ), making intention a complete moderator of the rumination to fruit intake relationship. The between level moderation was also significant for intention ( $\beta = .791, p = .023$ ) and the interaction term ( $\beta = .475, p = <.001$ ), with trending significance for rumination ( $\beta = -.087, p = .079$ ; see Table 6). Intention as a moderator for vegetable intake showed a similar trend, demonstrating significance for intention and the interaction term, but not rumination, at both the within (intention  $\beta = .472, p = .034$ ; rumination\*intention  $\beta = -.152, p = .011$ ; rumination  $\beta = .075, p = .260$ ) and between level (intention  $\beta = .391, p = .033$ ; rumination\*intention  $\beta = .399, p = <.001$ ; rumination  $\beta = .044, p = .457$ ; see Table 7). Exercise demonstrated the same trend, at the within (intention  $\beta = .048, p = <.001$ ; rumination\*intention  $\beta = .075, p = .050$ ; rumination  $\beta = -.831, p = .320$ ) and between (intention  $\beta = .252, p = .010$ ; rumination\*intention  $\beta = .006, p = <.001$ ; rumination  $\beta = 1.474, p = .339$ ) level (see Table 8). It is noteworthy that intention changes the sign of the rumination to exercise relationship from negative to positive. With alcohol, intention is not a significant moderator at the within person level, with alcohol being related to rumination ( $\beta = .338, p = .042$ ), and intention to drink marginally ( $\beta = .010, p = .095$ ), but not the interaction term ( $\beta = .007, p = .939$ ). Intention significantly moderated the between person rumination to alcohol relationship (interaction  $\beta = .830, p = <.001$ ; see Table 9). Intention to take sexual risks was also a significant moderator for within person (intention  $\beta = .700, p = .043$ ; rumination\*intention  $\beta = .707, p = .094$ ; rumination  $\beta = .339, p = .012$ ) and between person (intention  $\beta = .090, p = .003$ ; rumination\*intention

$\beta = .830, p = <.001$ ; rumination  $\beta = 1.525, p = .127$ ) sexual risk taking, the interaction on the within person level being of marginal significance at the  $p < .10$  level (see Table 10).

Figure 6 shows that most moderating relationships are in the direction expected, such that high intention strengthens the rumination to health behavior relationship and low intention weakens the rumination to health behavior relationship. However, surprisingly, for exercise intake, increased intention seems to slightly decrease the rumination to exercise relationship (see Figure 6).

*Mindfulness.* Surprisingly, mindfulness (Level 2 mindfulness; see Table 11) is not a significant buffers of the rumination-health behavior relationship at the within level. However, there is some significance at the between level for both variables for fruit intake, vegetable intake, and sexual risk taking. Specifically, at the within level, there were no significant relationships between any health behavior and rumination, mindfulness, or the rumination\*mindfulness interaction term, besides sexual risk, which was marginally related to rumination ( $\beta = .320, p = .085$ ; see Table 11). Mindfulness appears to be a significant moderator for between person rumination (sum of daily rumination) times between person intention (sum of daily intention) and fruit intake ( $\beta = .124, p = .021$ ), vegetable intake ( $\beta = .110, p = <.001$ ), and sexual risk taking ( $\beta = 1.233, p = <.001$ ; see Table 11).

*Perceived behavioral control.* Perceived behavioral control is a between person (Level 2) moderator. At the within person, perceived behavioral control is a significant moderator for alcohol intake only, such that perceived behavioral control buffers the relationship between rumination and alcohol intake ( $\beta = -.682, p = .011$ ; see Figure 8). At the between person, perceived behavioral control buffers the relationship between rumination and fruit intake ( $\beta = .229, p = .003$ ).

*Neuroticism.* Neuroticism is a between person (Level 2) moderator. At the within person level, perceived behavioral control is a significant moderator for alcohol intake only, such that perceived behavioral control strengthens the relationship between rumination and alcohol intake ( $\beta =$

-.682,  $p = .011$ ; see Figure 12). Neuroticism also strengthens the relationship between rumination and alcohol intake at the between level ( $\beta = -.182$ ,  $p = .054$ ).

*Emotional Intelligence.* Emotional Intelligence was a between person (Level 2) moderator variable. Emotional intelligence was not a significant moderator for any within or between rumination to health behavior relationships (see Figure 12).

*Summary of moderators.* At the within level, rumination is significantly related to all outcomes when taking into account intention as a moderator. Trait mindfulness and emotional intelligence are not showing up as significant buffers of the rumination-health behavior relationship. Perceived behavioral control and neuroticism are significant moderators for alcohol only (See Figure 12).

**Hypothesis three: Moderated mediation and mediation.** While we tested four constructs as mediators in the rumination health behavior relationship, according to hypothesis three. Parameter estimates are presented for primary moderators of interest only: impulsivity (see Tables 12-16) and motivation (see Tables 17-21). Also, again, we ran mediation models with intention as a moderator for both the path from rumination to the mediator as well as the mediator to the outcome, because we believe intention is an important theoretical moderator of all relationships. If moderation terms were not significant, we reran the model without moderators, as just mediation models.

*Impulsivity.* We tested the moderated mediation models for each health behavior outcome, but the intention moderator only significant in the A path from rumination to impulsivity in the exercise model. We ran a plain mediation model from Level 1 rumination to Level 1 impulsivity to Level 1 health behaviors for all other models, removing the moderator term. When removing intention as a moderator from the models, the mediation model significance remained the same. We therefore have presented all mediation models for impulsivity without intention as a moderator, except for exercise (see Tables 12-16).

Impulsivity was a significant mediator of the rumination to exercise (exercise on rumination  $\beta = .070, p = .082$ ; exercise on impulsivity  $\beta = -1.772, p = .052$ ; impulsivity on rumination  $\beta = .162, p = .044$ , impulsivity on intention  $\beta = .267, p = .002$ ; impulsivity on rumination\*intention  $\beta = .762, p = .038$ ; see Table 14), alcohol (alcohol on rumination  $\beta = .500, p = .049$ ; alcohol on impulsivity  $\beta = .189, p = .038$ ; impulsivity on rumination  $\beta = -.309, p = <.001$ ; see Table 15), and sexual risk taking (sexual risk on rumination  $\beta = .763, p = .018$ ; sexual risk on impulsivity  $\beta = .203, p = .011$ ; impulsivity on rumination  $\beta = .302, p = .003$ ; see Table 16) relationships, with intention as a significant moderator in each path from rumination to impulsivity in these models. Impulsivity seems to partially mediate the relationships between rumination and exercise, alcohol, and sexual risk taking.

In the rumination to impulsivity to exercise model, for each unit of rumination, impulsivity increases .162 units. (SE = .105,  $z = -1.940, p = .044$ ). The model predicts that about 95% of the population has slopes in the range of -.168 and .012. The impulsivity to exercise relationship slope for the average person is -1.772 (SE = .469,  $z = 2.528, p = .052$ ), so every unit of impulsivity increase decreases exercise by 1.772 units, times 15 minutes = 26.58 minutes. Exercise is related to rumination such that every unit increase in rumination leads to a .258 decrease in exercise, times 15 minutes, means 3.87 minutes less of exercise, at marginal significance (SE = .550,  $z = -.167, p = .092$ ).  $c = c' + ab + o_{ajbj} = -.258 + (.162 * -1.772) + .05 = .491$ . Given these results, we can calculate that 36% of the average relationship between rumination and exercise can be explained by impulsivity (see Table 14 and Figure 7).

For the rumination to impulsivity to alcohol model, for each unit of rumination increase, impulsivity increases .309 units. (SE = .093,  $z = 3.317, p < .001$ ). The model predicts that about 95% of the population has slopes in the range of .018 to .382. The impulsivity to alcohol relationship slope for the average person is .189 (SE = .012,  $z = 2.116, p = .038$ ), so every unit of impulsivity

increase increases alcohol by .189 units. Alcohol is related to rumination such that every unit increase in rumination leads to a .269 decrease in alcohol, at marginal significance ( $SE = .193$ ,  $z = 1.393$ ,  $p = .091$ ).  $c = c' + ab + o_{ajbj} = .269 + (.309*.189) + .01 = .337$ . Given these results, we can calculate that 11% of the average relationship between rumination and alcohol can be explained by impulsivity (see Table 15 and Figure 8).

For the rumination to impulsivity to sexual risk taking model, for each unit of rumination increase, impulsivity increases .302 units. ( $SE = .091$ ,  $z = 2.782$ ,  $p = .011$ ). The model predicts that about 95% of the population has slopes in the range of .127 to .390. The impulsivity to sexual risk taking relationship slope for the average person is .203 ( $SE = .259$ ,  $z = 2.116$ ,  $p = .038$ ), so every unit of impulsivity increases sexual risk taking by .203 units. Sexual risk taking was not related to rumination ( $SE = .116$ ,  $z = .273$ ,  $p = .116$ ), so there appears to be complete mediation.  $c = c' + ab + o_{ajbj} = .196 + (.302*.203) + .19 = .416$ . Given these results, we can calculate that 23% of the average relationship between rumination and sexual risk taking can be explained by impulsivity (see Table 16 and Figure 9).

*Motivation.* We examined a motivation variable measured at the Level 1 daily within level (see Tables 17-21). Daily motivation is only a significant mediator in the rumination to exercise relationship (see Table 19). At the between person level, motivation is significantly related to rumination in the fruit ( $\beta = .181$ ,  $p = .044$ ; see Table 17), vegetable ( $\beta = .204$ ,  $p = .038$ ; see Table 18), and sexual risk taking models ( $\beta = -.225$ ,  $p = .027$ ; see Table 21), but motivation is not related to any health behavior outcome at the daily level. Intention did not moderate any relationship, so regular mediation models are presented (Tables 17-21).

At the within level, for each unit of rumination, motivation decreases .18 units ( $SE = .031$ ,  $z = -.274$ ,  $p = .082$ ). The model predicts that about 95% of the population has slopes in the range of -.206 and .160. The motivation to exercise relationship slope for the average person is .919 ( $SE =$

.672,  $z = 1.993$ ,  $p = .093$ ), so every unit of motivation increases exercise by .919 units, times 15 minutes = 13.719 minutes. Exercise does not appear to have a direct relationship with rumination, indicating full mediation.  $c = c' + ab + o_{ajbj} = -.32 + (-.18 \times .92) + .03 = .456$ . Given these results, we can calculate that 56% of the average relationship between rumination and exercise can be explained by motivation (see Table 19 and Figure 10).

*Self Control.* Intention as a moderator was not significant for any within person path, so a plain mediation model was run for each health behavior outcome. At the within level, while rumination was related to self control, self control was only significantly related to one health behavior in one model, vegetable intake. Self control was therefore a partial mediator of rumination to vegetable intake, in an indirect effects relationship. Rumination was related to self control ( $\beta = -.582$ ,  $p = .012$ ), self control was related to vegetable intake, ( $\beta = .082$ ,  $p = .036$ ), and rumination was related directly to vegetable intake as well ( $\beta = -.127$ ,  $p = .024$ ). Each unit of rumination increase (0-4) decreases vegetable intake by .74 vegetables.

*Health Behaviors as Coping.* Using health behaviors as coping is a significant mediator between rumination and all health behaviors besides sexual risk taking, where there is a significant path from rumination to using health behaviors as coping ( $\beta = -.019$ ,  $p = .046$ ), but not from health behaviors as coping to sexual risk taking ( $\beta = -.560$ ,  $p = .160$ ). Intention as a moderator was significant in the rumination to health behaviors as the coping path for the exercise model and for health behaviors as coping to vegetable intake in that model, so these two were estimated as moderated mediation models (see Figure 12).

**Secondary analyses and results.** Regarding the question of subtypes of ruminators, secondary hypothesis number one, depressive people ruminate and then do not act (amotivation) and anxious people ruminate and then act impulsively, mediation models show a trending significance at  $p = .071$  for depression to rumination to motivation (see Table 22) and a trending mediation for trait



anxiety to rumination to impulsivity (see Table 24). Trait depression seems to fully moderate the relationship between rumination and motivation (see Table 23) while anxiety seems to partially moderate the relationship between rumination and impulsivity (see Table 25).

Specifically, the depression to rumination to amotivation between person model demonstrated statistically significant relationships between depressive symptoms to rumination ( $\beta = .057$ ,  $SE = .007$ ,  $z = 8.106$ ,  $p < .001$ ), a trend for rumination and motivation ( $\beta = -.133$ ,  $SE = .101$ ,  $z = -1.315$ ,  $p = .095$ ; see Table 28), and motivation and depressive symptoms ( $\beta = -.041$ ,  $SE = .012$ ,  $z = -1.315$ ,  $p < .001$ ).  $c = c' + ab + o_{ajbj} = .041 + (.057 * -.133) + .08 = .113$ . Given these results, we can calculate that 29% of the average relationship between depression and motivation can be explained by rumination (see Table 22 and Figure 13). In moderation analyses, depressive symptoms completely moderated the relationship between rumination and amotivation (motivation on depression\*rumination  $\beta = .043$ ,  $p = .024$ ; motivation on rumination  $\beta = -.042$ ,  $p = .697$ ; see Table 23).

The anxiety to rumination to impulsivity Level 2 mediation model is marginally significant, with anxiety being related to rumination ( $\beta = .060$ ,  $SE = .008$ ,  $z = 7.206$ ,  $p < .001$ ), rumination being related to impulsivity ( $\beta = .134$ ,  $SE = .070$ ,  $z = 1.927$ ,  $p = .051$ ), and anxiety trending significance to being related to impulsivity ( $\beta = .014$ ,  $SE = .011$ ,  $z = 1.752$ ,  $p = .080$ ).  $c = c' + ab + o_{ajbj} = .014 + (.060 * .134) + .09 = .112$ . Given these results, we can calculate that 17% of the average relationship between rumination and exercise can be explained by impulsivity (see Table 24 and Figure 14). Anxiety\*Rumination was also a significant interaction term, strengthening the positive correlation between anxiety and impulsivity ( $\beta = .524$ ,  $p < .001$ ; see Table 25).

**Post-hoc analyses and results.** Further exploration of the rumination to depression and rumination to mindfulness relationships is below.

*Rumination and depression.* Rumination appears to impact health behaviors above and beyond depression. Specifically, depression does not generally appear to be a significant within-person moderator of the rumination to health behavior relationship, except for sexual risk taking, ( $\beta = .325, p = .024$ ; see Table 26). In moderated mediation relationships, for a rumination to depression to health behaviors model, there is a significant link between rumination and depression in the vegetable, exercise, sexual risk, and alcohol models, and a significant link from depression to alcohol intake. Intention as a moderator was not significant, so was removed from the model. Therefore, depression appears to be a significant mediator for alcohol use only ( $\beta = .028, p = .031$ ; see Tables 27-31).

*Rumination and mindfulness.* Because mindfulness was not shown to be a significant moderator, and because this is a key element in interventions used to decrease rumination, we wanted to explore the relationships among rumination, mindfulness, and health behaviors further with mediation analyses (see Tables 33-37). Mindfulness, surprisingly, does not mediate the relationship from rumination to health behaviors, except for decreasing alcohol intake. Similar to depression, there were significant paths from rumination to mindfulness, in this case of a converse relationship as expected, and only one path from mindfulness to any outcome, in this case alcohol use ( $\beta = -1.127, p = .041$ ). Therefore, mindfulness appears to mediate the rumination to alcohol relationship such that low mindfulness increases the rumination to alcohol relationship, or high mindfulness decreases the rumination to alcohol relationship.

## Discussion

Rumination is a common cognitive process, but is widely unstudied as a possible cognitive predictor of maladaptive health behavior patterns. Understanding the possible mediators and moderators of rumination will allow us to develop appropriate interventions for college students, which could broadly improve overall health later in life for a large group of the US population.

## **Descriptive Statistics**

Health behavior frequencies for exercising, fruit intake, vegetable intake, exercise, alcohol intake, and sexual risk taking in this study were similar to those that have been found in previous studies of university students' health behaviors (Raynor & Levine, 2009; Trockel, Barnes & Egget, 2000). Therefore, this sample may be similar to other university student samples in terms of the amount and type of health behaviors engaged in, and these findings may be reasonably generalizable to other college students in the United States.

With descriptive statistics, we also found support for the theory of planned behavior, and the intention behavior gap, as there were substantive gaps between intended and actual behavior for each health behavior (Sheeran, 2002). Noticeably, participants drank 1.03 more drinks than intended and had .06 more sexual risk taking incidents than intended when they did participate in these activities at all. Considering a binge of alcohol is currently defined as men consuming 5 or more drinks and women consuming 4 or more drinks in about a two hour period (CDC, 2014), and sexual risk taking has dangerous immediate risks such as STIs and unwanted pregnancies (CDC, 2008), these gaps by which participants are engaging in behavior that is not intended and not wanted may have significant health consequences.

While there are some statistically significant relationships among health behaviors, in both bivariate correlations and in multivariate modeling, these relationships are not large ( $r = .055$  to  $.314$ ), demonstrating the importance of measuring multiple health behaviors in current and future research. As discussed below, patterns emerge for mediators and moderators being significant for most outcomes, or few, or none. Measuring each of the health behaviors separately will be important in order to be able to see which interventions impact all versus few or none of the health behaviors, in order to choose the most efficacious interventions.

## Primary hypotheses

**Hypothesis one: Rumination will be related to health behaviors.** First, this study hypothesized that rumination will be related to health behaviors. This hypothesis was predominantly supported. Bivariate correlations show that both trait rumination and state (daily) rumination are significantly correlated to all health behaviors. Multilevel modeling shows that, when taking into account time on all levels, on the within person level, rumination was significantly related to fruit, vegetable, and alcohol intake, but surprisingly, not exercise or sexual risk taking. However, at the between person level, rumination was related to all health behaviors but exercise. Therefore, it appears that rumination is not related to sexual risk taking on a daily level within person, but overall, between person, there is a significant positive relationship.

The frequencies of sexual risk taking on a daily level are low, so it is possible that no change is detectable on the daily level due to a floor effect. Perhaps additional reported sexual risk taking, sampling over a longer period of time, or with an EMA method whereby a person reports only when a sexual risk taking incident occurs, would yield more incidents of sexual risk taking to model statistically. Or, perhaps rumination is not related to sexual risk taking on the daily level, within person at all, and is more appropriately measured at the between level.

Rumination is not significantly related to exercise on the within or between level in this study. However, the significance level is  $p = .112$ , and there is a somewhat strong negative effect ( $\beta = -.339$ ), so perhaps impulsivity, motivation, and using health behaviors as coping, all significant mediators, are completely mediating the relationship between rumination and health behaviors. Further exploration is warranted.

**Hypothesis two: Moderation.** Second, the hypothesis that moderators will increase or decrease the relationship between rumination and health behaviors including intention (increase), perceived behavioral control (decrease), neuroticism (increase), emotional intelligence (decrease),

and mindfulness (decrease; See Figure 2) was somewhat supported. Namely, intention strengthened the rumination to health behavior relationships for all health behaviors, and perceived behavioral control and neuroticism did moderate significantly in the direction expected, but for alcohol only. Mindfulness and emotional intelligence were not significant moderators. Again, intention and mindfulness were primary moderators of interest.

*Intention.* At the within person level, intention was a significant moderator of all rumination to health behavior relationships, as predicted. In fact, intention appears to be a complete moderator of the fruit, vegetable, and exercise to rumination relationships, because it eliminates the health behavior to rumination link when included in the model. More intention as a moderator strengthened the negative relationship between rumination and adaptive health behaviors and the positive relationship between rumination and maladaptive health behaviors. Interestingly, including intention as a moderator of the rumination to exercise relationship changed the sign of the relationship between rumination and exercise from negative to positive. In other words, when a person intends to exercise, rumination will more likely lead to actual exercise. This speaks to the potentially adaptive qualities of rumination, even brooding rumination (Park, 2010).

For most models, intention also independently predicted the health behaviors, in addition to being a moderator, meaning it is likely an important piece of the rumination to health behavior model, and should be included in more health behavior studies in the future. However, intention appeared to moderate only few mediation paths. Therefore, converse to our prediction, it may not be important to measure intention as a moderator for mediation paths in the future.

*Mindfulness.* We hypothesized that mindfulness would provide an important buffer for the maladaptive rumination to health behavior relationship within person, providing us with a potential potent intervention target for decreasing this link. However, this hypothesis was not supported, but, there were some significant moderation effects at the between person level. Mindfulness decreased

the maladaptive relationship between rumination and fruit intake, vegetable intake, and sexual risk taking between person, but not for exercise or alcohol intake. Perhaps mindfulness matters for the general relationships between rumination and health behavior patterns between individuals, but not for the within person within day links between rumination and health behaviors. Alternately, perhaps we did not see relationships of this trait mindfulness variable affecting variables on the daily level because trait mindfulness matters less than state mindfulness for daily processes. There is some research to suggest substantive fluctuations in state mindfulness day to day and moment to moment (McManus, 2013; Snippe et al., 2015). In one study of college undergraduates, daily motivation scores revealed both within and between person variability (McManus, 2013). Additionally, there were significant associations between daily mindfulness and daily health and emotional wellbeing (McManus, 2013). It is possible that if we measured mindfulness on a daily level, we would be able to see a more clear buffering of the within person daily processes of these variables. More studies should explore daily mindfulness and its relationship to daily rumination and daily health behaviors.

Another explanation for the null finding is the possible limitations of current mindfulness measures (Chiesa, 2013; Park, Reilly-Spong, & Gross, 2013), the way we define mindfulness in Western culture (Chiesa, 2013; Purser & Milillo, 2014), and/or the poor definition of and limits to the mindfulness construct itself (Chiesa, 2013; Schooler et al., 2014), all of which have begun to be explored in the past few years.

Alternately, perhaps a specific component of mindfulness is potent in combatting rumination. Specifically, Ayduk and Kross (2010) suggested that self-distancing most potently combats rumination. The mindfulness construct itself may not be enough to adequately combat rumination on its own, unless it includes or heavily emphasizes self-distancing. It will be important to compare the components of a mindfulness intervention that may contain self-distancing components to a spontaneous self-distancing intervention such as the one used in Ayduk and Kross, to see what best

facilitates the decrease of the most maladaptive aspects of rumination (2010). Comparisons of cognitive approaches to mindfulness interventions are warranted too, as cognitive interventions have been shown to decrease maladaptive rumination as well (Watkins, Scott, Wingrove, & Rimes, 2007).

*Perceived behavioral control.* Within person, perceived behavioral control moderated the rumination to alcohol relationship in the direction expected (decreases; changes direction). It appears that, within person, increased perceived behavioral control is able to limit the negative impacts of rumination on excessive drinking. This is an obviously important finding for college campuses (CDC, 2014). Glanz and Bishop (2010) suggest focusing on coping strategies and behavior change that increase perceived behavioral control on college campuses.

However, on average, between person, perceived behavioral control appears to increase the maladaptive relationship between increased rumination and decreased fruit intake. This again speaks to the potential limitations of a mostly adaptive variable; perceived behavioral control may backfire if a person believes they have so much control that they do not need to prepare for any potentially difficult situations or barriers to health behavior engagement or lack thereof, an important consideration in health behavior change (Bellg et al., 2004; Stretcher, 1986).

*Neuroticism.* Neuroticism was also only a significant moderator of the rumination to alcohol relationship at the within level. This strong relationship is unsurprising, as this personality trait has been linked to higher alcohol intake and alcoholism in much literature previously (e.g., Sandahl, Lindberg, & Bergman, 1987; Liu, Wang, Zhan, & Shi, 2009). This finding not only supports previous literature; it supports previous recommendations for intervention for college students, such that individual personality traits, such as sensation seeking and neuroticism, provide information about at-risk populations in need of intervention (Ham & Hope, 2003). Ham and Hope (2003) showed in their literature review that expectancies and drinking motives serve as explanations of the neuroticism to drinking behavior relationship and are cognitive and emotional patterns ripe for

intervention in people with neurotic personality tendencies. Perhaps programs aimed at decreasing alcohol intake could focus on this at risk population (people who tend to have neurotic personality traits) with cognitive and emotion regulation interventions.

*Emotional intelligence.* Emotional intelligence was not a significant moderator of the rumination to health behavior relationship. While emotional intelligence refers to knowing one's own emotional patterns, perhaps it does not translate specifically to knowing one's own cognitive patterns. Rumination has been shown to include a strong cognitive component (Nolen-Hoeksema, 2008). Perhaps emotional intelligence does not buffer rumination's harmful effects because it cannot combat rumination's cognitive component (Cote, 2006).

These null findings are also supported by previous literature linking emotional intelligence more closely to mental and emotional health outcomes than to physical health outcomes, especially health behaviors. Specifically, Fernandez-Abascal and Martin-Diaz (2015) showed that emotional intelligence components predicted a lower percentage of health related behaviors than they did health components, and less health in general than mental health outcomes, especially among young people. Older people (aged 60 and older) tended to have a stronger relationship between emotional intelligence and preventative health behaviors. The authors surmised that the increased variability in engaging in preventative health behaviors in older adults explained some of the increase in the strength of this relationship. Perhaps emotional intelligence is not a significant moderator of these relationships in college students, but might be in older individuals, because the emotional intelligence construct or measure is understood differently with age or maturity, or perhaps emotional intelligence develops more at an older age or is more potent at an older age. More research about this construct's developmental trajectory is warranted.

**Hypothesis three: Moderated mediation and mediation.** The third hypothesis, that rumination will be associated with more maladaptive and less adaptive health behaviors through four



pathways (mediators): impulsivity, low motivation, low self control, and using health behaviors as coping, was generally supported. Again, primary mediators of interest are impulsivity and motivation. Impulsivity was a mediator for three of the five health behaviors, while motivation was a mediator for only one health behavior. Details are discussed below.

*Impulsivity.* Impulsivity was a significant mediator of the rumination to exercise, alcohol, and sexual risk taking relationships, but not for the rumination to fruit or vegetable intake relationships. It makes sense that impulsivity impacts engaging in maladaptive health behaviors more so than not engaging in adaptive health behaviors, because impulsivity, as a construct, generally manifests in doing something one should not do without thinking. It also makes sense that impulsivity links rumination and lack of exercise, as impulsivity could easily cause one to engage in behaviors that would end in a person not exercising, and exercise has been previously related to impulsivity (Cho, 2014). However, impulsivity may not impact not eating fruits and vegetables; previous research has shown that eating unhealthy foods is not necessarily related to not eating fruit and vegetables; they are not mutually exclusive (Freeland-Graves & Nitzke, 2014).

While many college students consume alcohol without consequence, there are still many negative effects of excessive alcohol intake that necessitate increased intervention on college campuses. According to the Centers of Disease and Control, 1,825 college students between the ages of 18 and 24 die each year from alcohol, not to mention the assault, sexual assault, injury, academic problems, and health and mental issues associated with bingeing and excessive alcohol intake (2015). The strong relationship between alcohol use and impulsivity has been widely documented (Dick et al., 2010). However, researchers have noted that the etiological nature of this relationship remains unclear (Dick et al., 2010; Stautz & Cooper, 2013). The current study, which demonstrates a cognitive process (rumination) as an antecedent to this impulsivity to alcohol relationship, provides

insight into one of the processes responsible for this connection, and suggests an additional area for interventions to target for decreasing excessive alcohol intake: decreasing rumination.

A broad literature already links impulsivity to sexual risk taking (see Hoyle, Fejfar, & Miller, 2000, for a review), a construct also strongly associated with alcohol intake (CDC, 2015). Hoyle, Fejfar, and Miller (2000) called for increased study of factors associated with the impulsivity to sexual risk taking relationship, and this study contributes a possible additional construct.

While rumination, to our knowledge, has never been studied with regards to sexual risk taking behavior, it extends the current literature linking “hot thoughts,” or a lack of awareness due to exciting, stimulating positive thoughts, a possible proxy of rumination, to sexual risk taking (Vanable, 2004). Rumination could be an important unstudied precursor to sexual risk taking, or one of the primary paths between depression and sexual risk taking (Wilson, Asbridge, Kisely, & Langille, 2010).

*Motivation.* Surprisingly, daily motivation was only a mediator for the rumination to exercise relationship. This may be because the daily measure used, four items from the GMS-28, seems to measure a general thought that healthy behaviors do not matter, or some negative affect, general pessimism, or even depression, rather than feeling unmotivated to act because of ruminative thoughts. Items include “Today I struggled to engage in healthy behaviors because: 1. I do not see the benefit in what I am doing, 2. It does not make a difference whether I do them or not, 3. Even though I do not have a good reason for doing them, and 4. I believe they are not worth the trouble,” measured on a seven point Likert scale (1-7). The mean responses to these items were low, ranging from 1.3 (SD = .24) to 1.7 (SD = .42). This may have meant that there were floor effects; there was not enough variance and endorsement of these items to detect significant relationships. These items did not appear to tap the construct we intended to measure; in the future, researchers should ask

about lack of motivation around health behaviors specifically in response to rumination, using a different scale.

That motivation related to exercise is not surprising; a mountain of previous literature has shown a robust relationship between motivation and exercise (Hagger & Chatzisarantis, 2007; Roberts, 1992; Wilson et al., 2003). Exercise may require more motivation than other health behaviors studied because there are a number of specific barriers that one is often required to overcome for exercise, as opposed to fruit intake, vegetable intake, alcohol intake, and sexual risk taking, comparatively. For example, people may not have access to an area to exercise, not live in a safe neighborhood, have health problems, be too busy (working multiple jobs and caring for children) or feel as though they don't know where to start, or be unable to afford access to an exercise area or the necessary equipment for some sports or physical activity (Downes, 2006). Because people also endorse difficulties overcoming barriers to eating well (Downes, 2006), although not as much as to exercise, and thus require motivation, it is surprising that relationships between motivation and eating were not also significantly related.

We theorize that not acting at all in response to rumination, because one feels too preoccupied by the rumination to act on anything else, is an important construct. The construct of motivation may not be the best proxy for what that inability to act. It is possible that in the future researchers may have to develop a measure to this effect, which may be important for better examining relationships between cognitive constructs and health behaviors.

*Self control.* Self control was a mediator for vegetable intake only, in an indirect effects relationship at the within person level; it was unanticipated that self control would not relate to other health behaviors, especially exercise, as motivation and exercise are highly correlated and self control and motivation are related constructs (e.g., Muraven & Slessareva, 2003). For example, in one study of college students, depletion, having used self control in other situations recently,

combined with a lack of motivation, predicted self control failures (Muraven & Slessareva, 2003). More studies should examine this combined effect of self control and motivation.

It is surprising that self control did not mediate the rumination to fruit relationship even though it mediated the rumination to vegetable relationship. One potential explanation for this differential relationship is the greater variance in vegetable intake, and thus the increased ability to detect relationships with more variability in responses.

*Health behaviors as coping.* Daily use of health behaviors as coping mediated the rumination to health behaviors link at the within level, besides the rumination to sexual risk taking relationship. Using health behaviors as coping involved responding to “how did you cope with the rumination you experienced today (above)?” with items like “I ate a lot of snacks.” This measure is unique because it is the only one to our knowledge that measures the widely acknowledged use of maladaptive health behaviors in order to cope with negative affect or stress, and should be used in health behavior research more often. However, examining the content of this measure provides an explanation for its mediating effects of fruit, vegetable, exercise, and alcohol, but not for sexual risk taking: it covers diet, exercise, and alcohol intake, but not sexual risk taking behavior. This measure could and should be adapted to include sexual risk taking items.

These findings also demonstrate that, while alcohol intake and sexual risk taking tend to be highly correlated, they do have some differential predictors.

Clearly, developing interventions that focus on teaching new coping strategies in order to cope with rumination, as well as practice implementing these strategies in lieu of engaging in maladaptive health behaviors, will be important, due to the strong mediation effect observed here.

### **Secondary hypotheses**

Secondary hypotheses tested were primarily supported. Our secondary hypothesis was that there are predictors of ruminators who act impulsively and ruminators who don't act at all (low

motivation); specifically, our hypothesis that there are subtypes of ruminators, trait anxious people ruminate and then act impulsively and trait depressive people who ruminate and then don't act, was supported.

Mediation analyses showed that the relationship between rumination and motivation was mediated by depression, and the relationship between rumination and impulsivity was mediated by anxiety. Likewise, mediation analyses showed that it is possible that people who endorsed depression symptoms had decreased motivation through rumination, and it is possible that people who endorsed anxiety symptoms had increased impulsivity through rumination.

Moderation analyses showed that depression fully moderated the rumination to motivation relationship while anxiety partially mediated the rumination to impulsivity relationship. These models could possibly be interpreted as follows: rumination makes motivation decrease, especially when a person endorses depressive symptoms and rumination makes impulsivity increase, especially when a person endorses anxiety symptoms. These findings mean that those who suffer from depression or anxiety symptoms likely experience an increased link to rumination and maladaptive outcomes, and may be a population to target specifically for treatment and intervention to decrease rumination. Depression and anxiety symptoms are some of the most reported symptoms among college students seeking help in college counseling centers.

These findings are also very important for characterizing the construct of rumination, developing appropriate interventions, and also characterizing the similarities and differences between depression and anxiety.

*Defining rumination.* The construct of rumination has not been well-defined or extensively studied and is in need of further conceptualization (Smith & Alloy, 2009). Of particular interest to this study is the confusion in the literature whereby rumination is generally considered in relation to depression, but several studies have demonstrated a lack of specificity to depression, and show

particular overlap with symptoms of anxiety (Smith & Alloy, 2009). The authors of this review called for further specificity regarding how rumination may differentially impact mental health outcomes, in order to increase understanding of the construct of rumination, and to remind the research and clinical world that rumination, even depressive rumination, does not just impact the onset and duration of depression but rather contributes to and is a part of multiple outcomes.

*Defining depression and anxiety.* Additionally, creating specificity in the mediators through which rumination may differentially impact depression and anxiety may help the field of psychology further understand the overlap of and differences between depression symptoms and anxiety symptoms, and/or depression diagnoses and anxiety diagnoses. There is high comorbidity of anxiety and depression disorders (Fawcett, Cameron, & Schatzberg, 2009). Over 60% of clients who present with symptoms of GAD also qualify for a diagnosis of major depressive disorder (Brown, Campbell, Lehman, Grisham, & Mancill, 2001), and a mixed anxiety depressive disorder was proposed for inclusion in both the DSM-IV (Zinbarg et al., 1994) and the DSM-5 (APA, 2013).

Some researchers have suggested that rumination and worry are related constructs that are both part of a larger construct, such as repetitive thinking or avoidant coping; that rumination is past focused and worry is future focused, and that this past versus future focus in measures is what distinguishes depression and anxiety. However, the present research suggests that depressive rumination about the past is still significantly related to anxiety. The present research also offers another way to possibly distinguish between depression versus anxiety as an outcome of rumination not presented in previous literature: the tendency to be impulsive or unmotivated. This study also shows that rumination for those who are depressed and rumination for those who are anxious may manifest in different ways, and have different outcomes: those who have depressive symptoms and ruminate may experience increased amotivation or avolition, and those who have anxiety symptoms and ruminate may experience increased impulsivity. Further study is needed.

*Developing interventions based on secondary hypothesis one.* These findings are important for developing effective interventions, such that people who are depressed and ruminative may be experiencing amotivation and require a treatment such as behavioral activation (Martell, Addis, & Jacobson, 2001), whereas those who are anxious and ruminative may require intervention for impulsivity, such as relaxation training (Borkovec et al., 1987; Manzoni et al., 2008).

### **Post-hoc hypotheses**

**Depressive symptoms as moderator and mediator.** Rumination appears to affect health behaviors above and beyond depression, emphasizing the importance of studying rumination as its own construct, separate and apart from depression.

Within person, depressive symptoms were a significant moderator for rumination to sexual risk taking only, partially explaining how rumination affects sexual risk taking, and depressive symptoms were a significant mediator for the rumination to alcohol intake relationship only, increasing the rumination to alcohol intake relationship. This research also further contributes to how we understand how depressive symptoms impact health outcomes, adding further specificity to current literature (Whooley et al., 2008; Allgower et al., 2001).

**Mindfulness as mediator.** While trait mindfulness does not appear to moderate or buffer rumination to health behavior relationships, it does mediate one rumination to health behavior relationship, for alcohol intake. It seems as though cultivating mindfulness may be a particularly good intervention for decreasing alcohol intake in college students, which again, is needed (CDC, 2015). It is surprising that mindfulness is not buffering the rumination to health behavior maladaptive link in any way, again considering much research to the contrary (Black et al., 2012).

### **Limitations**

No study is without limitations. For example, the sample for this study may limit the application of this research. The participant pool sample may be demographically representative of

the University of Connecticut participant pool population, but may not be generalizable to the broader college student or young adult population.

Methodologically, while using multilevel modeling to estimate effects between variables suggests causality, it is still primarily correlational (Pearl, 2012). However, it is as close as one can get to analyzing outright causal links in ongoing naturalistic relationships (Shpitser & Pearl, 2006). There are strengths to assessing within-individual processes, which can help examine immediate relationships instead of more abstract accounts of overall experiences. This type of analysis helps reduce biases and error that may occur at the interindividual level. Despite these advances, causal directionality still cannot be truly determined for a variety of reasons. All mediation constructs were measured at each survey opportunity, complicating the support for causal inference. For instance, the lack of temporal separation of constructs especially for assessing the within-level mediation is necessary to help determine directionality. In other words, mediational and direct effect paths reflect concurrently assessed variables only, which might result in method effects and subsequently inflate the relationship (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003).

Further insights might be gained by examining more lagged effects between predictor and outcome variables. Further, Bolger and Laurenceau (2013) as well as Imai, Keele and Tingley (2010) discuss that one reason (among others) it is problematic for linear MSEM models to establish causal mediation is the difficulty in extending linear frameworks to nonlinear models. Examining nonlinear models is crucial because reciprocal, dynamic effects might occur among many stressor-strain models. Future research should temporally separate the assessment of measures of predictor and criterion variables.

Additionally, as noted, we did not measure mindfulness on a daily basis, which will be important if we want to measure its possible salutary effects on rumination, as indicated in previous literature, and rumination's effect on daily behaviors.



Also, we included items on the health behaviors as coping scale for cigarette smoking, yet did not include this variable in analyses because of the very low number of incidents of smoking reported (See Appendix A). If we had removed the smoking items within the health behaviors as coping scale, the scale would likely demonstrate better internal consistency, and this construct would likely more strongly mediate the rumination to health behaviors relationships.

Finally, measuring health behaviors at the day's end, relying on recall and accurate reporting throughout the day, can be somewhat problematic. While asking about health behaviors for the previous 24 hours at day's end is preferable a longer recall, as is common in many other types of studies, data still shows that people tend to not estimate their day's activities and intake well, due to individual bias, poor estimation or poor memory of the day's events (e.g., Illner et al., 2012). For example, measuring daily food intake at the end of one's day has been shown to yield only low to moderate valid estimates of individual dietary intakes (Illner et al., 2012). Even technology provided to decrease recall issues, to measure food intake when it occurs, is still prone to bias. More research to determine how to collect the most accurate data is needed (Illner et al., 2012). Technology that measures behaviors objectively, such as bracelets that measure movement and calorie intake as well as wearable cameras that measure all activities, will be useful in obtaining the most valid data (Doherty et al., 2013).

### **Future Research**

Based on these results, we suggest a number of specific recommendations for future work in this area, with a focus on methodology, measures, additional third variables to include, additional moderation analyses, and, most importantly, interventions.

**Methodology.** As mentioned previously, measuring more variables of interest on the daily level, and adding more sampling instances, would increase the ability to determine temporal cause of variables, as well as further explicate the relationships between these variables.

**Measures.**

*Intention in health behavior studies.* It also seems as though intention may be an important predictor of health behavior outcomes, as not only was impulsivity a significant mediator of the rumination to health behavior relationship, but it was a consistent independent predictor of health behaviors. Intention is included in many studies of health behavior (e.g., Murphy et al., 2014), but is not included in all by any means (Gallagher & Updegraff, 2012). Intention should be included in studies of health behaviors in the future.

*Measure multiple health behaviors.* Much research today is specific to each type of health behavior outcome. While it is important to dive into specifics of relationships, noticing patterns of cognitive, emotional, and behavioral antecedents to health behavior engagement and avoidance across health behaviors can provide important information for developing the most efficacious interventions at the population level, getting the most output for one's intervention input.

*Measure for inability to act.* As mentioned previously, it would be helpful to create a measure for the inability to act following "getting stuck in one's head," and being preoccupied by that. No such measure currently exists.

**Additional constructs.** Also as discussed throughout this paper, there are other constructs that may be important to study in the context of rumination and health behaviors in the future. Namely, because mindfulness measures were not shown to be a significant moderator or mediator of the rumination to health behavior relationships on the whole, it may be important to identify the potent and efficacious components of mindfulness that may not be captured with these measures, or that may need to be measured separately, if they are important constructs in decreasing the effects of rumination on maladaptive health. Self distancing and self compassion are two constructs previously discussed in this manuscript that will be important to include in future studies.

**Possible predictors of the rumination to mediator relationships.** Because impulsivity, low motivation, low self control, and coping mediate the relationship between rumination and health behaviors, future research should examine what causes rumination to lead to each of these mechanisms. Intention, perceived behavioral control, mindfulness, and personality variables such as neuroticism and emotional intelligence may determine who may be most at risk for rumination's deleterious effect on health behaviors.

**Interventions.** A primary focus of this research is to inform interventions to decrease maladaptive health behaviors and increase adaptive health behaviors in college students, as a primary prevention technique for decreasing chronic illness in the United States.

*Current health behavior interventions in colleges.* Currently, college campuses tend to implement wide reaching interventions for health in a few ways: through mandatory courses for freshmen students, through programs run by health services and wellness centers, and through offered programs and psychotherapy in college counseling centers (Mann et al., 1997). However, very few studies have examined these programs, fewer have described methods for implementation within the university and assessing university-wide outcomes, and fewer still have described how to implement these interventions in other college settings, or have made an attempt to design college-wide interventions to be widely disseminated throughout colleges in the United States. Designing far reaching health behavior interventions with implementation in mind, and conducting translational research, is desperately needed. Organizations such as the American College Health Association and the National College Health Association, which partnered to create recommendations and standards for campus health promotion and disease prevention, are a good start, and more research is warranted.

Increasingly, electronic interventions are being developed and used, offering promise for health behavior interventions on college campuses, as college students use technology during most

waking hours. A recent meta-analysis showed that, compared with controls, participants who received a computer-delivered intervention improved several hypothesized antecedents of health behavior (knowledge, attitudes, intentions); intervention recipients also improved health behaviors (nutrition, tobacco use, substance use, safer sexual behavior, binge/purge behaviors) and general health maintenance (Portnoy, Scott-Sheldon, Johnson, & Carey, 2008). Computer-delivered interventions have been shown to lead to improved behavioral health outcomes at first post-intervention assessment, but need to be studied further, especially in terms of implementation and translational science, and computer-based interventions for rumination aimed at decreasing health behaviors should be tested.

Mann and colleagues (1997) warned against programs that may normalize problematic health behaviors; they provided an eating disorder prevention program during which classmates who had recovered from eating disorders described their experiences and provided information about eating disorders. At follow up, intervention participants had more symptoms of eating disorders than did controls, perhaps because, the authors guessed, by reducing the stigma of these disorders, intended to encourage students with problems to seek help, the program may have inadvertently normalized them. More research should be conducted in this area to determine the cause of the increase in maladaptive health behaviors, because there could be many other reasons for the apparent increase in symptoms. For example, if students are just more comfortable with reporting their symptoms on measures because stigma is reduced, response bias could have decreased, thus causing symptomology to appear to increase. If Mann and colleagues' assumptions are correct, that decreasing stigma normalized maladaptive health behaviors, we should closely examine mindfulness interventions to ensure they are not decreasing self judgment to the point of providing a normalizing of the behavior or an excuse for the behavior.

*Rumination interventions: Mindfulness.* As mentioned previously, mindfulness interventions have been shown to decrease rumination, so it will be important to test whether mindfulness interventions are doing something that current mindfulness measures do not measure, or whether the link between rumination and health behaviors is not appropriate for a mindfulness intervention. For example, the link between rumination and health outcomes could be more behavioral, making behavioral interventions more appropriate, or more cognitive, making cognitive interventions more appropriate.

In a study of college students comparing brief training in mindfulness meditation to brief somatic relaxation training and a wait list control group, however, mindfulness training decreased rumination more than did the relaxation training and control groups, suggesting there is something particularly potent about mindfulness meditation training above and beyond relaxation skills for decreasing rumination (Jain et al., 2007). Here, the mindfulness intervention was a shortened 4 week version of the 8 week MBSR course (Kabat-Zinn, 1987). The authors suggested that cultivating moment-to-moment awareness may decrease one's focus on negative things in the past. The authors also emphasized the inclusion of loving-kindness meditation, which cultivates self compassion. It is possible self-compassion may help one decrease negative thoughts about oneself, as well as getting stuck in those negative thoughts, the 'over and over' component. Self compassion should be included as a variable of interest in future intervention studies.

Additionally there are interventions for which mindfulness is a component that should be tested as a possible intervention for the rumination to health behavior relationship, such as yoga (Shelov & Suchday, 2009), especially as yoga is increasing in popularity amongst college students (Gaskins et al., 2014; Park, Braun & Siegel, 2015).

*Rumination interventions: Other interventions.* Other interventions have been shown to decrease rumination that could decrease rumination's impact on health behaviors, or could interrupt the rumination to health behavior link.

Behavioral activation and cognitive behavioral therapy has been shown to decrease rumination (Watkins et al., 2007), with wide support and evidence for strong and various adaptive outcomes (Butler, Chapman, Forman & Beck, 2006), making them good candidates for widespread intervention on college campuses. These interventions should be tested against mindfulness interventions for decreasing the rumination to health behavior link.

Interestingly, Watkins and colleagues (2011) have recently developed an intervention called rumination-focused cognitive-behavioral therapy, a manualized treatment showing promise for decreasing rumination. The treatment consists of up to 12 individual sessions scheduled weekly, and is designed to coach individuals to shift from unconstructive rumination to constructive rumination, through the use of functional analyses, experiential/imagery exercises, and behavioral experiments. These adaptations mean that rumination-focused CBT differs from standard CBT for depression, which focuses on modifying the content of individual thoughts, by having a greater emphasis on directly modifying the process of thinking. For example, rumination-focused CBT incorporates the functional-analytic and contextual principles and techniques of behavioral activation, but explicitly and exclusively focuses on rumination (for further details, see Watkins et al., 2011). Within behavioral activation and rumination-focused CBT, rumination is conceptualized as a form of avoidance, and functional analysis is used to facilitate more helpful approach behaviors. Rumination-focused CBT also uses functional analysis to help individuals realize that their rumination about negative self-experience can be helpful or unhelpful and to coach them in how to shift to a more helpful style of thinking. In addition, patients use directed imagery to recreate previous mental states when a more helpful thinking style was active, such as memories of being completely absorbed in an

activity (for example ‘flow’ or ‘peak’ experiences), which directly counter to rumination. This protocol should be researched in--and could be implemented in--college counseling centers in particular.

*Interventions based on significant moderation and mediation relationships.* As noted previously, interventions that target significant mediation paths and populations with significant moderation variables will be important to study in college students. Also noted previously, those significant mediators and moderators that impact most types of health behaviors will be the most important to study in order to develop the most efficacious interventions, especially if one is focusing on population based interventions, which aim to treat the most number of people with a primary, broad based intervention.

The mediators that seem to have a significant salutary effect on the greatest number of health behaviors are impulsivity and using health behaviors as coping. Impulsivity can be decreased with cognitive behavioral therapy, specifically focusing cognitively on noticing impulsive urges and behaviorally delaying response, as well as cognitive emotion regulation skills, and behaviorally setting up environments and states in which impulsivity happens less (Donohew et al., 2000). Using health behaviors as coping could be decreased through interventions focusing on teaching coping skills, a typical component of any cognitive-based intervention, and certainly a large component of a cognitive behavioral stress management intervention (Antoni, Schneiderman, & Ironson, 2011).

The moderator that seems to have a significant salutary effect on the greatest number of health behaviors is intention. Previous research has shown that increasing knowledge about the negative consequences of health behavior increases intention to engage in healthy behavior, so increased inclusion of this information in lesson plans and around campus may be important (Fishbein & Yzer, 2003). Additionally, helping students plan out their schedules helps them to

prioritize important behaviors, and may increase intention to be healthy (Hagger & Luszczynska, 2014).

If the primary aim of a college intervention is to decrease alcohol intake, as it is particularly problematic on college campuses and closely related to other maladaptive health behavior patterns (CDC, 2015), targeting a sub-population of college students who are neurotic may be important. Again, one could do this in the context of a personality battery within a college student counseling center, providing access to intervention groups for decreasing alcohol intake for those who score particularly high on the neuroticism trait variable, and/or for whom excessive alcohol intake or bingeing is problematic.

*Overall recommendations for interventions on college campuses.* Overall, much more testing of appropriate interventions to both decrease the rumination to health behavior link, as well as decrease maladaptive health behavior patterns in general, on college campuses, is needed. Specifically, we should test mindfulness interventions against cognitive behavioral interventions, and rumination-focused cognitive behavioral therapy, with an eye on implementation, asking which interventions could be best implemented where, and developing a system for implementing them. More administrative organization around health behavior change intervention work within the main framework of a college campus is also warranted.

### **Concluding Remarks**

Rumination, an understudied construct, has clear relationships to health behavior engagement, and the moderators and mediators of this relationship studied here present unique new combinations of predictors of health behavior engagement and avoidance. More studies should be conducted to further explicate these relationships and to develop appropriate interventions aimed at decreasing rumination in college students, or decreasing rumination's effect on health behaviors, in order to decrease maladaptive health behavior patterns and chronic illness in the United States.



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**Table 1: Studies of rumination and health behaviors**

Study	Health Behavior Outcome	Findings	Proposed Mechanisms
Nolen-Hoeksema et al., 2007	Bulimia, substance abuse	Rumination predicted future increases in bulimic and substance abuse symptoms	Cognitive vulnerability
Rawal et al., 2010	Eating disorder behavior	Eating disorders were related to ruminative brooding but not reflection	Avoidance of negative affect
Richmond et al., 2001	Cigarette smoking	Rumination increases smoking and moderates the relationship between smoking and depression	None
Dvorak, Simons, & Wray, 2011	Smoking quit attempts	Impulsivity moderates the association between depressive rumination and number of failures by smokers	Affect regulation; impulsivity strengthens effects of depressive rumination, decreasing likelihood of successfully quitting
Thomsen et al., 2004	Healthcare utilization	Elderly, not young, participants, had a positive correlation between rumination and healthcare utilization (phone calls to doctors).	None
Zawadzki, Graham, & Gerin, 2013	Sleep	Rumination is associated with sleep (and fully mediated the loneliness-sleep relationship)	None
Nolen-Hoeksema & Harrell, 2002	Alcohol and drug use	Rumination was related with more alcohol and drug use, especially in women	Individuals who ruminate may consume alcohol to escape distressing repetitive thoughts
Caselli et al., 2010	Alcohol use	Rumination was related with more alcohol use in alcohol abusers	Negative affect or depression and lack of control
Ciesla et al., 2011	Alcohol use	Rumination was significantly related to more alcohol use	Avoid repetitive, unwanted, ruminative thoughts
Caselli et al., 2008	Alcohol abuse	Rumination was an independent predictor of classification as “problem drinker”	Coping with distress
Hochli et al., 2001	Sexual risk behavior	Rumination significantly predicted sexual risk behavior in sexual contact with casual partners	None

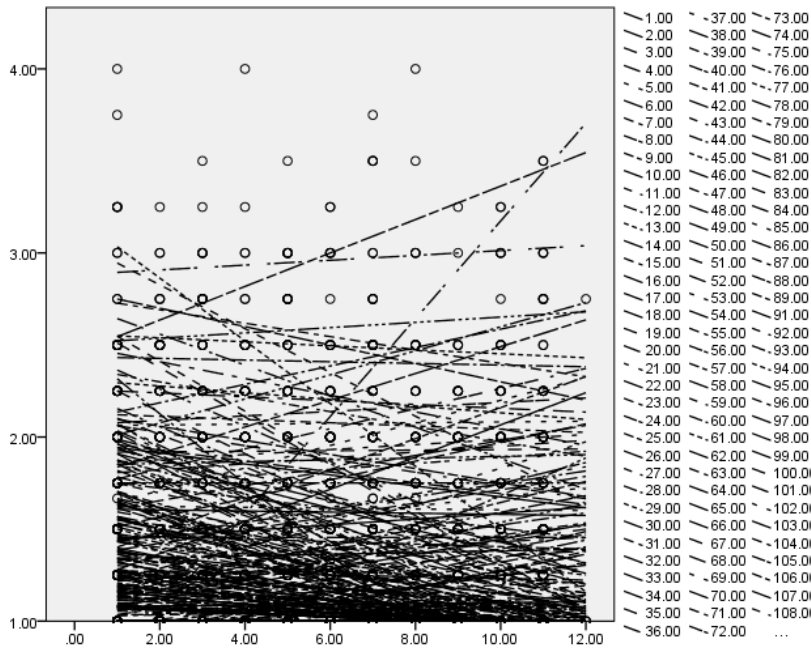


**Table 2: Studies of rumination and other behaviors**

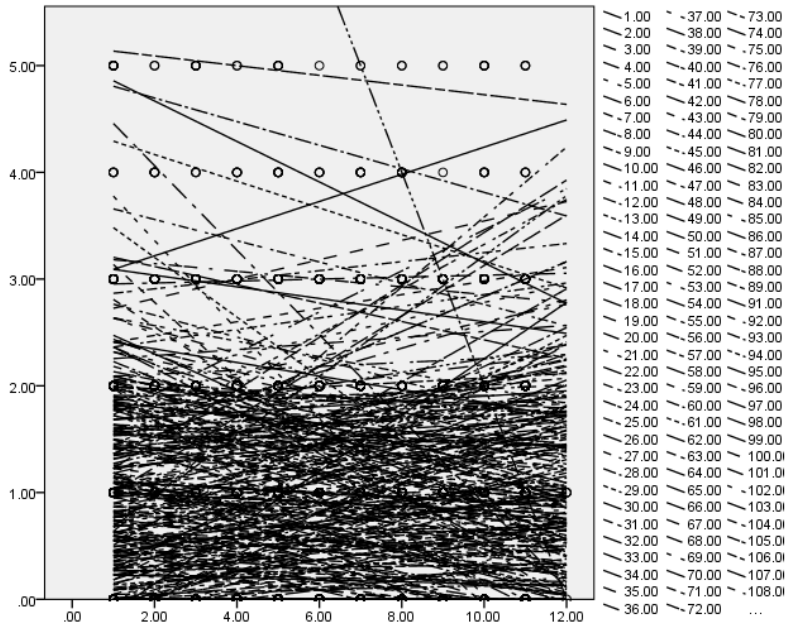
Study	Health Behavior Outcome	Conclusion	Proposed Mechanisms
Bushman, 2002	Aggression behavior	Those in a rumination group exhibited more aggressive behaviors than others	None
Collins & Bell, 1997	Aggression behavior	High-ruminators displayed higher levels of aggression	Personality type
Denson, 2011	Aggression behavior	Rumination increased aggression	Reduced self control capacity was a mediator
Davis, 2001	Pathological Internet use	Rumination is significantly related to pathological internet use	Maladaptive cognitions
Borrill et al., 2009	Self-harm	Self-harm is significantly correlated with rumination	Lack of mindfulness
Mikolajczak et al., 2009	Self-harm	Self-harm is significantly correlated with rumination in an adolescent sample	Less emotionally intelligent people use maladaptive coping strategies (avoidance, rumination)

Figure 4. Spaghetti plots

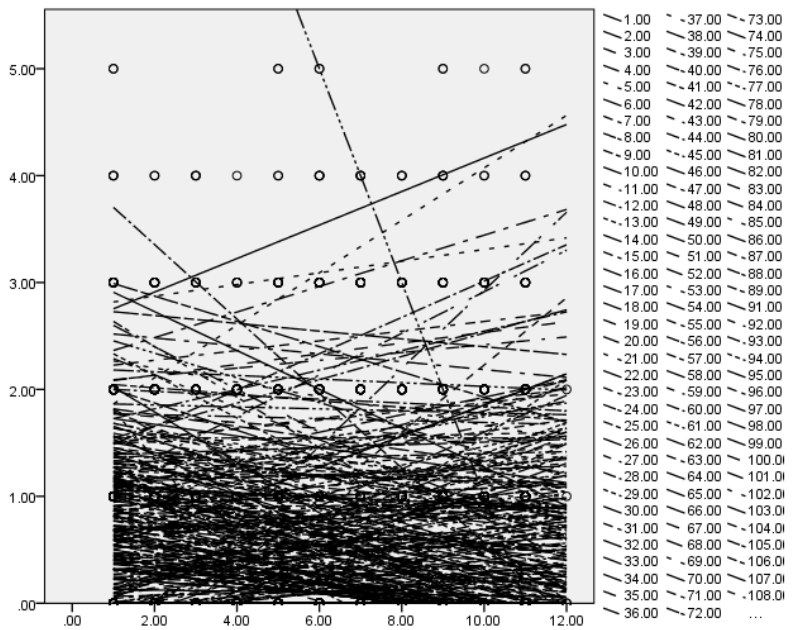
Daily rumination



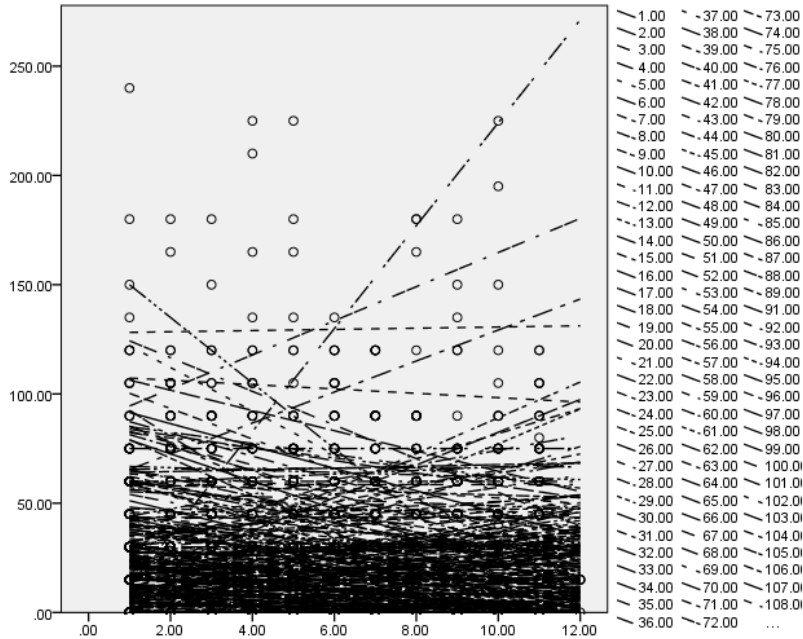
Daily fruit Intake



Daily vegetable intake



Daily exercise



The figure is a scatter plot with the X-axis representing the number of employees (ranging from 0.00 to 12.00) and the Y-axis representing the number of accidents (ranging from 0.00 to 25.00). The plot contains a large number of data points, many of which are clustered at low values of accidents (below 5.00). Several regression lines are drawn through the data, showing different slopes and intercepts, which suggests a complex, non-linear relationship between the variables. The lines vary in style, including solid, dashed, and dotted lines, and some are accompanied by small arrows indicating the direction of the relationship.

The figure is a scatter plot with the x-axis labeled 'Number of nodes' ranging from 0.00 to 12.00 and the y-axis labeled 'Number of edges' ranging from 0.00 to 6.00. The plot contains numerous data points, some of which are highlighted with open circles. A prominent dashed line starts at approximately (1, 3.4) and ends at (12, 5.8). Several other lines, both solid and dashed, are plotted, representing different network configurations. The legend on the right side of the plot lists 36 configurations, each identified by a number (1.00 to 36.00) and a corresponding line style and color. The configurations are listed in two columns: the first column contains configurations 1.00 through 18.00, and the second column contains configurations 19.00 through 36.00. The lines represent different network topologies, with some showing a clear upward trend and others showing a more horizontal or slightly downward trend.

**Table 3: Health behavior intercorrelations**

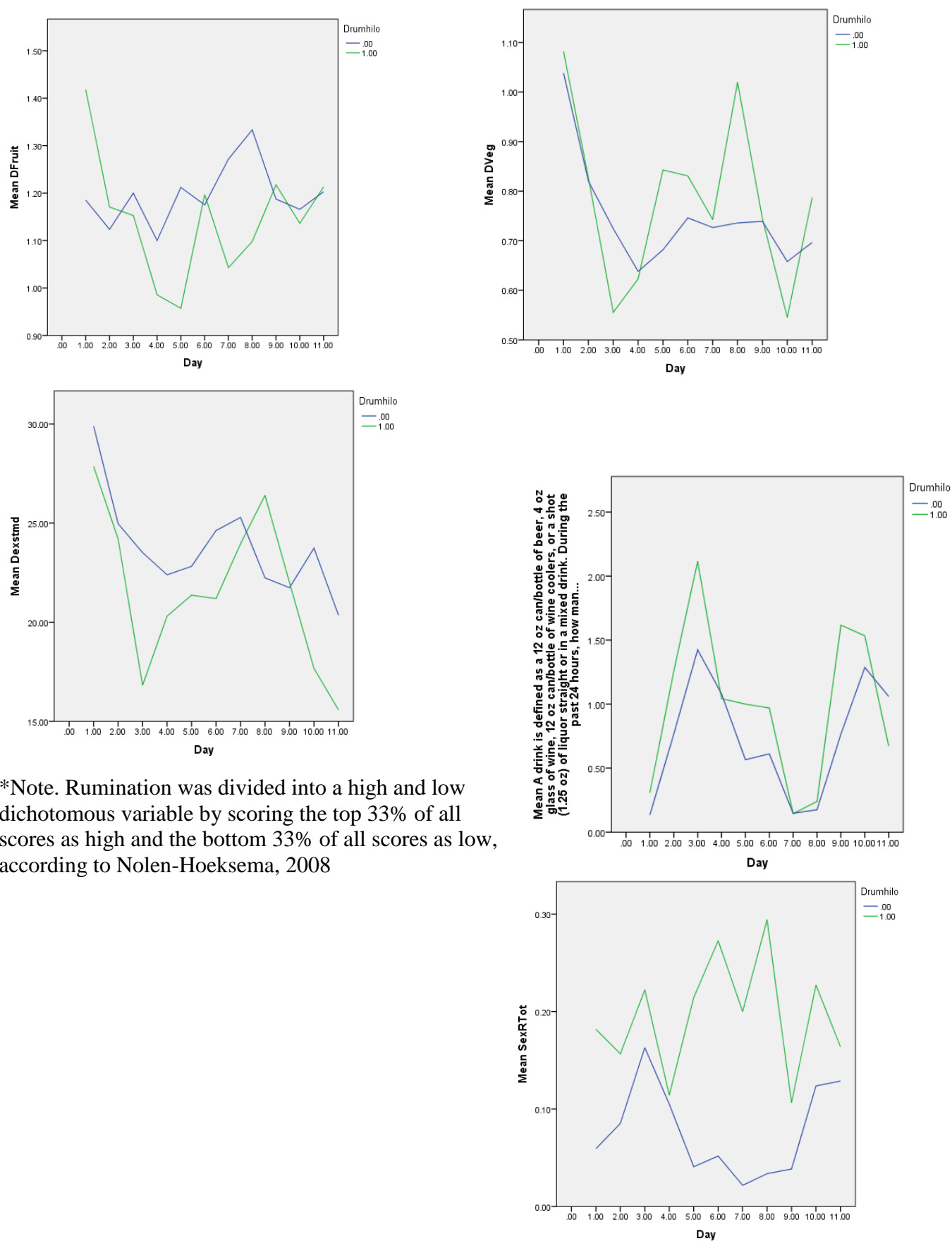
	Exercise	Fruit	Vegetable	Alcohol
Exercise	--			
Fruit	.125**	--		
Vegetable	.118**	.314**	--	
Alcohol	.116**	-.030	.004	--
Sexual Risk	.055**	-.017	.041*	.224**

Note. \*  $\dagger < .10$ ,  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

**Table 4: Correlation of daily rumination with moderators and mediators**

	Trait Rumination	Daily Rumination
Moderators		
Intention		
Fruit	-.069***	-.034 <sup>†</sup>
Vegetable	-.080***	-.055**
Exercise	-.072***	-.079***
Alcohol	-.067***	.023*
Sexual Risk	.002	.033*
Perceived Behavioral Control	-.111***	-.143***
Neuroticism	.635***	.381***
Emotional Intelligence	-.349***	-.259***
Mindfulness	-.428***	-.265***
Impulsivity	.148***	.148***
Motivation	-.399***	-.399***
Self Control	-.272***	-.272***
Health Behaviors as Coping	-.092***	-.076***
Depression	.489***	.365***

Note. \* <sup>†</sup> < .10,  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

**Figure 5: Rumination (dichotomous, high versus low) and health behaviors**

\*Note. Rumination was divided into a high and low dichotomous variable by scoring the top 33% of all scores as high and the bottom 33% of all scores as low, according to Nolen-Hoeksema, 2008

**Table 5: Multilevel model of daily rumination to daily health behavior outcomes over time**

	Estimate	(SE)	$t^a$	$p^b$	$CI_{95}$	
					Lower	Upper
Within Level						
Fruit Intake on						
Rumination (within)	-.085	.051	1.673	.084	-.015	.185
Time	.003	.006	.454	.650	-.009	.015
Vegetable Intake on						
Rumination (within)	-.060	.039	1.546	.092	-.040	.136
Time	-.015	.005	-3.010	.003	-.026	-.005
Exercise on						
Rumination (within)	-.379	1.540	-.246	.806	-3.398	2.640
Time	-.494	.164	-3.014	.003	-.816	-.173
Alcohol on						
Rumination (within)	.252	.140	1.796	.062	-.225	.527
Time	.003	.015	.214	.830	-.073	.032
Sexual Risk on						
Rumination (within)	.181	.207	.874	.382	-.255	.588
Time	-.008	.025	-.315	.753	-.057	.042
Between Level						
Fruit Intake on						
Rumination (between)	-.182	.062	2.342	.053	-.015	.185
Vegetable Intake on						
Rumination (between)	-.092	.041	2.146	.047	-.040	.136
Exercise on						
Rumination (between)	-.339	1.540	-.246	.112	-.498	1.640
Alcohol on						
Rumination (between)	.252	.140	1.796	.041	-.125	.927
Sexual Risk on						
Rumination (between)	.122	.97	1.3744	.092	-.127	.238
Intercept (within)						
Fruit	1.171	.057	20.475	<.001	-.015	.121
Vegetable	.830	.043	19.474	<.001	-.016	.136
Exercise	25.629	1.603	15.992	<.001	-3.398	2.640
Alcohol	1.543	.221	13.782	<.001	-.023	.527
Sexual Risk	2.682	.177	15.149	<.001	-.225	.588



**Table 6: Parameter estimates for intention as moderator of the rumination fruit intake relationship in a multilevel model**

	Estimate	(SE)	$t^a$	$p^b$	$CI_{95}$	
					Lower	Upper
Within Level						
Fruit Intake on						
Rumination (within)	.038	.054	.692	.489	-.069	.144
Intent (within)	.872	.62	1.235	.034	-.302	.009
Rumination*Intent (within)	-.099	.054	-1.853	.044	-.204	.006
Time	.007	.006	1.217	.224	-.004	.018
Between Level						
Fruit Intake on						
Rumination (between)	-.087	.050	-1.755	.079	-.185	.010
Intent (between)	.791	.023	4.23	.023	.006	.212
Rumination*Intent (within)	.475	.018	26.202	<.001	.440	.511
Intercept (between)						
Fruit	.053	.035	1.528	.127	-.015	.121

**Table 7: Parameter estimates for intention as moderator of the rumination vegetable intake relationship in a multilevel model**

	Estimate	(SE)	$t^a$	$p^b$	$CI_{95}$	
					Lower	Upper
Within Level						
Vegetable Intake on						
Rumination (within)	.075	.066	1.125	.260	-.055	.205
Intent (within)	.472	.072	-1.238	.034	-.034	.010
Rumination*Intent (within)	-.152	.060	-2.551	.011	-.270	-.035
Time	-.017	.007	-2.355	.019	-.031	-.003
Between Level						
Vegetable Intake on						
Rumination (between)	.044	.059	.744	.457	-.072	.160
Intent (between)	.391	.023	4.23	.033	.003	.112
Rumination*Intent (within)	.399	.020	20.287	<.001	.348	.431
Intercept (between)s						
Fruit	-.281	.042	-6.624	<.001	-.364	-.198

**Table 8: Parameter estimates for intention as moderator of the rumination exercise relationship in a multilevel model**

	Estimate	(SE)	$t^a$	$p^b$	$CI_{95}$	
					Lower	Upper
Within Level						
Exercise on						
Rumination (within)	-.831	.836	-.994	.320	-.116	.048
Intent (within)	.048	.011	4.436	<.001	.001	.009
Rumination*Intent (within)	.075	.030	1.781	.050	.000	.007
Time	-.015	.093	-.160	.873	.010	.908
Between Level						
Exercise on						
Rumination (between)	1.474	1.541	.956	.339	-.054	.245
Intent (between)	.187	.003	4.33	.010	.003	.112
Rumination*Intent (between)	.006	.020	5.185	<.001	.348	.431
Intercept (between)						
Exercise (between)	9.340	.743	12.567	<.001	7.883	10.796
Residual variances						
Exercise	72.158	8.309	8.684	<.001	187.608	211.072

**Table 9: Parameter estimates for intention as moderator of the rumination alcohol (categorical) relationship in a multilevel model**

	Estimate	Odds Ratio	(SE)	$t^a$	$p^b$	$CI_{95}$	
						Lower	Upper
Within Level							
Alcohol on							
Rumination (within)	.338	1.402	.166	2.033	.042	.012	.664
Intent (within)	.010	1.102	.103	.767	.095	-.003	.122
Rumination*Intent (within)	.007	1.008	.099	.076	.939	-.186	.201
Time	-.017	1.010	.007	-2.355	.019	-.038	.046
Between Level							
Alcohol on							
Rumination (between)	.348		.228	1.525	.127	-.099	.795
Intent (between)	.090		.010	5.73	.003	.343	.582
Rumination*Intent (within)	.830		.080	10.432	<.001	.674	.986

**Table 10: Parameter estimates for intention as moderator of the rumination sexual risk taking (categorical) relationship in a multilevel model**

	Estimate	(SE)	$t^a$	$p^b$	$CI_{95}$	
					Lower	Upper
Within Level						
Sexual risk on						
Rumination (within)	.339	.135	2.507	.012	.012	.664
Intent (within)	.700	.114	1.834	.043	-.003	.122
Rumination*Intent (within)	.707	.442	1.675	.094	-.186	.201
Time	-.016	.019	-.867	.386	-.038	.046
Between Level						
Sexual risk on						
Rumination (between)	.348	.228	1.525	.127	-.099	.795
Intent (between)	.090	.010	5.73	.003	.343	.582
Rumination*Intent (within)	.830	.080	10.432	<.001	.674	.986

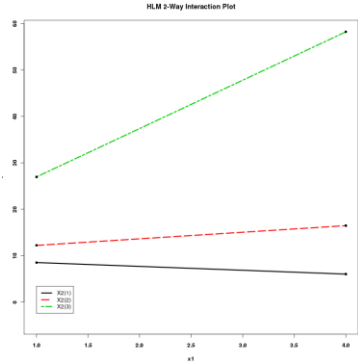
**Table 11: Parameter estimates for multilevel model of health behavior outcomes as a function of rumination and Level 2 mindfulness**

	Estimate	(SE)	$t^a$	$p^b$	$CI_{95}$	
					Lower	Upper
Within Level						
Fruit on						
Rumination (within)	.104	.071	1.471	.141	-.078	.243
Rumination*Mindfulness (within)	-.059	.113	-.525	.599	-.558	1.098
Time	.000	.006	.030	.976	-.011	.012
Vegetable on						
Rumination (within)	.076	.090	.850	.395	-.155	.252
Rumination*Mindfulness (within)	-.002	.140	-.013	.990	-.275	.272
Time	-.021	.007	-.2782	.005	-.035	-.006
Exercise on						
Rumination (within)	-.032	.054	-.591	.554	-.139	.075
Rumination*Mindfulness (within)	-.028	.091	-.311	.756	-.734	.368
Time	.001	.005	.114	.909	-.012	.010
Alcohol on						
Rumination (within)	.135	.210	.640	.522	-.277	.546
Rumination*Mindfulness (within)	.382	.365	1.047	.295	-.333	1.098
Time	.009	.019	.493	.622	-.028	.098
Sexual risk on						
Rumination (within)	.320	.186	1.724	.085	-.158	.685
Rumination*Mindfulness (within)	-.183	.281	-.652	.514	-.734	.368
Time	-.012	.019	-.644	.519	-.050	.025
Between Level						
Fruit on						
Rumination (between)	-.109	.053	-2.070	.038	-.244	-.006
Mindfulness (between)	.151	.039	3.925	<.001	.052	.227
Rumination*Mindfulness (within)	.124	.022	2.128	.021	.002	.234
Vegetable on						
Rumination (between)	-.065	.066	-.988	.323	-.193	.064
Mindfulness (between)	.210	.049	4.311	<.001	.115	.306
Rumination*Mindfulness (within)	.110	.029	3.296	<.001	.001	.026
Exercise on						
Rumination (between)	.081	.093	.870	.384	-.101	.263
Mindfulness (between)	.076	.072	1.050	.294	-.066	.218
Rumination*Mindfulness (within)	.078	.092	1.523	.382	-.015	.312
Alcohol on						

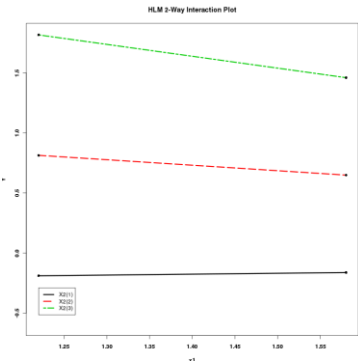
Rumination (between)	.267	.318	.839	.402	-.357	.891
Mindfulness (between)	-.130	.254	-.513	.608	-.627	.367
Rumination*Mindfulness (within)	.012	.152	.826	.275	-.292	.261
Sex Risk on						
Rumination (between)	1.437	.118	12.127	<.001	1.205	1.669
Mindfulness (between)	.744	.133	5.586	<.001	.483	1.005
Rumination*Mindfulness (within)	1.233	.101	6.252	<.001	1.021	1.340
Intercept (between)						
Fruit	.093	.041	2.287	.022	.013	.173
Vegetable	-.291	.051	-5.717	<.001	-.421	-.191
Exercise	1.231	.057	21.634	<.001	1.120	.1343
Alcohol	2.059	.212	9.716	<.001	1.644	2.475
Sex Risk	-2.711	.146	-18.629	<.001	-2.996	-2.425

**Figure 6. Moderation graphs for statistically significant moderation effects**

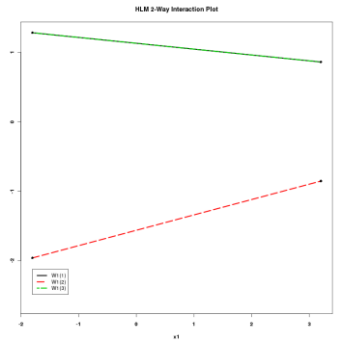
Intention: Fruit



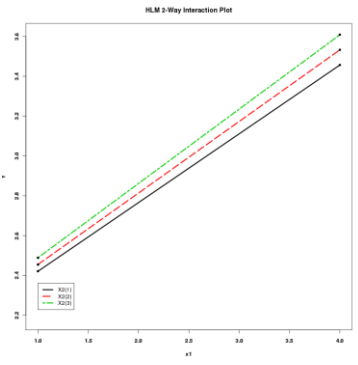
Intention: Vegetable



Intention: Exercise

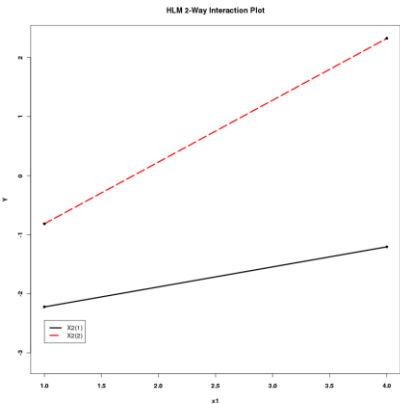


Intention: Alcohol

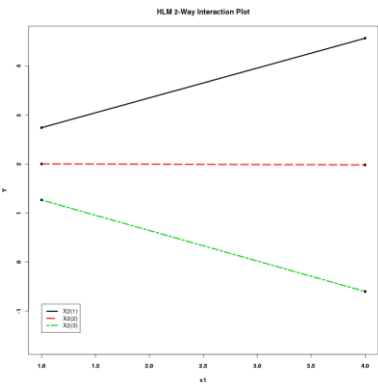




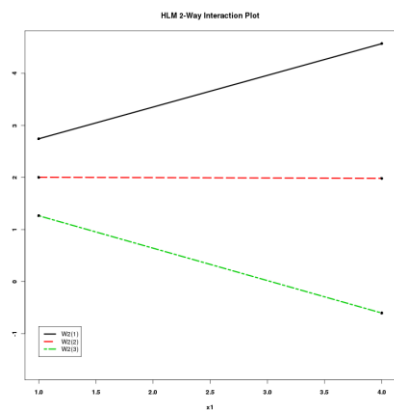
Intention: Sexual Risk



Perceived Behavioral Control: Alcohol



Neuroticism: Alcohol



\*Note. X axis is daily rumination, Y axis is daily health behavior outcome, and lines within the graph are intention. Lines are at mean and 1 standard deviation above and below the mean.

**Table 12: Parameter estimates of Level 1 impulsivity as a mediator of the Level 1 rumination to Level 1 fruit intake relationship in a multilevel model**

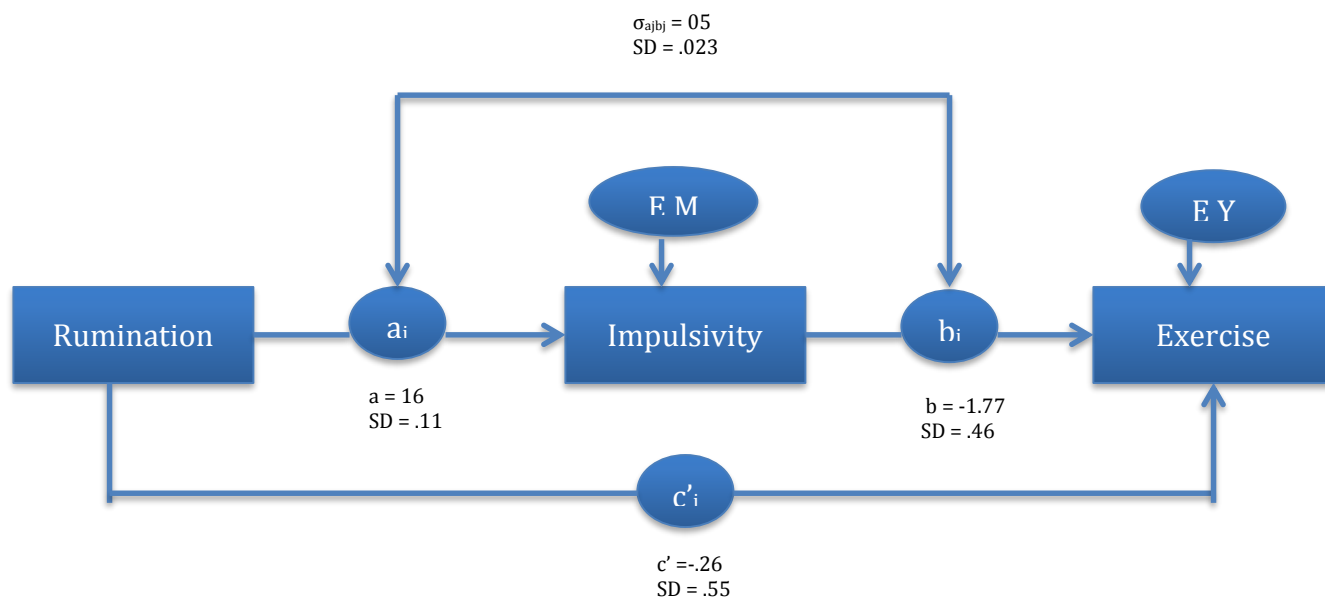
Random Effects	Estimate	(SE)	$t^a$	$p^b$	$CI_{95}$	
					Lower	Upper
Level 1 (within person)						
Fruit (within) on:						
Rumination (within)	.010	.050	1.1631	.267	-.045	.152
Time	.007	.006	1.137	.291	-.005	.020
Level 2 (between person)						
Fruit (between) on:						
Rumination (between)	-.023	.093	-.246	.806	-.206	.160
Impulsivity (between)	-.062	.071	-.866	.387	-.078	.246
Impulsivity (between) on:						
Rumination (between)	.293	.023	4.826	<.001	-.473	.113
Fixed effects						
Intercepts						
Fruit (between)	1.279	.132	9.700	<.001	1.020	1.536
Impulsivity (between)	1.795	.034	52.031	<.001	1.727	1.862
Variances						
Fruit (between)	.284	.050	5.686	<.001	.186	.381
Impulsivity (between)	.315	.023	13.624	<.001	.270	.361

**Table 13: Parameter estimates of Level 1 impulsivity as a mediator of the Level 1 rumination to Level 1 vegetable intake relationship in a multilevel model**

Random Effects	Estimate	(SE)	$t^a$	$p^b$	$CI_{95}$	
					Lower	Upper
Level 1 (within person)						
Vegetable (within) on:						
Rumination (within)	.050	.050	1.006	.314	-.079	.149
Time	.007	.006	1.085	.278	-.005	.019
Level 2 (between person)						
Vegetable (between) on:						
Rumination (between)	-.041	.088	-.464	.643	-.213	.112
Impulsivity (between)	.054	.075	.725	.468	-.092	.244
Impulsivity (between) on:						
Rumination (between)	-.125	.095	-1.310	.190	-.371	.062
Fixed effects						
Means						
Vegetable (between)	1.010	.238	4.239	<.001	.543	1.477
Impulsivity (between)	3.033	.030	102.370	<.001	2.975	3.091
Variances						
Vegetable (between)	.291	.049	5.954	<.001	.195	.386
Impulsivity (between)	.237	.024	9.996	<.001	.191	.284

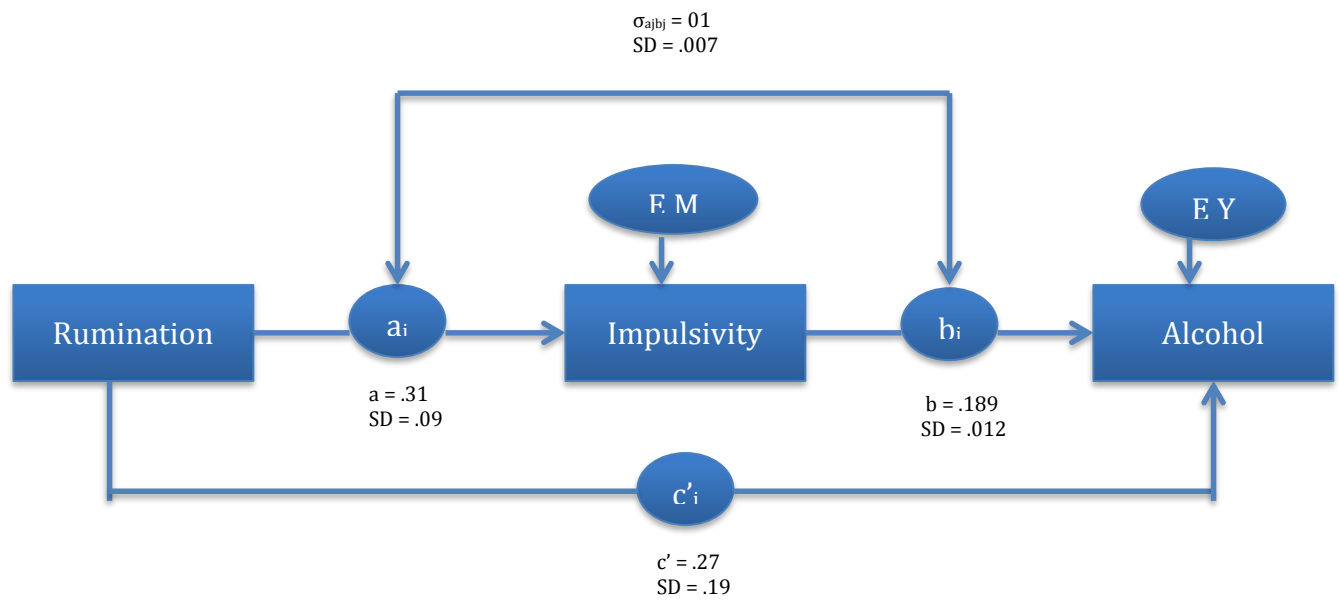
**Table 14: Parameter estimates of Level 1 impulsivity as a mediator of the Level 1 rumination to Level 1 exercise relationship in a multilevel model**

Random Effects	Estimate	(SE)	$t^a$	$p^b$	$CI_{95}$	
					Lower	Upper
Level 1 (within person)						
Exercise (within) on:						
Rumination (within)	-.258	.550	-.167	.092	-2.780	3.296
Time	-.420	.181	-2.315	.231	-.775	-.064
Level 2 (between person)						
Exercise (between) on:						
Rumination (between)	.070	3.525	.020	.082	-9.009	6.969
Impulsivity (between)	-1.772	.469	2.528	.052	-1.066	8.610
Impulsivity (between) on:						
Rumination (between)	.162	.105	-1.940	.044	-.368	.044
Intention	.267	.25	-4.940	.002	-1.242	-.008
Rumination*Intention	.762	.005	-2.940	.038	-.943	.126
Fixed effects						
Intercepts						
Exercise (between)	123.212	.238	4.239	<.001	-1.303	29.618
Impulsivity (between)	3.033	.030	102.370	<.001	2.963	3.084
Variances						
Exercise (between)	.291	.049	5.954	<.001	193.656	501.388
Impulsivity (between)	.237	.024	9.996	<.001	.196	.286

**Figure 7: Rumination to impulsivity to exercise model**

**Table 15: Parameter estimates of Level 1 impulsivity as a mediator of the Level 1 rumination to Level 1 alcohol relationship in a multilevel model**

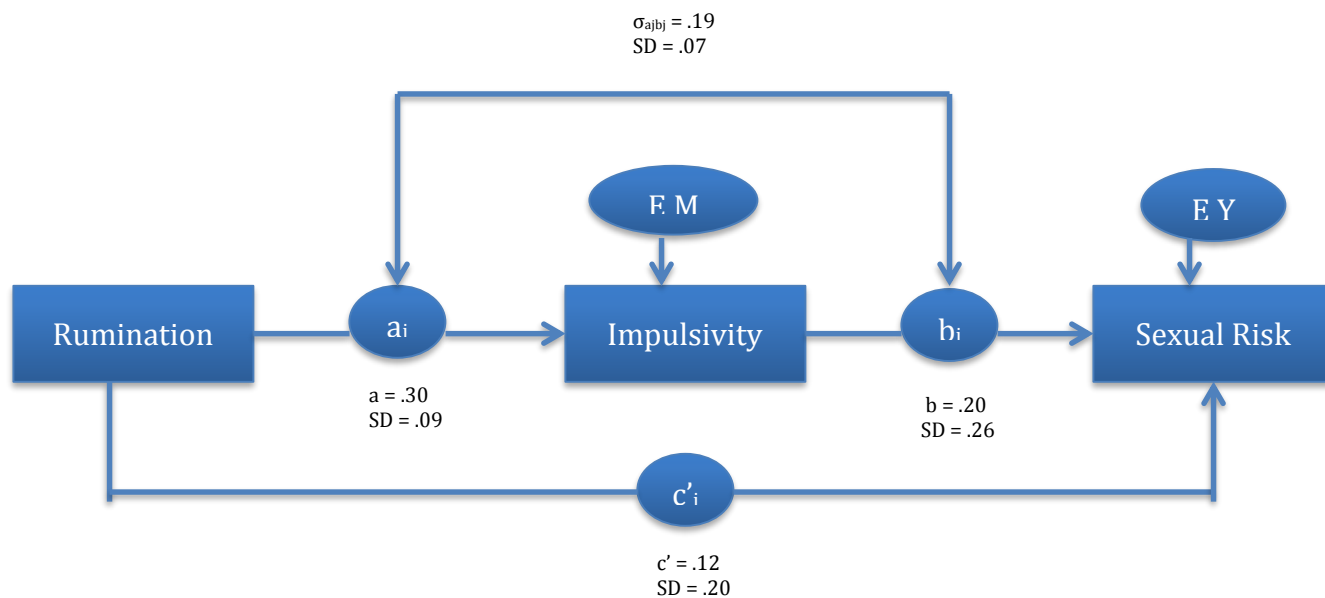
Random Effects	Estimate	(SE)	$t^a$	$p^b$	$CI_{95}$	
					Lower	Upper
Level 1 (within person)						
Alcohol (within) on:						
Rumination (within)	.269	.193	1.393	.091	-.110	.649
Time	.016	.022	.722	.470	-.028	.060
Level 2 (between person)						
Alcohol (between) on:						
Rumination (between)	.500	.255	1.965	.049	.001	.999
Impulsivity (between)	.189	.012	2.116	.038	-.146	.524
Impulsivity (between) on:						
Rumination (between)	.309	.093	3.317	<.001	-.491	.126
Fixed effects						
Intercepts						
Alcohol (between)	1.883	.342	5.509	<.001	1.213	2.553
Impulsivity (between)	1.795	.035	51.614	<.001	1.727	1.863
Variances						
Alcohol (between)	1.220	.272	4.492	<.001	.688	1.753
Impulsivity (between)	.323	.023	13.794	<.001	.277	.369

**Figure 8: Rumination to impulsivity to alcohol model**

**Table 16: Parameter estimates of Level 1 impulsivity as a mediator of the Level 1 rumination to Level 1 sexual risk taking relationship in a multilevel model**

Random Effects	Estimate	(SE)	$t^a$	$p^b$	$CI_{95}$	
					Lower	Upper
Level 1 (within person)						
Sex Risk (within) on:						
Rumination (within)	.196	.116	.273	.716	.474	-.340
Time	-.008	.992	.038	-.202	.840	-.081
Level 2 (between person)						
Sex Risk (between) on:						
Rumination (between)	.673	.355	1.898	.018	.326	.829
Impulsivity (between)	.203	.259	2.782	.011	-.001	.527
Impulsivity (between) on:						
Rumination (between)	.302	.091	4.109	.003	.208	.403
Fixed effects						
Intercepts						
Sex Risk (between)	4.405	.583	7.554	<.001	.908	5.092
Impulsivity (between)	1.792	.035	51.886	<.001	1.659	1.825
Variances						
Sex Risk (between)	1.990	.465	4.281	<.001	1.572	2.154
Impulsivity (between)	.322	.023	13.887	<.001	.301	.352



**Figure 9: Rumination to impulsivity to sexual risk taking model**

**Table 17: Parameter estimates of Level 1 motivation as a mediator of the Level 1 rumination to Level 1 fruit relationship in a multilevel model**

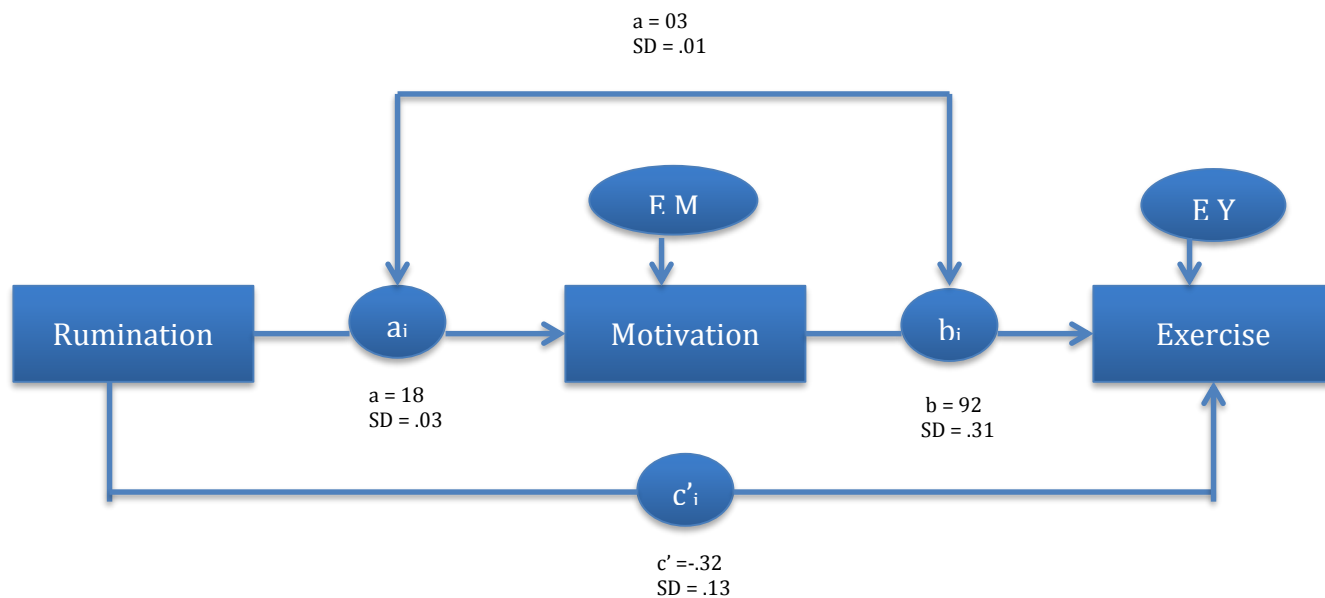
Random Effects	Estimate	(SE)	$t^a$	$p^b$	$CI_{95}$	
					Lower	Upper
Level 1 (within person)						
Fruit (within) on:						
Rumination (within)	.181	.050	1.064	.094	.131	.212
Motivation (within)	.027	.121	.621	.126	-.012	.279
Time	.011	.008	1.165	.362	-.005	.020
Motivation (within) on:						
Rumination (within)	.181	.050	1.064	.044	-.206	.160
Time	.063	.012	.815	.392	-.001	.257
Level 2 (between person)						
Fruit (between) on:						
Rumination (between)	.014	.050	1.064	.588	-.045	.152
Motivation (between)	.027	.123	.936	.352		
Motivation (between) on:						
Rumination (between)	-.023	.093	-.246	.704	-.206	.160
Fixed effects						
Intercepts						
Fruit (between)	1.279	.132	9.700	<.001	1.020	1.536
Motivation (between)	1.795	.034	52.031	<.001	1.727	1.862
Variances						
Fruit (between)	.284	.050	5.686	<.001	.186	.381
Motivation (between)	.315	.023	13.624	<.001	.270	.361

**Table 18: Parameter estimates of Level 1 motivation as a mediator of the Level 1 rumination to Level 1 vegetable relationship in a multilevel model**

Random Effects	Estimate	(SE)	$t^a$	$p^b$	$CI_{95}$	
					Lower	Upper
Level 1 (within person)						
Vegetable (within) on:						
Rumination (within)	.181	.050	1.064	.144	.131	.212
Motivation (within)	.027	.121	.621	.126	-.012	.279
Time	.011	.008	1.165	.362	-.005	.020
Motivation (within) on:						
Rumination (within)	.204	.051	.986	.038	-.206	.160
Time	.063	.012	.815	.392	-.001	.257
Level 2 (between person)						
Vegetable (between) on:						
Rumination (between)	.014	.050	1.064	.588	-.045	.152
Motivation (between)	.027	.123	.936	.352		
Motivation (between) on:						
Rumination (between)	-.023	.093	-.246	.704	-.206	.160
Fixed effects						
Intercepts						
Vegetable (between)	1.279	.132	9.700	<.001	1.020	1.536
Motivation (between)	1.795	.034	52.031	<.001	1.727	1.862
Variances						
Vegetable (between)	.284	.050	5.686	<.001	.186	.381
Motivation (between)	.315	.023	13.624	<.001	.270	.361

**Table 19: Parameter estimates of Level 1 motivation as a mediator of the Level 1 rumination to Level 1 exercise relationship in a multilevel model**

Random Effects	Estimate	(SE)	$t^a$	$p^b$	$CI_{95}$	
					Lower	Upper
Level 1 (within person)						
Exercise (within) on:						
Rumination (within)	-.327	.304	-.251	.144	.131	.212
Motivation (within)	.919	.672	1.993	.093	-.012	.279
Time	.009	.008	1.165	.662	-.005	.020
Motivation (within) on:						
Rumination (within)	-.182	.031	-.274	.082	-.206	.160
Time	.003	.012	.895	.092	-.001	.257
Level 2 (between person)						
Exercise (between) on:						
Rumination (between)	.018	.050	1.064	.588	-.045	.152
Motivation (between)	.027	.123	.936	.352	.001	.182
Motivation (between) on:						
Rumination (between)	-.023	.093	-.246	.704	-.206	.160
Fixed effects						
Intercepts						
Exercise (between)	24.893	1.497	16.663	<.001	4.271	48.536
Motivation (between)	1.795	.034	52.031	<.001	1.727	1.862
Variances						
Exercise (between)	422.219	40.858	10.334	<.001	.186	.381
Motivation (between)	.315	.023	13.624	<.001	.270	.361

**Figure 10: Rumination to motivation to exercise model**

**Table 20: Parameter estimates of Level 1 motivation as a mediator of the Level 1 rumination to Level 1 alcohol relationship in a multilevel model**

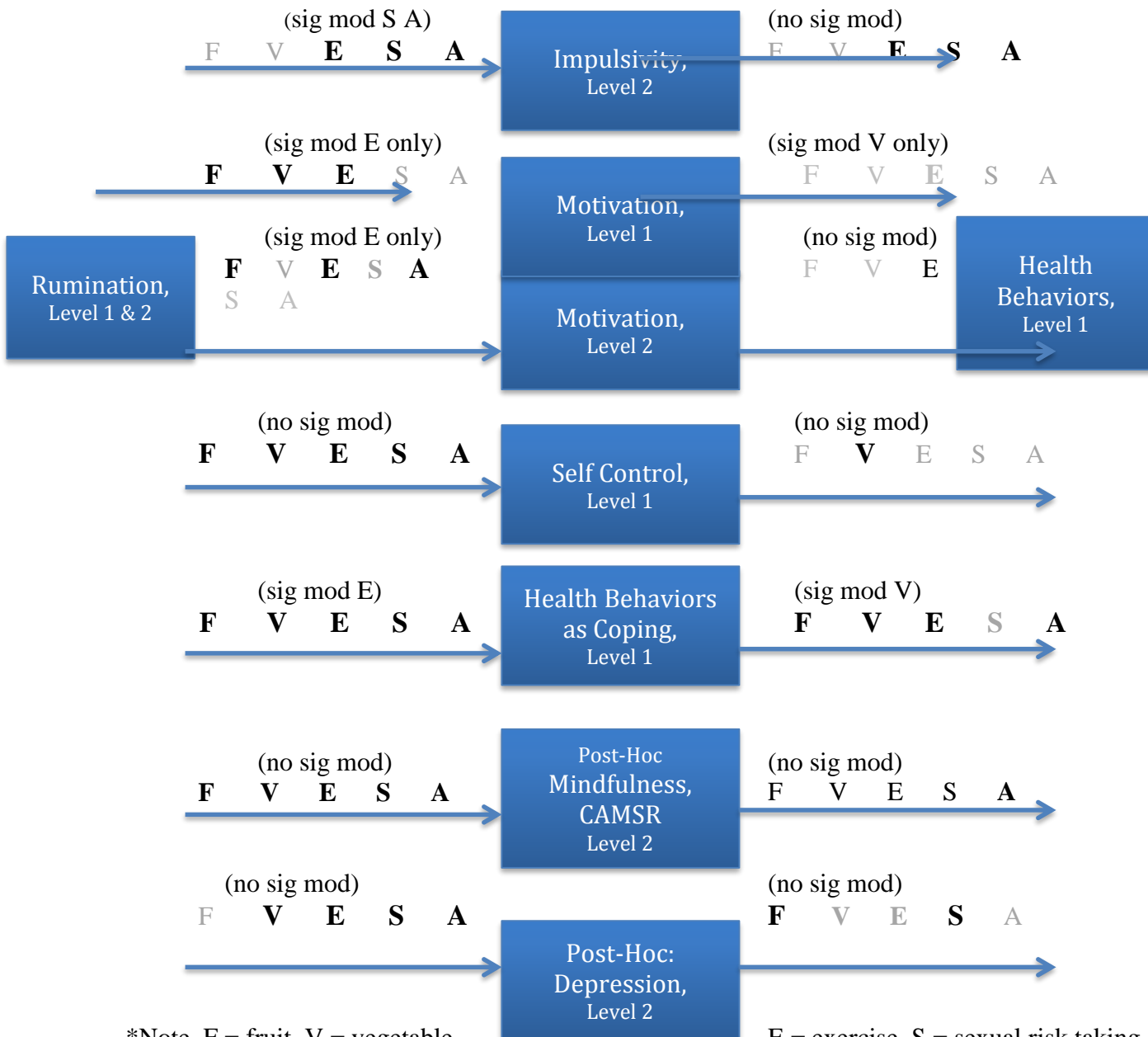
Random Effects	Estimate	(SE)	$t^a$	$p^b$	$CI_{95}$	
					Lower	Upper
Level 1 (within person)						
Alcohol (within) on:						
Rumination (within)	.251	.180	1.392	.164	.131	.212
Motivation (within)	-1.698	.255	-6.664	.129	-.012	.279
Time	.009	.010	1.115	.281	-.005	.020
Motivation (within) on:						
Rumination (within)	-.031	.015	-2.215	.103	-.206	.160
Time	-.008	.002	-4.781	<.001	-.001	.257
Level 2 (between person)						
Alcohol (between) on:						
Rumination (between)	.014	.050	1.064	.588	-.045	.152
Motivation (between)	.027	.123	.936	.352		
Motivation (between) on:						
Rumination (between)	-.023	.093	-.246	.704	-.206	.160
Fixed effects						
Intercepts						
Alcohol (between)	2.281	.171	13.347	<.001	1.020	2.536
Motivation (between)	.041	.101	4.251	<.001	.027	1.862
Variances						
Alcohol (between)	2.667	.453	5.884	<.001	.186	.381
Motivation (between)	.070	.002	36.517	<.001	.060	.078

**Table 21: Parameter estimates of Level 1 motivation as a mediator of the Level 1 rumination to Level 1 sexual risk taking relationship in a multilevel model**

Random Effects	Estimate	(SE)	$t^a$	$p^b$	$CI_{95}$	
					Lower	Upper
Level 1 (within person)						
Sexual risk(within) on:						
Rumination (within)	.214	.267	.802	.423	-.281	-.211
Motivation (within)	-.562	.400	1-.405	.160	-.012	.279
Time	-.016	.031	-.521	.602	-.005	.020
Motivation (within) on:						
Rumination (within)	-.255	.051	-.386	.027	-.206	.160
Time	.008	.002	5.610	<.001	-.001	.257
Level 2 (between person)						
Sexual risk (between) on:						
Rumination (between)	.172	.022	1.046	.588	-.045	.152
Motivation (between)	-.027	.037	-.936	.558	.001	.126
Motivation (between) on:						
Rumination (between)	-.023	.003	-.296	.484	-.206	.160
Fixed effects						
Intercepts						
Sexual risk (between)	4.712	.132	9.700	<.001	1.020	1.536
Motivation (between)	1.261	.034	52.031	<.001	1.727	1.862
Variances						
Sexual risk (between)	6.593	.050	5.686	<.001	.186	.381
Motivation (between)	.121	.023	13.624	<.001	.270	.361

**Figure 11: Moderated mediation, with intent moderating paths A and B, summary**

F = Fruit, V = Vegetable, E = Exercise, S = Sexual Risk Taking, A = Alcohol

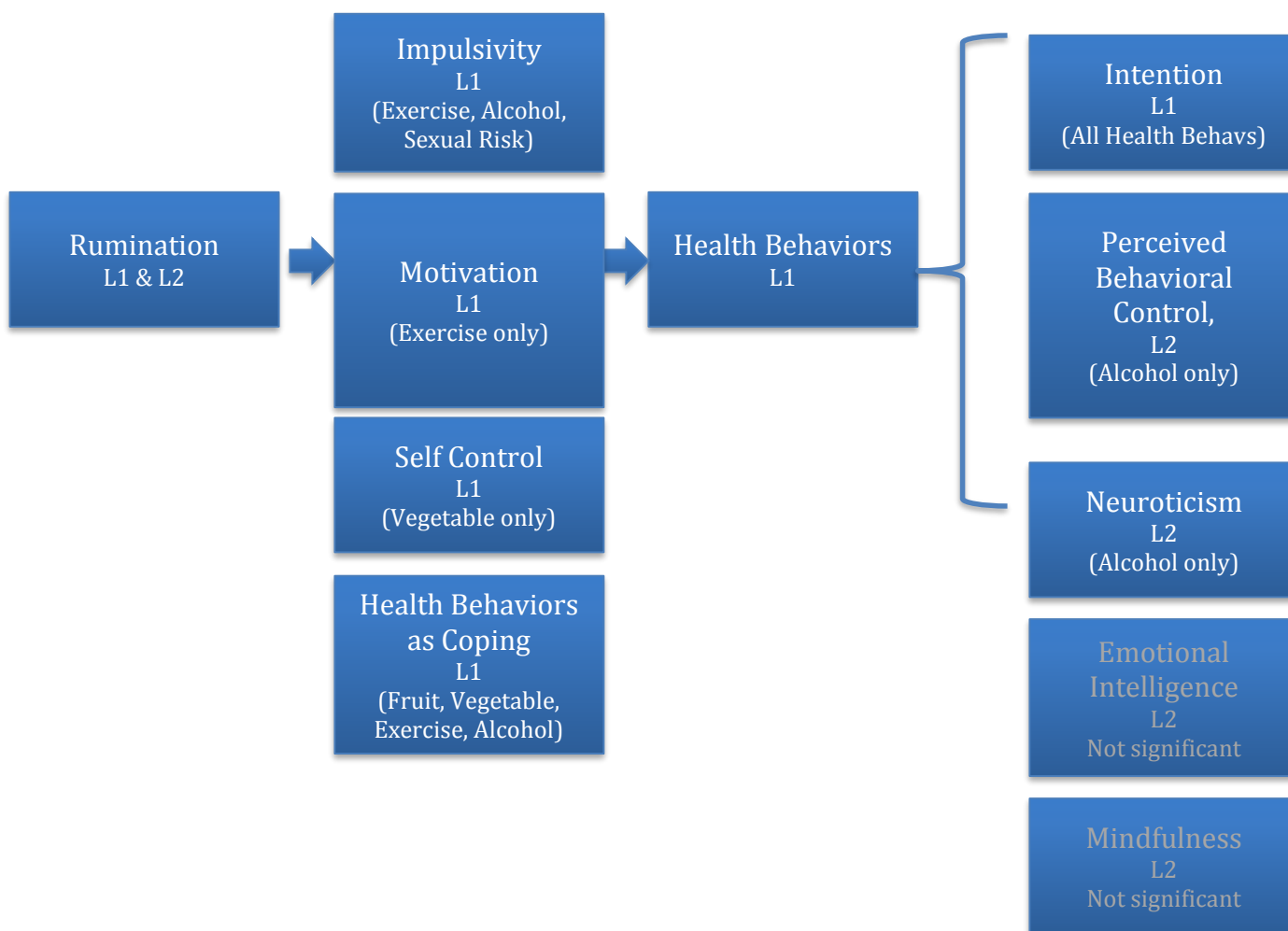


\*Note. F = fruit, V = vegetable, alcohol intake.

Bold = significant relationship ( $p < .10$ )

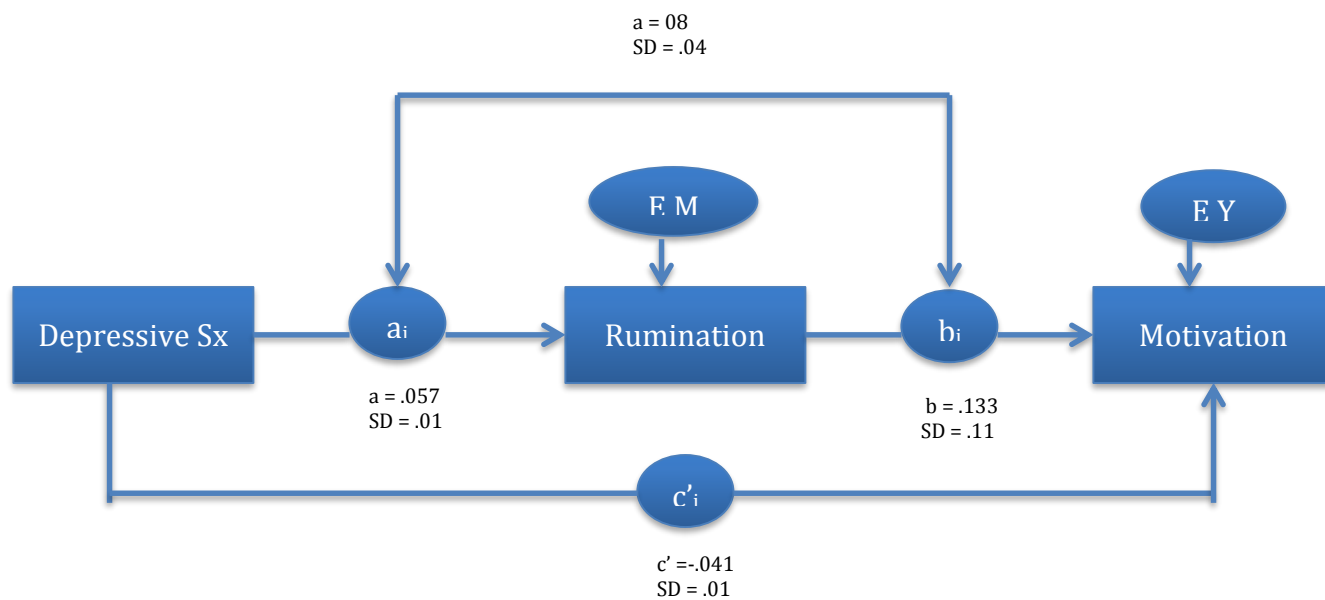
E = exercise, S = sexual risk taking, A =



**Figure 12: Total figure final**

**Table 22: Parameter estimates of Level 1 rumination (at Level 2) as a mediator of the Level 2 depression to Level 1 motivation relationship in a multilevel model**

Random Effects	Estimate	(SE)	$t^a$	$p^b$	$CI_{95}$	
					Lower	Upper
Level 1 (within person)						
Rumination (within) on:						
Time	-.016	.003	-6.430	<.001	-.021	-.011
Intercept, Rumination(within)	.080	.013	6.315	<.001	.055	.105
Variances, Rumination(within)	.110	.011	10.468	<.001	-.89	.131
Level 2 (between person)						
Motivation (between) on:						
Depression (between)	-.041	.012	-3.459	<.001	-.064	.018
Rumination (between)	-.133	.101	-1.315	.095 <sup>†</sup>	-.330	.065
Rumination (between) on:						
Depression (between)	.057	.007	8.106	<.001	.043	.070
Intercepts						
Rumination(between)	.228	.041	5.581	<.001	.148	.309
Motivation (between)	-1.953	.062	-31.641	<.001	1.832	2.074
Variances						
Rumination(between)	.114	.015	7.839	<.001	.086	.143
Motivation(between)	.309	.023	13.382	<.001	.264	.354

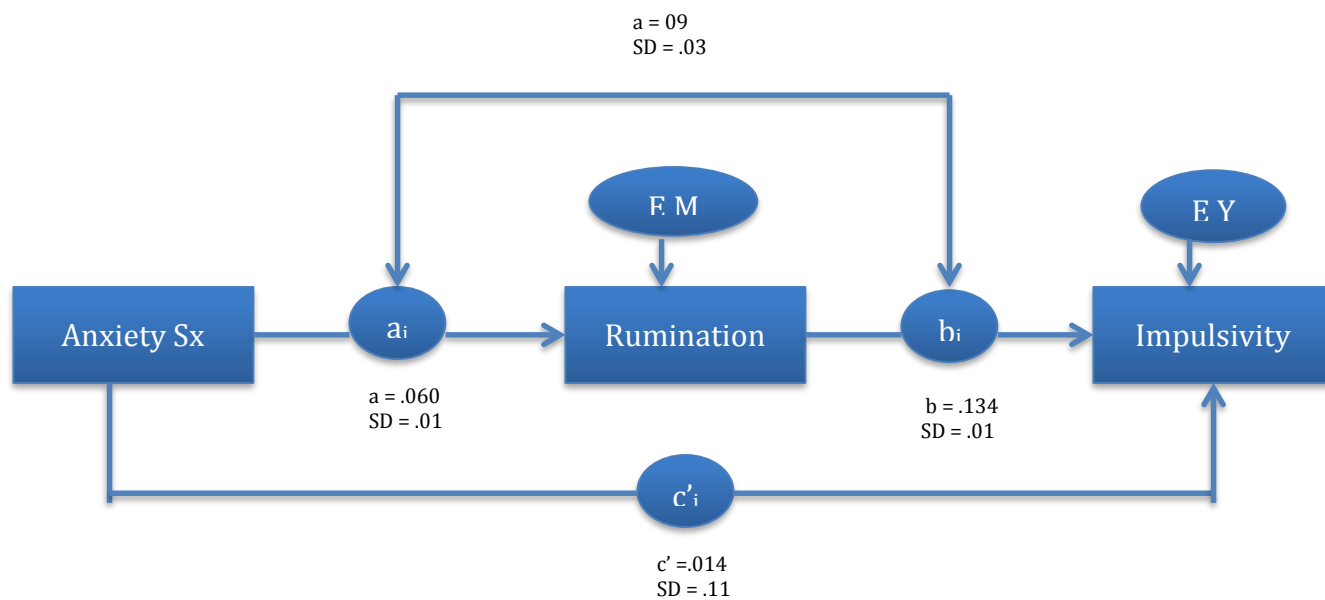
**Figure 13. Depression symptoms to rumination to motivation model**

**Table 23: Parameter estimates of Level 2 depression as a moderator of the Level 2 rumination to Level 1 motivation relationship in a multilevel model**

Random Effects	Estimate	(SE)	$t^a$	$p^b$	$CI_{95}$	
					Lower	Upper
Level 1 (within person)						
Rumination (within) on:						
Time	-.016	.002	-8.166	<.001	-.021	-.012
Intercept,	.080	.012	6.830	<.001	.057	.103
Rumination(within)						
Variances,	.110	.003	37.463	<.001	.105	.116
Rumination(within)						
Level 2 (between person)						
Motivation (between) on:						
Rumination (between)	-.042	.108	-.389	.697	-.254	.170
Depression (between)	-.051	.012	-4.122	<.001	-.076	.027
Depression*Rumination	.043	.021	2.049	.040	.002	.084
Depression*Rumination						
on:						
Rumination (between)	-1.081	.271	3.986	<.001	-1.613	-.549
Depression (between) on:						
Rumination (between)	4.298	.457	9.399	<.001	3.402	5.195
Intercepts						
Depression(between)	-3.907	.178	-21.987	<.001	-4.192	-3.563
Motivation(between)	2.021	.064	31.342	<.001	1.894	2.147
Depression*Rumination	.624	.105	5.919	<.001	.417	.830
Variances						
Depression(between)	8.647	.739	11.705	<.001	7.119	10.095
Motivation(between)	.304	.026	11.641	<.001	.253	.355
Depression*Rumination	3.041	.260	11.705	<.001	2.372	3.550

**Table 24: Parameter estimates of Level 1 rumination (at Level 2) as a mediator of the Level 2 anxiety to Level 2 impulsivity relationship in a multilevel mode**

Random Effects	Estimate	(SE)	$t^a$	$p^b$	$CI_{95}$	
					Lower	Upper
Level 1 (within person)						
Rumination (within) on:						
Time	-.016	.003	-6.430	<.001	-.021	-.011
Intercept, Rumination(within)	.080	.013	6.315	<.001	.055	.105
Variances, Rumination(within)	.110	.011	10.468	<.001	.083	.131
Level 2 (between person)						
Impulsivity (between) on:						
Anxiety (between)	.014	.011	1.752	.080	-.002	.030
Rumination (between)	.134	.070	1.927	.051	-.002	.271
Rumination (between) on:						
Anxiety (between)	.060	.008	7.206	<.001	.044	.077
Intercepts						
Rumination(between)	.241	.046	5.285	<.001	.152	.331
Impulsivity(between)	2.100	.039	53.473	<.001	2.023	2.177
Variances						
Rumination(between)	.118	.014	8.290	<.001	.090	.146
Impulsivity(between)	.119	.010	11.407	<.001	.099	.140

**Figure 14. Anxiety symptoms to rumination to impulsivity model**

**Table 25: Parameter estimates of Level 2 anxiety as a moderator of the Level 1 rumination (at Level 2) to Level 2 impulsivity relationship in a multilevel model**

Random Effects	Estimate	(SE)	$t^a$	$p^b$	$CI_{95}$	
					Lower	Upper
Level 1 (within person)						
Rumination (within) on:						
Time	-.016	.002	-8.166	<.001	-.020	-.012
Intercept,	.080	.012	6.830	<.001	.057	.103
Rumination(within)						
Variances,	.110	.003	37.463	<.001	.105	.116
Rumination(within)						
Level 2 (between person)						
Impulsivity (between) on:						
Rumination (between)	.133	.068	1.956	.050	.000	.266
Anxiety (between)	.014	.008	1.772	.076	-.002	.030
Anxiety*Rumination	.524	.086	6.116	<.001	-.031	.029
Anxiety*Rumination on:						
Rumination (between)	-1.459	.221	-6.614	<.001	-1.891	-1.027
Anxiety (between) on:						
Rumination (between)	3.616	.413	8.751	<.001	2.806	4.426
Intercepts						
Anxiety(between)	-3.878	.161	-24.155	<.001	-4.192	-3.563
Impulsivity(between)	2.101	.041	51.871	<.001	2.205	2.180
Anxiety*Rumination	.524	.086	6.116	<.001	.356	.692
Variances						
Anxiety(between)	7.058	.603	11.705	<.001	5.876	8.240
Impulsivity(between)	.119	.010	11.705	<.001	.099	.139
Anxiety*Rumination	2.012	.172	11.705	<.001	1.675	2.349

**Table 26: Parameter estimates of Level 2 depression as a moderator of the Level 1 rumination to Level 1 health behaviors relationships in a multilevel model**

	Estimate	(SE)	<i>t</i> <sup>a</sup>	<i>p</i> <sup>b</sup>	<i>CI</i> <sub>95</sub>	
					Lower	Upper
Within Level						
Fruit on						
Rumination (within)	.161	.067	2.412	.016	-.436	.764
Rumination*Dep (within)	-.099	.048*	-2.085	.037	-.498	.914
Time	.003	.019	.159	.874	-.031	.040
Vegetable on						
Rumination (within)	.081	.078	1.033	.302	-.015	.456
Rumination*Dep (within)	-.004	.017	-.253	.801	-.846	.488
Time	-.010	.007	-2.809	.005	-.043	.029
Exercise on						
Rumination (within)	-.495	1.498	-.330	.741	-2.994	7.204
Rumination*Dep (within)	-.054	.313	-.171	.864	-9.169	2.475
Time	-.535	.142	-3.762	<.001	-.782	-.238
Alcohol on						
Rumination (within)	.013	.214	.059	.953	-.625	.764
Rumination*Dep (within)	-.099	.048	-2.085	.037	-.498	.914
Time	.003	.214	.059	.953	-.031	.040
Sexual risk on						
Rumination (within)	.325	.225	1.444	.149	-2.994	7.204
Rumination*Dep (within)	.029	.048	.598	.550	-9.169	2.475
Time	-.006	.019	-.317	.752	-.782	.238
Between Level						
Fruit on						
Rumination (between)	-.003	.055	-.049	.961	-.807	.230
Dep (between)	.499	.125	3.696	<.001	-.109	.227
Vegetable on						
Rumination (between)	.017	.067	.262	.793	-.698	.612
Dep (between)	-.019	.008	-2.377	.017	-.125	.238
Exercise on						
Rumination (between)	-.810	3.714	-.218	.827	-.988	.920
Dep (between)	5.705	3.084	1.850	.890	-7.731	.725
Alcohol on						
Rumination (between)	.605	.332	1.819	.069 <sup>t</sup>	-2.121	3.894
Dep (between)	-.037	.040	-.918	.359	-2.118	.021
Sex Risk on						
Rumination (between)	1.564	.936	1.672	.095	-.270	3.398
Dep (between)	-.495	.252	-1.961	.049	-.989	.000
Intercept (between)						



Fruit	-.013	.068	1.765	.078	-.013	.254
Vegetable	-.196	.085	-2.303	.021	-.416	-.029
Exercise	23.484	4.647	5.054	<.001	-24.731	55.725
Alcohol	1.813	.400	4.534	<.001	1.029	2.596
Sex Risk	-2.126	.230	-9.240	<.001	-2.577	-1.675

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**Table 27: Parameter estimates of Level 2 depression as a mediator of the Level 1 rumination (at Level 2) to Level 1 fruit intake relationship in a multilevel model**

Random Effects	Estimate	(SE)	$t^a$	$p^b$	$CI_{95}$	
					Lower	Upper
Level 1 (within person)						
Fruit (within) on:						
Rumination (within)	.051	.050	1.016	.309	-.048	.149
Intent to Fruit (within)	.070	.024	2.888	.004	.022	.117
Rumination*Intent(within)	-.094	.078	-1.202	.229	-.246	.059
Time(within)	.007	.006	1.089	.276	-.005	.019
Level 2 (between person)						
Fruit (between) on:						
Rumination (between)	-.038	.091	-.423	.677	-.256	.138
Dep (between)	-.004	.012	-.331	.741	-.207	.165
Intention (between)	.598	.367	1.623	<.001	1.611	1.628
Dep*Intention(between)	-.004	.012	-.307	.756	-.248	.264
Dep(between) on:						
Rumination (between)	-.419	.066	-6.330	<.001	-.549	-.289
Intention (between)	.045	.209	1.550	.121	-.012	.103
Rumination*Intention(btwn)	.037	.073	.502	.616	-.106	.180
Fixed effects						
Intercepts						
Dep (between)	2.669	.026	103.145	<.001	2.618	2.720
Fruit (between)	1.227	.259	4.743	<.001	.720	1.735
Variances						
Dep between)	.186	.015	12.726	<.001	.158	.215
Fruit (between)	.292	.049	5.977	<.001	.196	.387

**Table 28: Parameter estimates of Level 2 depression as a mediator of the Level 1 rumination (at Level 2) to Level 1 vegetable intake relationship in a multilevel model**

Random Effects	Estimate	(SE)	$t^a$	$p^b$	$CI_{95}$	
					Lower	Upper
Level 1 (within person)						
Vegetable (within) on:						
Rumination (within)	.085	.039	2.151	.031	.008	.162
Intent to Vegetable (within)	.027	.018	1.509	.131	-.019	.061
Rumination*Intent(within)	-.103	.052	-1.974	.048	-.206	-.001
Time(within)	-.012	.005	-2.206	.027	-.022	-.001
Level 2 (between person)						
Vegetable (between) on:						
Rumination (between)	.051	.095	.537	.591	-.135	.237
Dep (between)	.006	.012	.457	.648	-.019	.030
Intention (between)	.419	.054	7.732	<.001	.313	.525
Dep*Intention(between)	.024	.011	2.159	.031	.002	.046
Dep(between) on:						
Rumination (between)	4.178	.575	7.267	<.001	3.051	5.305
Intention (between)	-.330	.150	-2.196	.028	-.625	-.035
Rumination*Intention(btwn)	-.657	.427	-1.540	.124	-1.494	.179
Fixed effects						
Intercepts						
Dep (between)	-3.932	.170	-23.093	<.001	-4.266	-3.599
Vegetable (between)	.866	.063	13.768	<.001	.743	.989
Variances						
Dep between)	8.449	1.099	7.691	<.001	5.619	10.602
Vegetable (between)	.260	.027	9.789	<.001	.192	.312

**Table 29: Parameter estimates of Level 2 depression as a mediator of the Level 1 rumination (at Level 2) to Level 1 exercise relationship in a multilevel model**

Random Effects	Estimate	(SE)	$t^a$	$p^b$	$CI_{95}$	
					Lower	Upper
Level 1 (within person)						
Exercise (within) on:						
Rumination (within)	.235	1.550	.152	.879	-2.803	3.723
Intent to Exercise (within)	.109	.023	4.727	<.001	.022	.117
Rumination*Intent(within)	.152	.106	1.428	.153	-.122	.360
Time(within)	-.422	.181	-2.326	.020	-.778	-.066
Level 2 (between person)						
Exercise (between) on:						
Rumination (between)	.792	4.315	.184	.854	-7.666	9.250
Dep (between)	.025	.485	.051	.959	.926	.976
Intention (between)	..434	.114	3.809	<.001	.211	.658
Dep*Intention(between)	.033	.021	1.593	.111	-.008	.074
Dep(between) on:						
Rumination (between)	4.282	.587	7.291	<.001	3.131	5.433
Intention (between)	-.001	.007	-.168	.867	-.015	.012
Rumination*Intention(btwn)	-.002	.023	-.087	.931	-.046	.042
Fixed effects						
Intercepts						
Dep (between)	-3.908	.174	-22.493	<.001	-4.193	-3.567
Exercise (between)	25.940	2.519	10.299	<.001	21.003	30.877
Variances						
Dep between)	8.646	1.155	7.484	<.001	6.382	10.911
Exercise (between)	364.259	65.863	5,531	<.001	235.167	493.350

**Table 30: Parameter estimates of Level 2 depression as a mediator of the Level 1 rumination (at Level 2) to Level 1 alcohol relationship in a multilevel model**

Random Effects	Estimate	(SE)	$t^a$	$p^b$	$CI_{95}$	
					Lower	Upper
Level 1 (within person)						
Alcohol(within) on:						
Rumination (within)	.264	.194	1.360	.174	--.116	.644
Intent to drink Alc(within)	.361	.044	8.276	<.001	.275	.446
Rumination*Intent(within)	.079	.112	.701	.483	-.141	.298
Time(within)	.017	.022	.745	.456	-.027	.060
Level 2 (between person)						
Alcohol(between) on:						
Rumination (between)	.398	.274	1.449	.147	-.140	.935
Dep (between)	.010	.031	.323	.746	-.051	.071
Intention (between)	1.056	.257	4.112	<.001	.395	1.560
Dep*Intention(between)	.033	.043	.769	.042	-.051	.116
Dep(between) on:						
Rumination (between)	4.381	.587	7.463	<.001	3.230	5.532
Intention (between)	-.340	.108	-3.143	.003	-.552	-.128
Rumination*Intention(btwn)	-.685	.212	-3.238	.001	-1.100	-.271
Fixed effects						
Intercepts						
Dep(between)	-3.891	.172	-22.618	<.001	-4.228	-3.554
Alcohol (between)	2.163	.204	10.592	<.001	1.763	2.563
Variances						
Dep(between)	8.236	1.082	7.610	<.001	6.115	10.358
Alcohol (between)	1.214	.276	4.398	<.001	.673	1.755

**Table 31: Parameter estimates of Level 2 depression as a mediator of the Level 1 rumination (at Level 2) to Level 1 sexual risk taking relationship in a multilevel model**

Random Effects	Estimate	(SE)	$t^a$	$p^b$	$CI_{95}$	
					Lower	Upper
Level 1 (within person)						
Sexual risk (within) on:						
Rumination (within)	.762	.127	1.610	.090	-.048	.149
Intent to sex risk(within)	.263	.024	7.126	.009	.022	.117
Rumination*Intent(within)	.079	.112	.701	.023	-.246	.059
Time(within)	.017	.022	.745	.176	-.005	.019
Level 2 (between person)						
Sexual risk (between) on:						
Rumination (between)	.298	.174	1.449	.077	-.256	.138
Dep (between)	.010	.031	.323	.015	-.207	.165
Intention (between)	1.056	.257	4.112	.004	1.133	1.628
Dep*Intention(between)	.033	.043	.769	.056	-.248	.264
Dep(between) on:						
Rumination (between)	4.381	.587	7.463	<.001	-.549	-.289
Intention (between)	-.340	.108	-3.143	.012	-.012	.103
Rumination*Intention(btwn)	-.685	.212	-3.238	.016	-.106	.180
Fixed effects						
Intercepts						
Dep (between)	-3.891	.172	-22.618	<.001	2.618	2.720
Sexual risk (between)	2.163	.204	10.592	<.001	.720	1.735
Variances						
Dep between)	8.236	1.082	7.610	<.001	.158	.215
Sexual risk (between)	1.214	.276	4.398	<.001	.196	.387

	Estimate	(SE)	<i>t</i> <sup>a</sup>	<i>p</i> <sup>b</sup>	<i>CI</i> <sub>95</sub>	
					Lower	Upper
Within Level						
Fruit on						
Rumination (within)	.315	.259	1.216	.224	-.436	.764
Rumination* Mindfulness (within)	.750	.348	2.154	.031	-.498	.914
Time	.002	.006	.306	.760	-.031	.040
Vegetable on						
Rumination (within)	.274	.312	.878	.380	-.015	.456
Rumination* Mindfulness (within)	-.074	.125	-.595	.552	-.846	.488
Time	-.020	.007	-.2784	.005	-.043	.029
Exercise on						
Rumination (within)	-9.519	6.353	-1.498	.134	-2.994	7.204
Rumination* Mindfulness (within)	-3.370	2.535	1.472	.141	-9.169	2.475
Time	--.530	.142	-3.730	<.001	-.782	-.238
Alcohol on						
Rumination (within)	-1.543	.868	-1.777	.076	-.625	.764
Rumination* Mindfulness (within)	.750	.348	2.154	.031	-.498	.914
Time	.003	.019	.254	.857	-.031	.040
Sexual risk on						
Rumination (within)	.858	.627	1.370	.171	-2.994	7.204
Rumination* Mindfulness (within)	-.160	.251	-1.039	.299	-9.169	2.475
Time	-.007	.018	-.364	.716	-.782	.238
Between Level						
Fruit on						
Rumination (between)	-.119	.052	-2.286	.022	-.807	.230
Mindfulness (between)	.499	.125	3.696	<.001	-.109	.227
Rum* Mindfulness (between)	.044	.276	.161	.872	-.467	.585
Vegetable on						
Rumination (between)	-.043	.334	-.130	.897	-.698	.612
Mindfulness (between)	.056	.093	.607	.544	-.125	.238
Rum* Mindfulness (between)	-.072	.347	-.208	.835	-.753	.609
Exercise on						
Rumination (between)	-.810	3.714	-.218	.827	-.988	.920
Mindfulness (between)	5.705	3.084	1.850	.890	-7.731	.725
Rum* Mindfulness (between)	2.129	1.525	.755	.450	-4.036	.559
Alcohol on						

Rumination (between)	1.149	1.668	.689	.491	-2.121	3.894
Mindfulness (between)	-.904	.472	-1.916	.050	-2.118	.021
Rum* Mindfulness (between)	.60	1.729	.092	.926	-.823	.012
Sex Risk on						
Rumination (between)	1.564	.936	1.672	.095	-.270	3.398
CAMSR (between)	-.495	.252	-1.961	.049	-.989	.000
Rum* CAMSR(between)	-.073	.951	.077	.939	-1.936	1.790
Intercept (between)						
Fruit	-.145	.068	1.765	.078	-.013	.254
Vegetable	-.196	.085	-2.303	.021	-.416	-.029
Exercise	23.484	4.647	5.054	<.001	-24.731	55.725
Alcohol	1.813	.400	4.534	<.001	1.029	2.596
Sex Risk	-2.126	.230	-9.240	<.001	-2.577	-1.675



**Table 33: Parameter estimates of Level 2 mindfulness as a mediator of the Level 1 rumination (at Level 2) to Level 1 fruit intake relationship in a multilevel model**

Random Effects	Estimate	(SE)	$t^a$	$p^b$	$CI_{95}$	
					Lower	Upper
Level 1 (within person)						
Fruit (within) on:						
Rumination (within)	.050	.050	1.006	.314	-.048	.149
Intent to Exercise (within)	.070	.024	2.888	.004	.022	.117
Rumination*Intent(within)	-.094	.078	-1.202	.229	-.246	.059
Time(within)	.007	.006	1.089	.276	-.005	.019
Level 2 (between person)						
Fruit (between) on:						
Rumination (between)	-.059	.101	-.585	.559	-.256	.138
Mindfulness (between)	-.021	.095	-.217	.828	-.207	.165
Intention (between)	.595	.367	1.623	.105	.347	1.628
Mindfulness	.008	.131	.062	.951	-.248	.264
*Intention(between)						
Mindfulness (between) on:						
Rumination (between)	-.419	.066	-6.330	<.001	-.549	-.289
Intention (between)	.045	.209	1.550	.121	-.012	.103
Rumination*Intention(btwn)	.037	.073	.502	.616	-.106	.180
Fixed effects						
Intercepts						
Mindfulness (between)	2.669	.026	103.145	<.001	2.618	2.720
Fruit (between)	1.227	.259	4.743	<.001	.720	1.735
Variances						
Mindfulness (between)	.186	.015	12.726	<.001	.158	.215
Fruit (between)	.292	.049	5.977	<.001	.196	.387

**Table 34: Parameter estimates of Level 2 mindfulness as a mediator of the Level 1 rumination (at Level 2) to Level 1 vegetable intake relationship in a multilevel model**

Random Effects	Estimate	(SE)	$t^a$	$p^b$	$CI_{95}$	
					Lower	Upper
Level 1 (within person)						
Vegetable(within) on:						
Rumination (within)	.085	.039	2.150	.032	-.017	.162
Intent to Vegetable (within)	.027	.018	1.510	.131	-.008	.061
Rumination*Intent(within)	-.103	.052	-1.975	.048	-.238	-.001
Time(within)	-.012	.005	-2.199	.028	-.022	-.057
Level 2 (between person)						
Vegetable (between) on:						
Rumination (between)	.055	.095	.576	.564	-.131	.240
Mindfulness (between)	.004	.083	.048	.962	-.211	.168
Intention (between)	.446	.223	2.001	.045	-.128	.883
Mindfulness	-.046	.083	-.548	.584	-.260	.118
*Intention(between)						
Mindfulness (between) on:						
Rumination (between)	-.424	.067	-6.363	<.001	-.555	-.292
Intention (between)	.037	.025	1.507	.132	.000	.054
Rumination*Intention(btwn)	.034	.068	.504	.615	-.006	.045
Fixed effects						
Intercepts						
Mindfulness (between)	2.673	.026	101.625	<.001	2.618	2.720
Vegetable (between)	.823	.225	3.656	<.001	.243	1.264
Variances						
Mindfulness (between)	.186	.015	12.726	<.001	.158	.215
Vegetable (between)	.265	.027	9.656	<.001	.211	.319

**Table 35: Parameter estimates of Level 2 mindfulness as a mediator of the Level 1 rumination (at Level 2) to Level 1 exercise relationship in a multilevel model**

Random Effects	Estimate	(SE)	$t^a$	$p^b$	$CI_{95}$	
					Lower	Upper
Level 1 (within person)						
Exercise (within) on:						
Rumination (within)	.245	1.551	.158	.874	-2.794	3.284
Intent to Exercise (within)	.108	.023	4.724	<.001	.063	.153
Rumination*Intent(within)	.153	.106	1.442	.149	-.055	.362
Time(within)	-.422	.182	-2.323	.020*	-.778	-.066
Level 2 (between person)						
Exercise (between) on:						
Rumination (between)	2.292	3.815	.601	.548	-5.186	9.679
Mindfulness (between)	3.759	2.796	1.344	.179	-1.722	9.239
Intention (between)	.988	.327	3.021	.003	.347	1.628
Mindfulness	-.258	.115	-2.239	.025	-.483	-.032
*Intention(between)						
Mindfulness (between) on:						
Rumination (between)	-.423	.067	-6.318	<.001	-.555	-.292
Intention (between)	.002	.001	1.628	.100	.000	.004
Rumination*Intention(btwn)	.000	.003	-.028	.977	-.006	.005
Fixed effects						
Intercepts						
Mindfulness (between)	2.669	.026	103.145	<.001	2.618	2.720
Exercise (between)	16.046	7.538	2.129	.033	1.272	30.820
Variances						
Mindfulness (between)	.186	.015	12.726	<.001	.158	.215
Exercise (between)	361.157	65.462	5.517	<.001	232.471	389.463

**Table 36: Parameter estimates of Level 2 mindfulness as a mediator of the Level 1 rumination (at Level 2) to Level 1 alcohol relationship in a multilevel model**

Random Effects	Estimate	(SE)	$t^a$	$p^b$	$CI_{95}$	
					Lower	Upper
Level 1 (within person)						
Alcohol (within) on:						
Rumination (within)	.265	.194	1.366	.172	-.340	.728
Intent to Exercise (within)	.361	.044	8.190	<.001	.2.129	-.729
Rumination*Intent(within)	.078	.113	.689	.491	-.824	3.267
Time(within)	.018	.022	.784	.433	-.081	.066
Level 2 (between person)						
Alcohol (between) on:						
Rumination (between)	.227	.271	.838	.402	-.175	1.449
Mindfulness (between)	-.378	.218	-1.736	.083	-1.022	.464
Intention (between)	1.711	.958	1.797	.072	-10.057	4.367
Mindfulness	-.292	.358	-.816	.415	-4.377	.705
*Intention(between)						
Mindfulness (between) on:						
Rumination (between)	-.434	.065	-6.829	<.001	-.568	-.315
Intention (between)	-.042	.020	2.134	.104	.000	.004
Rumination*Intention(btwn)	-.016	.035	-.454	.650	-.006	.005
Fixed effects						
Intercepts						
Mindfulness (between)	2.673	.026	103.145	<.001	2.618	2.720
Alcohol (between)	1.201	.579	2.074	.038	1.271	5.406
Variances						
Mindfulness (between)	.187	.015	12.726	<.001	.158	.215
Alcohol(between)	1.203	.364	4.561	<.001	1.105	2.915

**Table 37: Parameter estimates of Level 2 mindfulness as a mediator of the Level 1 rumination (at Level 2) to Level 1 sexual risk taking relationship in a multilevel model**

Random Effects	Estimate	(SE)	$t^a$	$p^b$	$CI_{95}$	
					Lower	Upper
Level 1 (within person)						
Sex risk (within) on:						
Rumination (within)	.194	.272	.712	.476	-.340	.728
Intent to Exercise (within)	-1.429	.357	-4.004	<.001	.2.129	-.729
Rumination*Intent(within)	1.221	1.043	1.171	.149	-.824	3.267
Time(within)	-.008	.038	-.203	.839	-.081	.066
Level 2 (between person)						
Sex risk (between) on:						
Rumination (between)	.637	.414	1.537	.124	-.175	1.449
Mindfulness (between)	-.279	.379	-.736	.461	-1.022	.464
Intention (between)	-2.845	3.680	-.773	.439	-10.057	4.367
Mindfulness	-1.836	1.296	-1.416	.157	-4.377	.705
*Intention(between)						
CAMSR (between) on:						
Rumination (between)	-.441	.065	-6.829	<.001	-.568	-.315
Intention (between)	-.244	.150	-1.624	.104	.000	.004
Rumination*Intention(btwn)	-.159	.346	-.459	.646	-.006	.005
Fixed effects						
Intercepts						
Mindfulness (between)	2.673	.026	103.145	<.001	2.618	2.720
Sex risk (between)	3.339	1.055	3.165	.002	1.271	5.406
Variances						
Mindfulness (between)	.187	.015	12.726	<.001	.158	.215
Sex risk (between)	2.051	.483	4.246	<.001	1.105	2.915

## Appendix A: Measures

### Baseline:

Principal Investigator: Crystal L Park

Student: Kristen E Riley

Title of Study: How Rumination Impacts Health Behaviors

**DAY ONE SURVEY- 30 MINUTES** You are invited to participate in this survey of rumination and health. I am a graduate student at the University of Connecticut, and I am conducting this survey as part of my course work. I am interested in finding out how rumination may impact the health behaviors we engage in on a daily basis. Your participation in this study will require completion of the attached questionnaire. This should take approximately (30) minutes of your time. Your participation will be anonymous and you will not be contacted again in the future. You will not be paid for being in this study. This survey does not involve any risk to you. However, the benefits of your participation may impact society by helping increase knowledge about how to increase health in college students. You do not have to be in this study if you do not want to be. You do not have to answer any question that you do not want to answer for any reason. We will be happy to answer any questions you have about this study. If you have further questions about this project or if you have a research-related problem, you may contact me, Kristen Riley (the student) at [Kristen.Riley@uconn.edu](mailto:Kristen.Riley@uconn.edu) or my advisor, Crystal Park, PhD at (860) 486-3520. If you have any questions about your rights as a research participant you may contact the University of Connecticut Institutional Review Board (IRB) at 860-486-8802. The IRB is a group of people who review research studies to protect the rights and welfare of research participants. Please complete the attached survey and return it in the next 24 hours. The nightly surveys start this evening at 8pm. Thank you.

I have read and understood the information above and am ready to begin this study

- ☐ Yes
- ☐ No

Age:

- ☐ 18
- ☐ 19
- ☐ 20
- ☐ 21
- ☐ 22
- ☐ 23 or older

Year in school:

- ☐ Freshman
- ☐ Sophomore
- ☐ Junior
- ☐ Senior
- ☐ Other \_\_\_\_\_

Sex:

- ☐ Male
- ☐ Female
- ☐ Other \_\_\_\_\_

Ethnic Background:

- ☐ Hispanic/Latino
- ☐ Non-Hispanic/Latino

Racial Background:

- ☐ American Indian or Alaskan native
- ☐ Asian
- ☐ Black or African-American
- ☐ Native Hawaiian or Pacific Islander
- ☐ White
- ☐ More than one race \_\_\_\_\_
- ☐ Other \_\_\_\_\_

*Baseline Depression (DASS)*

DASS. Please read each statement and choose a number 0, 1, 2 or 3 that indicates how much the statement applied to you over the past week. There are no right or wrong answers. Do not spend too much time on any statement.

The rating scale is as follows: 0 Did not apply to me at all 1 Applied to me to some degree, or some of the time 2 Applied to me to a considerable degree, or a good part of time 3 Applied to me very much, or most of the time

	Not at All (0)	Some of the Time (1)	A Good Part of the Time (2)	Most of the Time (3)
1. I found it hard to wind down	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. I was aware of dryness of my mouth	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. I couldn't seem to experience any positive feelings at all	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. I experienced breathing difficulty (eg. excessively rapid breathing, breathlessness in the absence of physical exertion)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. I found it difficult to work up the initiative to do things	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. I tended to over-react to situations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. I experienced trembling (eg. in the hands)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. I felt that I was using a lot of nervous energy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9. I was worried about situations in which I might panic and make a fool of myself	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10. I felt that I had nothing to look forward to	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11. I found myself getting agitated	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12. I found it difficult to relax	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
13. I felt down-hearted and blue	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
14. I was intolerant of anything that kept	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



me from getting on with what I was doing				
15. I felt I was close to panic	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
16. I was unable to become enthusiastic about anything	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
17. I felt I wasn't worth much as a person	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
18. I felt that I was rather touchy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
19. I was aware of the action of my heart in the absence of physical exertion (eg, sense of heart rate increase, heart missing a beat)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
20. I felt scared without any good reason	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
21. I felt that life was meaningless	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

*Baseline Mindfulness*

CAMS-R. Directions: People have a variety of ways of relating to their thoughts and feelings. For each of the items below, rate how much each of these ways applies to you.

	Rarely/Not at all (1)	Sometimes (2)	Often (3)	Almost always (4)
1. It is easy for me to concentrate on what I am doing.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. I am preoccupied by the future.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. I can tolerate emotional pain.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. I can accept things I cannot change.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. I can usually describe how I feel at the moment in considerable detail.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. I am easily distracted.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. I am preoccupied by the past.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. It's easy for me to keep track of my thoughts and feelings.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9. I try to notice my thoughts without judging them.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10. I am able to accept the thoughts and feelings I have.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11. I am able to focus on the present moment.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12. I am able to pay close attention to one thing for a long period of time.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

*Baseline Rumination*

RSS. Directions: Please indicate how frequently or infrequently you did each of the following regarding the most stressful event of the day.

	Not at all (1)	Occasionally (2)	Often (3)	Constantly (4)
1. Think about how alone you feel	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. Think "I won't be able to do my job if I don't snap out of this"	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. Think about your feelings of fatigue and achiness	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. Think about how hard it is to concentrate	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. Think "What am I doing to deserve this?"	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. Think about how passive and unmotivated you feel	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. Analyze recent events to try to understand why you are depressed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. Think about how you don't seem to feel anything anymore	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9. Think "Why can't I get going?"	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10. Think "Why do I always react this way?"	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11. Go away by yourself and think about why you feel this way	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12. Write down what you are thinking about and analyze it	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
13. Think about a recent situation, wishing it had gone better	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
14. Think "I won't be able to concentrate if I keep feeling this way"	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

15. Think "Why do I have problems other people don't have?"	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
16. Think "Why can't I handle things better?"	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
17. Think about how sad you feel	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
18. Think about all your shortcomings, failings, faults, mistakes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
19. Think about how you don't feel up to doing anything	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
20. Analyze your personality to try to understand why you are depressed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
21. Go someplace alone to think about your feelings	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
22. Think about how angry you are with yourself	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

*Check*

Have you ever had a fatal heart attack while watching TV?

- ☐ Yes  
☐ No

*Baseline Neuroticism, Extraversion, Optimism*

NEO. Directions: Read each statement below and rate how much each item applies to you.

	Rarely/Never (1)	Occasionally (2)	Often (3)	Almost always (4)	Always (5)
1. I am a worrier.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. I like to have a lot of people around me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. I often feel inferior to others.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. I laugh easily.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. When I'm under a great deal of stress, sometimes I feel like I'm going to pieces.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. I don't consider myself especially "light-hearted."	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. I rarely feel lonely or blue.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. I really enjoy talking to people.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9. I often feel tense and jittery.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10. I like to be where the action is.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11. Sometimes I feel completely worthless.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12. I usually prefer to do things alone.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
13. I rarely feel fearful or anxious.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
14. I often feel as if I'm bursting with energy.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
15. I often get angry at the way people treat me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
16. I am a cheerful, high-spirited person.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

17. Too often, when things go wrong, I get discouraged and feel like giving up.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
18. I am not a cheerful optimist.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
19. I am seldom sad or depressed.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
20. My life is fast-paced.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
21. I often feel helpless and want someone else to solve my problems.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
22. I am a very active person.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
23. At times I have been so ashamed I just wanted to hide.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
24. I would rather go my own way than be a leader of others.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

El. Instructions: Please answer each statement below by selecting number that best reflects your degree of agreement or disagreement with that statement. Do not think too long about the exact meaning of the statements. Work quickly and try to answer as accurately as possible. There are no right or wrong answers. There are seven possible responses to each statement ranging from 'Completely Disagree' (number 1) to 'Completely Agree' (number 7).

[illegible]

[illegible]



21. I would describe myself as a good negotiator.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
22. I tend to get involved in things I later wish I could get out of.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
23. I often pause and think about my feelings.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
24. I believe I'm full of personal strengths.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
25. I tend to "back down" even if I know I'm right.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
26. I don't seem to have any power at all over other people's feelings.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
27. I generally believe that things will work out fine in my life.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
28. I find it difficult to bond well even with those close to me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
29. Generally, I'm able to adapt to new environments	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
30. Others admire me for being relaxed.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please enter your email address (in lowercase letters) in order to receive credit for this survey

You will be receiving your first nightly survey this evening at 8pm. Click on the arrows below (>>) and wait for the thank you page to load in order to finish the survey!

**Daily Diary:**

Principal Investigator: Crystal L Park

Student: Kristen E Riley

Title of Study: How Rumination Impacts Health Behaviors

**DAY 1-11 NIGHTLY SURVEY** You are invited to participate in this survey of rumination and health. I am a graduate student at the University of Connecticut, and I am conducting this survey as part of my course work. I am interested in finding out how rumination may impact the health behaviors we engage in on a daily basis. Your participation in this study will require completion of the attached questionnaire. This should take approximately 5 minutes of your time. Your participation will be anonymous and you will not be contacted again in the future. You will not be paid for being in this study. This survey does not involve any risk to you. However, the benefits of your participation may impact society by helping increase knowledge about how to increase health in college students. You do not have to be in this study if you do not want to be. You do not have to answer any question that you do not want to answer for any reason. We will be happy to answer any questions you have about this study. If you have further questions about this project or if you have a research-related problem, you may contact me, Kristen Riley (the student) at [Kristen.Riley@uconn.edu](mailto:Kristen.Riley@uconn.edu) or my advisor, Crystal Park, PhD at (860) 486-3520. If you have any questions about your rights as a research participant you may contact the University of Connecticut Institutional Review Board (IRB) at 860-486-8802. The IRB is a group of people who review research studies to protect the rights and welfare of research participants. Please complete the attached survey and return it between now (8pm) and 2am. Thank you.

I have read and understood the information above and am ready to begin the survey.

☐ Yes

☐ No

*Daily Exercise*

Since last night, how many times did you do the following kinds of exercise for more than 15 minutes (write on each number on the appropriate line).

1. Strenuous Exercise (Heart Beats Rapidly) (e.g. running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, judo, roller skating, vigorous swimming, vigorous long-distance bicycling)
2. Moderate Exercise (Not Exhausting) (e.g. fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular and folk dancing)
3. Mild Exercise (Minimal Effort) (e.g. yoga, archery, fishing from river bank, bowling, horseshoes, golf, snow-mobiling, easy walking)

*Daily Sexual Risk Taking*

During the past 24 hours, on how many occasions did you...

	0	1	2	3	4	5	6+
1. Have unprotected sex with a monogamous partner (sex without protection against STDs and pregnancy with an exclusive dating partner)?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. Have unprotected sex with a nonmonogamous partner (sex without protection against STDs and pregnancy with a nonexclusive dating partner)?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

#### *Daily Alcohol Intake*

A drink is defined as a 12 oz can/bottle of beer, 4 oz glass of wine, 12 oz can/bottle of wine coolers, or a shot (1.25 oz) of liquor straight or in a mixed drink. During the past 24 hours, how many drinks have you had?

In the past 24 hours, have you missed class, work, or other commitments because of alcohol or a hangover?

- ☐ Yes  
☐ No

### Daily Fruit and Vegetable Intake

Since last night, how often did you drink...

[illegible]

Hi-C, cranberry drink, Gatorade, Red Bull or Vitamin Water? Include fruit juices you made at home and added sugar to. Do not include diet drinks or artificially sweetened drinks.							
---	--	--	--	--	--	--	--

Since last night, please indicate how often you ate...

[illegible]







During the past 24 hours have there been times when you felt you have eaten what other people would regard as an unusually large amount of food (e.g., a quart of ice cream) given the circumstances?

- ☐ Yes  
☐ No

During the times when you ate an unusually large amount of food, did you experience a loss of control (feel you couldn't stop eating or control what or how much you were eating)? .

- ☐ Yes  
☐ No

#### *Daily Cigarette Smoking*

How many cigarettes did you smoke in the last 24 hours?

#### *Check*

I perished in an avalanche in the Alps last summer.

- ☐ Yes  
☐ No

#### *Daily positive and negative affect; PANAS*

This scale consists of a number of words and phrases that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent you have felt this way during the past 24 hours.

	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
Interested	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Excited	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Strong	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Inspired	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Attentive	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Scared	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Proud	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hostile	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Distressed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Enthusiastic	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Irritable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Alert	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ashamed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jittery	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Upset	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Afraid	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Determined	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Guilty	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nervous	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

*Daily Rumination*

Rumination. Please indicate how frequently or infrequently you did each of the following in the past 24 hours:

	Not at all (1)	Ocasionally (2)	Often (3)	Constantly (4)
Think "What am I doing to deserve this?"	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Analyze recent events to try to understand why you are depressed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Think "Why do I always react this way?"	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Go away by yourself and think about why you feel this way	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Write down what you are thinking about and analyze it	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Think "Why can't I handle things better?"	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Think about how sad you feel	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Analyze your personality to try to understand why you are depressed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

*Health Behaviors as Coping*

How did you cope with the rumination you experienced today (above)?

	Not at all (1)	A little (2)	Occasionally (3)	Often (4)	Very much (5)
1. I exercised more than usual	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. I did some specific activity (walk, run, cycle, swim, workout).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. I ate foods that I know are not really good for me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. I ate a lot of snacks	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. I made sure to eat regular meals	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. I made sure to get regular sleep	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. I smoked more than I would usually	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. I gave up any attempt to control my smoking habit	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9. I drank more alcohol than I would normally	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10. I was careful not to drink too much alcohol	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

*Daily Self Control*

Using the scale provided, please indicate how much each of the following statements reflects how you have been today

	Not at all (1)	A little (2)	Occasionally (3)	Often (4)	Very much (5)
1. I am good at resisting temptation.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. I have a hard time breaking bad habits.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. I am lazy.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. I say inappropriate things.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. I do certain things that are bad for me, if they are fun.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. I refuse things that are bad for me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. I wish I had more self-discipline.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. People would say that I have iron self-discipline.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9. Pleasure and fun sometimes keep me from getting work done.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10. I have trouble concentrating.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11. I am able to work effectively toward long-term goals.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12. Sometimes I can't stop myself from doing something, even if I know it is wrong.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
13. I often act without thinking through all the alternatives.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

*Daily Impulsivity*

BIS. Directions: People differ in the ways they act and think in different situations. This is a test to measure some of the ways in which you act and think. Read each statement below and rate how much each item applies to you. Do not spend too much time on any statement. Answer quickly and honestly.

	Rarely/Never (1)	Occasionally (2)	Often (3)	Almost always (4)	Always (5)
1. I plan tasks carefully.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. I do things without thinking.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. I don't "pay attention."	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. I am self-controlled.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. I concentrate easily.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. I am a careful thinker.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. I say things without thinking.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. I act on the spur of the moment.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

*Daily Motivation*

Indicate to what extent each of the following statements corresponds generally to the reasons why you do different things  
Today I struggled to engage in healthy behaviors because...

	(1) Does not correspond accordingly	(2)	(3)	(4) Corresponds moderately	(5)	(6)	(7) Corresponds completely
I do not see the benefit in what I am doing.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It does not make a difference whether I do them or not.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I do not have a good reason for doing them.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I believe they are not worth the trouble.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

*Intention*

Do you intend to exercise tomorrow?

- ☐ Yes  
☐ No

How many minutes do you intend to exercise tomorrow?

Do you intend to engage in unprotected sex tomorrow?

- ☐ Yes  
☐ No

Do you intend to drink alcohol tomorrow?

- ☐ Yes  
☐ No

How many drinks do you intend to have tomorrow?

Do you intend to eat fruits tomorrow?

- ☐ Yes  
☐ No

How many fruits do you intend on eating tomorrow?

Do you intend to eat vegetables tomorrow?

- ☐ Yes
- ☐ No

How many vegetables do you intend on eating tomorrow?

Do you intend to limit your fat intake tomorrow?

- ☐ Yes
- ☐ No

Do you intend to smoke tomorrow?

- ☐ Yes
- ☐ No

How many cigarettes do you intend to smoke tomorrow?

**\*\*Please enter your UConn email address (in lowercase letters) to receive credit for this survey\*\*Example:  
kristen.riley@uconn.edu**

As a result of this survey, if you need to speak to a mental healthcare professional, please call the University of Connecticut's Counseling and Mental Health Services Help Line at 860-486-4705 and ask to speak to the "On-Call Therapist." If this is an emergency, please call 911. If you have any questions about the survey, please contact Kristen Riley at [Kristen.Riley@uconn.edu](mailto:Kristen.Riley@uconn.edu)

Please click the arrows below (>>) to complete the survey, and wait for the Thank You screen to load before exiting your browser window.