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Explication of the Relationship
between Depressive Symptoms, Stress, and Health Behaviors
in Young Adults

A dissertation submitted in partial satisfaction of the
requirements for the degree of Doctor of Philosophy
in Psychology

by

Elizabeth Dolin Dalton

2017
Explication of the Relationship
between Depressive Symptoms, Stress, and Health Behaviors
in Young Adults

by

Elizabeth Dolin Dalton

Doctor of Philosophy in Psychology
University of California, Los Angeles, 2017

Professor Constance L. Hammen, Chair

The current project aimed to clarify several aspects of the relationship between depressive symptoms, stress, and health behaviors among young adults. A large body of research supports bidirectional relationships between depression and poor physical health outcomes, and health behaviors such as substance use, physical inactivity, and poor sleep may serve as modifiable links between depression and physical health. It is particularly important to improve understanding of these processes in young adulthood, a crucial period in the development of physical and mental health. The current study sought, in part, to clarify the relative and interactive effects of chronic, acute, and daily stress in influencing health behaviors and subsequent mood. Results from Study 1 demonstrated that chronic stress, but not acute stress, predicted increased depressive symptoms several years later in part through maladaptive health behaviors, especially poor sleep, among young adults. Results from Study 2 demonstrated that depressive symptoms, chronic stress, and daily stress, but not acute stress, were associated with
higher levels of daily maladaptive health behavior engagement in college students. Contrary to Study 2 hypotheses, youth with elevated depressive symptoms were not more likely to respond to stress with maladaptive health behaviors than youth without elevated depressive symptoms. Results from Study 2 also indicated that fluctuations in daily affect mediated the effects of depressive symptoms on daily maladaptive health behavior engagement, and that individuals endorsing beliefs about the stress-relieving properties of exercise and alcohol consumption (but not smoking and eating) were likelier to engage in these behaviors when facing stress. Together, the current results indicate that chronic stress, depressive symptoms, and daily stress are associated with maladaptive health behavior engagement among young adults. Furthermore, fluctuations in daily affect and beliefs about health behavior engagement may serve as fruitful targets of interventions aimed to ameliorate the deleterious effects of stress and depression on health behaviors.
The dissertation of Elizabeth Dolin Dalton is approved.

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2017
Dedication Page

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# TABLE OF CONTENTS

LIST OF FIGURES ........................................................................................................... vii

LIST OF TABLES .............................................................................................................. vii

ACKNOWLEDGMENTS ................................................................................................. x

VITA/BIOGRAPHICAL SKETCH ................................................................................. xi

CHAPTER 1: GENERAL INTRODUCTION .................................................................. 1
  Project Overview ........................................................................................................ 25

CHAPTER 2: THE INFLUENCE OF CHRONIC AND ACUTE STRESS ON HEALTH
  BEHAVIORS AND SUBSEQUENT DEPRESSIVE SYMPTOMS AMONG YOUNG ADULTS
  (Study 1) ................................................................................................................... 28
  Methods .................................................................................................................... 30
  Results ...................................................................................................................... 36
  Discussion .................................................................................................................. 40

CHAPTER 3: DAILY EFFECTS OF STRESS AND DEPRESSIVE SYMPTOMS ON
  HEALTH BEHAVIORS IN COLLEGE STUDENTS (Study 2) ..................................... 48
  Methods .................................................................................................................... 52
  Results ...................................................................................................................... 73
  Discussion .................................................................................................................. 80

CHAPTER 4: GENERAL DISCUSSION ........................................................................ 101

APPENDIX .................................................................................................................... 120

TABLES ....................................................................................................................... 124

FIGURES ..................................................................................................................... 140

REFERENCES ............................................................................................................. 141
LIST OF FIGURES

Figure 1. Schematic of the structural equation model testing the indirect effect of chronic and acute stress at age 20 on depressive symptoms at age 22-25 via sleep, smoking, and exercise (Study 1)
LIST OF TABLES

Table 1. Intercorrelations, means, standard deviations, and ranges of primary study variables in Study 1 124

Table 2. Descriptive statistics and intraclass correlation coefficients for Life Stress Interview domains (Study 2) 125

Table 3. Proportions of sample meeting diagnostic and/or clinical thresholds on various measures (Study 2) 126

Table 4. Descriptive statistics for baseline measures in Study 2 127

Table 5. Correlations among primary study variables in Study 2 128

Table 6. Descriptive statistics for daily measures in Study 2 129

Table 7. Effects of baseline stress and depression on maladaptive daily health behaviors (Study 2) 130

Table 8. Relative effects of stress and depression on maladaptive daily health behaviors (Study 2) 131

Table 9. Effects of daily stress on maladaptive daily health behaviors (Study 2) 132

Table 10. Effect of 2-way interaction between daily stress and health coping belief in predicting health behavior (eating, drinking, smoking, and exercise; Study 2) 133

Table 11. Effect of 2-way interaction between chronic stress and health coping belief in predicting health behavior (eating, drinking, smoking, and exercise; Study 2) 134

Table 12. Effect of the three-way interaction between daily stress, chronic stress, and health-coping belief in predicting health behavior (exercise, drinking, smoking, and exercise; Study 2) 135
Table 13. Prediction of next-day negative affect by maladaptive health behaviors and daily stress alone, together, and in interaction (Study 2)  

Table 14. Effects of daily affect on daily maladaptive health behaviors (Study 2)  

Table 15. Interaction between daily affect and depression on maladaptive daily health behaviors, controlling for baseline maladaptive health behaviors (Study 2)  

Table 16. Daily positive and negative affect as mediators of the relationship between depressive symptoms and daily maladaptive health behaviors (Study 2)
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CHAPTER 1: GENERAL INTRODUCTION

Depression and Physical Health

Depression and physical health are closely interrelated. Depressive disorders and symptoms are associated with a variety of negative outcomes for physical health, including cardiovascular disease, obesity, hypertension, poor health-related quality of life, and all-cause mortality (Jaycox et al., 2009; Luppino et al., 2010; Meyer, Armenian, & Eaton, 2004; Whooley et al., 2008; Van der Kooy et al., 2007). The relationship between depression and poor physical health is bidirectional: depression is associated with elevated risk of subsequent physical health problems (Van der Kooy et al., 2007; Luppino et al., 2010), and physical health problems are associated with subsequent depression (Roberts, Kaplan, Shema, & Strawbridge, 1999). Furthermore, comorbidity is common: between 20 and 40% of cardiac patients meet criteria for Major Depressive Disorder or demonstrate an increase in depressive symptoms (Celano & Huffman, 2011); obesity rates among individuals with severe depression have been measured at 58% (Simon et al., 2008); and depression rate probability increases in a dose dependent manner with number of chronic physical health conditions (1 condition: 23%; 2 conditions: 27%; 3 conditions: 30%; 4 conditions: 31%; 5 or more conditions: 41%; Gunn et al., 2012).

The presence of comorbid depression and physical health problems predicts worse outcomes than either condition alone. Results from the World Health Organization Survey indicate that depression comorbid with angina, arthritis, asthma, or diabetes is predictive of worse overall health scores than any of these conditions alone, or any combination of these chronic diseases without depression (Moussavi et al., 2007). Depressive symptoms and disorders increase the risk of mortality among individuals with coronary heart disease and other medical illnesses (Barth, Schumacher, & Herrmann-Lingen, 2004; Stover, Fenton, Rosenfeld, & Insel, 2003). Remission from depression is associated with lower utilization and cost of mental health
and general medical services as compared with persistent depression (Simon, Khandker, Ichikawa, & Operskalski, 2006).

Despite the prevalence and severity of comorbid depression and physical illness, the mechanisms by which depression and physical health are connected remain poorly understood to date. Explication of the relationship between depressed mood and poor physical health is of particular importance during the adolescent and young adult years, which are critical periods in the development of both depression and physical health conditions (Kessler et al., 2005; Mulye et al., 2009). During adolescence, all trajectories of elevated depressive symptoms (consistently high, increasing, and decreasing) are associated with poor physical health (Wickrama, Wickrama, & Lott, 2009).

**Mechanisms Linking Depression and Physical Health: Health Behaviors**

Several mechanisms may contribute to the relationship between depressed mood and physical health, including alterations to the body’s physiological stress system, inflammatory processes, and changes to health behaviors such as sleep, eating, substance use, and exercise (Dantzer, O’Connor, Freund, Johnston, & Kelley, 2008; Lopresti, Hood, & Drummond, 2013; Whooley et al., 2008). Health behaviors are of particular importance given that, unlike biomarkers, they are amenable to behavioral intervention (Carek, Laibstain, & Carek, 2011; Luca, Luca, & Calandra, 2013). Furthermore, in a large-scale investigation of the relationship between depression and cardiovascular events in patients with coronary heart disease, the relationship between depression and subsequent cardiovascular events was entirely mediated by health behaviors (Whooley et al., 2008), suggesting that health behaviors play a crucial role in the relationship between depression and physical health outcomes.
The following sections will briefly review existing literature on the relationship between depression and specific selected health behaviors (exercise, smoking, alcohol consumption, sleep, and eating) with a particular emphasis on the relationship between these factors in adolescence and young adulthood. Next, key questions that remain in understanding the relationship between depression and health behaviors, particularly the roles of stress, coping, and affect, will be outlined. Finally, two studies that seek to address these gaps in the literature will be proposed and described.

**Depression and Exercise**

Among high school and college students, depression is associated with a self-reported lack of physical activity (Allgower, Wardle, & Steptoe, 2001). Meta-analytic investigations of the relationship between depression and exercise suggest that individuals who exercise are less depressed than those who do not (Lynette & Landers, 1998). Adolescents’ negative expectations for the future, a facet of depressogenic thinking, predict their subsequent exercise levels in young adulthood, such that perceiving oneself as less likely to attend college predicts decreased exercise levels (McDade et al., 2011).

The relationship between exercise and depression may be explained by a variety of factors. First, cognitive or psychosocial mechanisms may explain why individuals who exercise are less likely to be depressed: physical activity may provide an opportunity for mastery and self-efficacy or self-esteem (Conn, 2010; North, McCullagh, & Tran, 1990); it may serve to detract attention from negative stimuli (Morgan, 1985); and/or it might promote social interaction (Ransford, 1982). Depression may predict subsequent reductions in exercise due to similar mechanisms, for example, depressed individuals may anticipate or experience reduced mastery or pleasure in response to exercise. This is in keeping with studies demonstrating that individuals suffering
from or at risk of developing depression anticipate and experience reduced reward responses, and exhibit less approach-motivation for rewarding activities (Olino et al., 2014; Shankman, Klein, Tenke, & Bruder, 2007). Individuals with elevated depressive symptomatology or risk may be less likely to exercise due to experiences of fatigue and diminished energy. In addition to cognitive and psychosocial mechanisms, there are biological and physiological pathways connecting exercise and mood. Physical activity promotes the release of endorphins into the Central Nervous System (CNS), which promotes improved mood (Allen, 2000). Additionally, physical activity promotes synaptic transmission of monoamines, which have known antidepressant effects (Ransford, 1982; Dunn & Dishman, 1991). Finally, there is evidence to suggest that exercise might promote adult neurogenesis and/or reduce inflammation, which could in turn reduce vulnerability to depressed mood (Gleeson et al., 2011; Ernst, Olson, Pinel, Lam, & Christie, 2006).

Intervention studies provide tentative support for a protective effect of exercise on depression. For example, exercise interventions reduce depressive symptoms in adults with or without clinical depression (Conn, 2010), and improvements in cardiorespiratory fitness among children and adolescents have positive effects on depression and mood status (Ortega, Ruiz, Castillo, & Sjostrom, 2008). Female adolescents with mild to moderate depressive symptoms who were randomly assigned to an eight week group exercise intervention exhibited a decrease in depressive symptoms relative to those who were not (Nabkasorn et al., 2006). In sum, depression and exercise are negatively correlated, and both biological and psychosocial mechanisms likely contribute to bidirectional relationships between them.

**Depression and Cigarette Consumption**
Depression is associated with elevated levels of cigarette use among adolescents and young adults. College students who report any smoking behaviors have higher levels of depression than those who abstain from smoking (Halperin, Smith, Heiligenstein, Brown, & Fleming, 2010). Adolescents who smoke are at increased risk of experiencing depressive symptoms (Steuber & Danner, 2006). Young adults meeting criteria for Major Depressive Disorder have elevated rates of daily cigarette use and nicotine dependence compared to those who do not meet criteria for the disorder (Fergusson, Goodwin, & Horwood, 2003). A longitudinal study demonstrated that adolescents’ negative expectations about the future predicted their cigarette smoking in young adulthood, such that those who perceived themselves as less likely to live to 35 and/or less likely to go to college smoked more cigarettes one year later, controlling for socioeconomic status (McDade et al., 2011).

The relationship between smoking and depression is likely bidirectional. Smoking is associated with an increased risk of subsequent first depressive episode incidence in a dose-dependent manner among young adults (Klungsoyr, Nygard, Sorensen, & Sandanger, 2005). A longitudinal birth cohort study demonstrated support for an effect of cigarette consumption on subsequent depressive symptoms (Boden, Fergusson, & Horwood, 2010). A second longitudinal study demonstrated support for effects of early adolescent depression on early adolescent smoking and vice versa (Tjora, Hetland, Aaro, Wiium, & Overland, 2014).

Individuals suffering from depressed mood may smoke at elevated rates compared to non-depressed individuals due to the acute psychoactive properties of cigarettes. Both nicotine, the addictive substance in cigarette smoke, and the monoamine-oxidase (MAO) inhibitor found in cigarette smoke have psychoactive properties that elicit feelings of calm, well-being, and improved attention and concentration (Quattrocki, Baird, & Yurgelun-Todd, 2000); smoking
may be initiated in an effort to cope with the aversive mood states associated with depression. Chronic nicotine use, however, can be depressogenic due in part to its deleterious effects on neurotransmitters (Boden, Fergusson, & Horwood, 2010), particularly surrounding withdrawal (Picciotto, Brunzell, & Calderone, 2002). There is also emerging evidence to suggest that shared genetic risk factors may contribute to the relationship between depression and smoking (Tsuang, Francis, Minor, Thomas, & Stone, 2012). Overall, there is evidence to suggest that neurochemical changes associated with cigarette smoking contribute to the impact of depression on smoking, and smoking on depression.

### Depression and Alcohol Use

Alcohol use and depression co-occur in both clinical and non-clinical samples (Ayapong, 2013). Results of a longitudinal study indicated that problem-use of alcohol (how often alcohol resulted in behaviors that were later regretted or that hurt relationships), but not alcohol intake at ages 16 and 18, predicted Major Depressive Disorder in young adulthood (Mason et al., 2008). A longitudinal study of young adults found greater frequency of depressive symptoms among heavy drinkers compared to abstainers, but no differences in frequency of depressive symptoms among moderate drinkers and abstainers (Paschall, Freisthler, & Lipton, 2005). This is consistent with other evidence of non-linear relationships between alcohol use and depression among young adults, such that alcohol abstinence and heavy alcohol use, compared to light or moderate use, is associated with lower levels of positive affect and increased levels of depression (Caldwell et al., 2002; O’Donnell, Wardle, Dantzer, & Steptoe, 2006). The observed psychological benefits (or lack of psychological harm) associated with moderate alcohol consumption has been associated with other psychosocial variables, such as social interaction and connectedness, that are related to moderate social drinking (Peele & Brodsky, 2000). Alcohol consumption may influence the
course of adolescent depression: relative to depressed youth who used alcohol regularly or occasionally/not at all, depressed youth who reported excessive use (weekly drunkenness) were less likely to achieve remission from depression and had worse psychosocial functioning one year later (Meririnne et al., 2010).

Meta-analytic investigations have demonstrated support for a causal link between alcohol use disorders and subsequent depressive disorders, which is likely a result of neurophysiological or metabolic changes in response to alcohol exposure (Boden & Fergusson, 2011). Alternatively, or concurrently, alcohol abuse and/or dependence may result in stressful life events and impaired interpersonal relationships that in turn contribute to depressed mood (Agyapong, 2013). There is also support for effects of depression on subsequent alcohol use: relative to individuals with no depression or remitted depression, individuals with current depressive disorders are at an increased risk of first incidence of alcohol dependence (but not abuse) (Boschloo et al., 2013). Individuals experiencing depressive disorders or symptoms may utilize alcohol in an effort to reduce distress or cope with aversive emotions, which is consistent with the “self-medication hypothesis” of alcohol use (Agyapong, 2013). Consistent with this hypothesis, there is evidence that approximately a quarter of individuals with depression report using alcohol or drugs to improve their mood (Bolton, Robinson, & Sareen 2009). As with smoking, there is support for effects of biological and psychosocial mechanisms in the bidirectional relationships between alcohol and depression.

**Depression and Sleep**

Associations between sleep and depression among young adults have been well-established, with evidence to suggest that shared genetic factors and behaviors such as pre-sleep rumination may serve as mechanisms linking the two (Gregory et al., 2011; Vivek et al., 2014).
Nonetheless, it is unclear whether disrupted sleep is a cause, consequence, or correlate (or some combination thereof) of depressed mood. Emerging evidence suggests that sleep might play a role in increasing vulnerability to subsequent depression. Regular sleep disruption may contribute to the development of depression in adults via inhibited neurogenesis (Lucassen et al., 2010; Meerlo et al., 2009). Additionally, some studies have demonstrated support for altered emotional responses, both subjective and objective, in people suffering from insomnia as compared with people without a history of sleep disruption (Scott & Judge, 2006; Baglioni et al., 2010), which may be another pathway connecting sleep and mood. While depression and disturbed sleep are likely bidirectionally linked, the impact of sleep disturbance on subsequent depressive symptoms among young adults warrants further investigation.

**Depression and Eating Behaviors**

Longitudinal investigations provide evidence that, among adults, depression predicts subsequent obesity and vice versa (Luppino et al., 2010). There is evidence to suggest that disturbances in eating behaviors, in particular binge eating and emotional eating, are plausible mechanism linking depression and obesity (Konttinen, Silventoinen, Sarlio-Lahteenkorva, Mannisto, & Haukkala, 2010; Peterson, Latendresse, Bartholome, Warren, & Raymond, 2012). Among high school students, depression is correlated with perceived barriers to healthy eating, unhealthy weight control strategies, and decreased consumption of regular meals (Fulkerson, Sherwood, Perry, Neumark-Sztainer, & Story, 2004). Among early adolescents (ages 10-14), there is a negative association between adolescent depression and diet quality (Jacka et al., 2010). In an observational study, depressive symptoms were positively correlated with overall caloric intake as well as caloric intake from sweet snack foods (Mooreville et al., 2014). Furthermore, eating and weight related disturbances have been proposed as risk factors for
adolescent depression; it has been suggested that negative cognitions related to appearance, eating, and weight control present a cognitive vulnerability for depression during this developmental period (Rawana, Morgan, Nguyen, & Craig, 2010).

In a study utilizing ecological momentary assessment, adults with elevated depressive symptoms reported more emotional eating, more frequent binge eating, and higher levels of daily negative affect relative to adults without elevated levels of depressive symptoms (controlling for BMI; Goldschmidt et al., 2014). Furthermore, emotional eating mediated the relationship between depression and BMI; depressed individuals ate in response to negative affect, and this in turn contributed to higher BMI (Goldschmidt et al., 2014). The impact of daily stress or negative affect on eating behaviors may depend on coping beliefs and expectancies; in a daily diary study of adults, participants who reported that mood control influences their food choices ate more high-fat and high-sugar foods during high stress as compared to low stress weeks (Steptoe, Lipsey, & Wardle, 1998). Overall, there is support for eating as an effort to cope with difficult emotions as a mechanism by which depression predicts poor eating behaviors; conversely, poor eating may be associated with negative self-cognitions and/or low self-esteem, which could predict elevated levels of depressive symptoms.

**Affect and Health Behaviors**

Observed relationships between depressive symptoms/diagnoses and health behaviors may be partially capturing the impact of affect on health behaviors. Negative affect is a broad construct encompassing multiple aspects of subjective distress, including emotions such as sadness, anger, and disgust. Positive affect is not merely the opposite of negative affect, but instead reflects the subjective experience of a range of positive emotions (e.g., happiness, excitement, elation) that occur independently of (and sometimes in tandem with) negative affect.
Depression is generally associated with higher levels of negative affect and lower levels of positive affect (e.g., Strong et al., 2009).

Cross-sectional studies suggest that negative affect is associated with poor health behaviors, including increased cigarette consumption and reduced exercise and fruit intake (e.g., Allgower, Wardle, & Steptoe, 2001; Anton & Miller, 2005). Positive affect has generally been linked with health-promoting behaviors, such as healthy eating and exercise (Griffin, Friend, Eitel, & Lobel, 1993), however, both positive and negative emotions have been linked with increased alcohol consumption (Armeli, Tennen, Affleck, & Kranzler, 2000; Simons, Gaer, Oliver, Bush, & Palmer 2005; Steptoe & Wardle, 1999). A meta-analytic investigation demonstrated support for correlations between self-compassion and adaptive health behaviors (eating habits, exercise, sleep behaviors, and stress management), with small indirect effects of both positive and negative affect on the relationship between self-compassion and adaptive health behaviors (Sirois, Kitner, & Hirsch, 2014). Positive psychological characteristics longitudinally predict health behavior practices: controlling for depression, positive well-being was associated with fewer risky health behaviors (low physical activity, fast food consumption, binge drinking, smoking, and drug use) in young adulthood in the National Longitudinal Study of Adolescent Health (Hoyt, Chase-Lansdale, McDade, & Adam, 2011). A survey study of 265 adults demonstrated that poor health behaviors, in particular poor sleep and medical adherence (such as seeking health care when needed, taking medication as prescribed), served as mediators of the relationship between loneliness, a facet of negative affect, and poor health (Segrin & Passalacqua, 2010).

Little research has explicitly considered the role of affect in the relationship between depression and health behaviors. One experimental study involved the random assignment of
women with remitted MDD and women with no history of MDD to a 15-minute exercise or rest condition followed by sad mood inductions and affect measurements (Mata, Hogan, Joormann, Waugh, & Gotlib, 2013). Results indicated that the sad mood inductions did not produce increases in negative affect in the recovered depressed participants who exercised or the healthy controls; in contrast, the sad mood inductions produced an increase in negative affect among recovered depressed patients who did not exercise. All participants reported increases in positive affect following exercise; however, predicted effects regarding the impact of the sad mood induction on positive affect were not supported. These results suggest that exercise may protect against negative affect following sad or stressful events in women with a history of MDD. As individuals who have recovered from MDD display similar cognitive and affective biases to individuals with current depression (e.g., Fritzsche et al., 2009; Leppanen, 2006), there may be similar protective effects for currently depressed or at-risk individuals.

Models of the Relationships Among Depression, Affect, and Health Behaviors

Further investigation of the relationship between depression, affect, and health behaviors is crucial to the development of interventions aimed at identifying daily triggers of health behavior change among individuals suffering from, or at elevated risk for, depression. There are several plausible models of the relationship between depression, daily affect, and daily health behaviors that warrant further investigation. First, mediational processes might be at play: the influence of depression on daily health behaviors might take place in part through daily experiences of heightened negative affect and/or diminished positive affect. The observed relationship between depression and poor health behaviors may be due in part to daily experiences of negative affect, which is consistent with previous findings of a relationship between depressive symptoms and negative affect (e.g., Strong et al., 2009) and negative affect and poor health practices (Allgower,
Wardle, & Steptoe, 2001; Anton & Miller, 2005). Similarly, reduced experiences of daily positive affect among individuals with elevated depressive symptoms may contribute to fewer instances of health-promoting behaviors (Griffin, Friend, Eitel, & Lobel, 1993).

A second plausible model of the relationship between depressive symptoms, daily affect, and daily health behaviors is one of moderation. Depressed individuals may be more likely than non-depressed individuals to respond to experiences of negative affect with deleterious changes to health behaviors. Previous research has demonstrated that, relative to healthy controls, individuals with depression exhibit higher levels of maladaptive cognitive responses (e.g., rumination) in response to negative affect (Johnson, McKenzie, & McMurrich, 2008); providing some support for poorer coping strategies in response to negative affect among depressed individuals. Similarly, individuals with elevated depressive symptomatology may be less likely than those without elevated depressive symptomatology to respond to experiences of daily positive affect with health-promoting behaviors. Previous research provides preliminary evidence that, relative to healthy controls, individuals with depression suppress or are less likely to amplify positive emotions (Beblo, Fernando, Klocke, Griepenstroh, & Ashenbrenner, 2012; Werner-Seidler, Banks, Dunn, & Moulds, 2013); additionally, they tend to anticipate and experience diminished reward sensitivity in response to positive experiences (Olino et al., 2014; Shankman, Klein, Tenke, & Bruder, 2007). Individuals with elevated depression risk may be less susceptible to health-promoting effects of positive affect and/or more susceptible to unhealthy effects of negative affect. Disentangling these effects is crucial to designing appropriate interventions.

**Stress and Health Behaviors**
It is impossible to consider the relationships among depression, health behaviors, and affect without considering the role of stress. Stressful events and circumstances are known precipitants of poor health behavior practices, depressive episodes, and worsened affect (e.g., Boardman & Alexander, 2011; Hammen 2005; Mroczek & Almeida, 2004). Periods of heightened stress are associated with deleterious effects on a variety of health behaviors and practices. Furthermore, responding to stress with unhealthy behaviors is detrimental: among low-SES individuals, the effect of high stress on mortality is increased in the presence of poor health behaviors (Krueger & Chang, 2008).

Various types of stress have demonstrated influence on health behaviors. Among adults, work-related stress is associated with alcohol abuse and dependence, fat intake, diminished exercise, and cigarette consumption (Crum, Muntaner, Eaton, & Anthony, 2006; McCann, Warnick, & Knopp, 1990; Ng & Jeffery, 2003). Among high-risk pregnant women, perceived stress is associated with fewer health-promoting behaviors (Stark & Brinkley, 2007).

Among college students, examination stress is associated with negative changes to eating, exercise, self-care, alcohol consumption, and smoking behaviors (Ogden & Mitandabari, 1997; Steptoe, Wardle, Pollard, & Canaan, 1996; Weidner, Kohlmann, Dotzauer, & Burns, 1996). The effects of examination-related stress on alcohol may be moderated by social support: among students with high social support, there is evidence of a decrease in alcohol consumption during examination periods, while among students with low social support there is evidence of an increase in alcohol consumption (Steptoe, Wardle, Pollard, & Canaan, 1996). General (not necessarily academic) stress is related to initiation of smoking behavior, alcohol consumption, and obesity among adolescents (Boardman & Alexander, 2011; Byrne, Byrne, & Reinhart, 1995). Among African American adolescents, contextual stress (which includes community
violence, neighborhood disorder, and racial discrimination) longitudinally predicts later substance use (Copeland-Linder, Lambert, Chen, & Ialongo, 2011).

There is evidence to suggest an effect of daily stressors or hassles on daily health behavior practices. Daily hassles predict increases in high fat/sugar snacks and reductions in vegetable consumption and consumption of primary meals (O’Connor, Jones, Conner, McMilan, & Ferguson, 2008). Among college students, several measures of daily stress including perceived stress and stressful events related to peers and work are related to daily alcohol consumption (Aldridge-Gerry et al., 2011). Daily affect and coping strategies have been shown to partially mediate the relationship between daily stressors and alcohol consumption among college students such that positive affect, negative affect, and lower problem-focused coping are associated with more drinking in response to daily stressors (Park, Armeli, & Tennen, 2004). Daily exercise is associated with increased daily positive affect and decreased daily negative affect in college students (Giacobbi, Hausenblas, & Frye, 2005). Among adults, daily negative events and higher levels of perceived stress are associated with daily increased levels of cigarette consumption and urges to smoke (Todd, 2004). Importantly, it has been noted that daily hassles and stressful life events may have differential impacts on specific health behaviors (Cassidy, 2000). Overall, stress exerts a significant influence on health practices, and a variety of stressors including perceived global levels of stress, work and school related stress, and daily stressful events have demonstrated effects on health behaviors.

**Gender Differences in the Relationships Among Depression, Stress, and Health Behaviors**

In examining the relationships among depression, stress, and health behaviors in college students, it is important to consider the impact of gender on these constructs separately and in relationship to one another. It is well-established that women experience depressive disorders at
higher rates than men, beginning in adolescence (Nolen-Hoeksema & Girgus, 1994). Additionally, there is some evidence to suggest gender differences in the experience and reporting of stress. For example, there is some evidence that women report more chronic stress and daily minor stressors than men (Matud, 2004). Previous studies have also demonstrated that women rate stressful life event as less controllable and more negative than men and exhibit greater emotional reactivity to daily life stress than do men (Husky, Mazure, Maciejewski, & Swendsen, 2009; Matud, 2004). One study demonstrated, however, that men who had experienced prior depressive episodes exhibited the same level of emotional reactivity to daily life stress as women (Husky, Mazure, Maciejewski, & Swendsen, 2009). Finally, men and women may be differentially impacted by different types of stress; previous research suggests that gender roles and the nature of stress influence the stress responses of men and women (Lundberg, 2005), with women exhibiting greater susceptibility to interpersonal stress than men (Frankenhauser et al., 1989; Hammen, 2003).

There is also evidence to suggest that men and women differ in their likelihood of engagement in certain health behaviors. One study indicated that men exhibit poorer medical compliance, worse eating behaviors, less preventative health care, and riskier substance use than women (Courtenay, McCreary, and Merighi, 2002). A survey study of Israeli college students demonstrated that men and women differed in several of their positive health behavior practices; specifically, women were more likely to not smoke or drink, to eat breakfast regularly, and to sleep 7-8 hours per night, whereas men were more likely to engage in exercise, avoid snacking, and maintain a healthy body mass index (Soffer, 2010). It is well established that men exhibit higher rates of substance use disorders than women (Eaton et al., 2012).
A few studies have considered gender differences in the relationship between stress and health behaviors. A daily diary investigation demonstrated that although all participants smoked more cigarettes and experienced more urges to smoke on occasions with more negative events and higher levels of perceived stress, these relationships were stronger among men than women (Todd, 2004). A study comparing gender differences in smoking craving and stress reactivity in response to affect induction and neutral or smoking-related cues demonstrated that women exhibited greater craving and stress ratings in response to negative affect scripts (as compared to neutral scripts) than men; men’s and women’s responses to all other mood inductions and cues were comparable (Saladin et al., 2012). With regards to eating behaviors, a stress induction paradigm indicated that, while women’s food consumption increased following a stress induction paradigm, men’s food consumption decreased (Grunberg & Straub, 1992). A study investigating the relationship between stress and heavy drinking in several cross-sectional analyses from late adolescence into early adulthood indicated that, although there was a significant interaction between stress and tension-reduction drinking motives on heavy drinking for men and women, the relationship was consistently stronger for men than women (Rutledge & Sher, 2001). Similarly, a study investigating the relationship between number and type of past-year stressful life events and alcohol consumption indicated a consistent positive relationship between number of past year stressors and all measures of heavy drinking (but not other levels of drinking) for both men and women, however, men’s heavy drinking was more strongly influenced by presence of additional past year stressors than women’s (Dawson, Grant, & Ruan, 2005).

Very few studies have explicitly addressed how depression might differentially impact the influence of stress on health behaviors in men and women. In a survey study of college students, endorsement of depressive symptoms was directly related to binge drinking in men and
indirectly related to binge drinking in women through school-related stress (Pedersen, 2013).

These findings suggest that men’s binge drinking was directly attributable to depressive symptoms, whereas women’s was attributable to depressive symptoms only through other stressors that were themselves related to depression. Existing literature on the relationship between depression and health behaviors among young adults generally supports correlations between depression and poor health practices among both men and women; however, gender differences have been infrequently tested explicitly.

In sum, the existing literature provides evidence that both men and women exhibit worsened health behaviors in response to stress. Furthermore, it seems that depressive disorders and symptoms are associated with worsened health behaviors in both men and women. There is tentative evidence to suggest the strength of the relationship between stress and specific health behaviors may be influenced by gender: men may be more likely than women to respond to stressful circumstances with increased substance use and women may be more likely to exhibit negative changes to their diets. Given that research explicitly considering gender differences in the relationship between depression, stress, and health behaviors is sparse despite established gender differences in rates of depression, stress reporting and reactivity, and health behavior engagement, it is important to test these differences. The current study will seek to test hypotheses regarding the relationships between depression, stress, and health behaviors in the sample as a whole, as well as among men and women separately, should sample size and composition permit.

**Duration of Stress and Impact on Health Behaviors**

When considering the impact of stress on health behaviors, it is important to distinguish between stressors that are acute, singular events and those that are repeated and ongoing, given
that duration of stress has been found to impact various emotional and physiological outcomes. Comprehensively measured chronic stressors have a stronger and more consistent impact on mental and physical health conditions than do acute life events (Thoits, 2010; Schneiderman, Ironson, & Siegel, 2005). Chronic stress tends to be a more potent predictor of depressive episodes than is acute stress (Hammen, 2005). Repeated, but not singular, activation of the body’s physical stress response system is associated with changes to the hypothalamic-pituitary-adrenalcortical (HPA) axis that have negative consequences for physical and mental health (Jackson, Knight, & Rafferty, 2010). This is in keeping with a stress vulnerability model of addiction, which suggests that dysregulation of emotional and physical stress response occurs over periods of prolonged exposure to chronically stressful conditions, which in turn heightens risk of addictive behaviors (Sinha, 2008). While this evidence provides a precedent for the possibility of differential effects of chronic and acute stress on substance use, few studies have examined these distinctions in the health behavior literature. Many studies of health behaviors utilize checklist and self-report measures of perceived stress, which fail to adequately distinguish between or account for differences between chronic and acute stressors (e.g., Koval, Pederson, Mills, McGrady, & Carvajal, 2000; Lund, Reider, Whiting, & Prichar, 2010).

Studies of the effects of daily stressful life events or hassles have by and large failed to consider daily stressors in the context of ongoing life stress. It is conceptually important to understand whether daily stressors independently exert an influence on health behaviors, or whether the previously observed influence of daily stressors on health behaviors is better accounted for by ongoing stressful conditions. Prior studies of daily stressors have largely neglected to measure ongoing or chronic stress, and therefore have been unable to disentangle the impact of daily events and ongoing, chronic conditions. Furthermore, it may be the case that
daily stressors exert the strongest impact on health behaviors when they take place in conditions of ongoing chronic stress; this is in keeping with stress sensitization and kindling research which suggests that ongoing stressful conditions place individuals at increased susceptibility to the adverse effects of subsequent stressors (Monroe & Harkness, 2005).

**Mechanisms Connecting Stress and Health Behaviors**

While a large body of literature assumes that changes to health behaviors in the face of stress reflect efforts to cope with or alleviate distress following stressful situations, this premise has been insufficiently tested in the literature (Park & Iacocca, 2013). Many studies have demonstrated associations between stress and health behaviors, and interpreted these associations in the framework of coping, without explicitly examining whether these behavioral changes are being undertaken as coping efforts (e.g., Ng & Jeffery, 2003). There are, however, some studies that provide support for health-behaviors-as-coping models, with evidence that people who report using health behavior practices to cope with stress are more likely to do so when faced with stressful situations (e.g., Harris, Cronkite, & Moos, 2006). For example, college students who endorse higher drinking-to-cope motivation are more likely to drink on days with greater perceived stress (Park, Armeli, & Tennen, 2004). Similarly, in a cross-sectional study, the relationship between depressive symptoms and tobacco smoking was entirely mediated by students’ beliefs that smoking reduces negative affect (Schleicher, Harris, Catley, & Nazir, 2009). In a study investigating moderators of the relationship between daily hassles and food consumption, emotional eating (a self-reported tendency to eat more in response to emotional arousal) assessed at baseline moderated the relationship between daily hassles and consumption of high fat/sugar snacks (but not fruit or vegetable intake; O’Connor, Jones, Conner, McMilan, & Ferguson, 2008).
In a study of low-SES community residents, residents identified self-medication and self-soothing as reasons for engaging in a variety of poor health behaviors (uncontrolled eating, sleep deprivation, substance abuse, smoking, violence and aggression, and withdrawal and inactivity) during times of heightened stress, suggesting that people identify with health-behaviors-as-coping models (Kaplan, Madden, Mijanovich, & Purcaro, 2013). Among cancer survivors, identification with approach-coping strategies is associated with positive changes to health behaviors while avoidance coping strategies are associated with negative changes to health behaviors (Park, Edmondson, Fenster, & Blank, 2008). As Park & Iacocca (2014) identify, very little is known about the effectiveness of health behaviors as coping strategies, in terms of outcomes such as quality of life or mental health. In the long-term, it is likely that responding to stress with poor health practices would only serve to increase subsequent distress and poor mood, given the previously established prospective relationships between a variety of negative health behaviors and depression.

Efforts to cope with stressors may not be the only mechanism by which stress negatively impacts health behaviors. Stressors might restrict other resources – such as time or energy – which affect health practices. Some positive health practices, such as exercise, getting adequate sleep, and eating healthily, require more time and/or effort than their unhealthy counterparts (not exercising, sleeping less, consuming high-fat or high-sugar foods) and therefore might be neglected during times of perceived or actual limitations to resources. There is some evidence to suggest that stress might influence ability to process and retain information related to health behaviors. Adults reporting higher levels of perceived stress spend less time reading messages about disease detection behaviors than adults reporting lower levels of stress (Millar, 2005). Additionally, unlike adults experiencing low levels of stress, those experiencing high levels of
stress recalled less of the message about disease detection behaviors than of messages about health promotion behaviors.

**Relationship between Stress, Health Behaviors, and Depression**

The relationship between stress and health behaviors is particularly important to understand in the context of depression. As outlined previously, negative changes to health behaviors are one plausible pathway by which depressive episodes and symptoms are associated with poor physical health outcomes. Depressive disorders and symptoms have demonstrated associations with cigarette use, alcohol, exercise, and eating (Ayapong, 2013; Gregory *et al.*, 2011; Konttinen, Silventoinen, Sarlio-Lah延enkorva, Mannisto & Haukkala, 2010; Lynette & Landers, 1998; Peterson, Latendresse, Bartholome, Warren, & Raymond, 2012; Steuber & Danner, 2006; Vivek, Steenburg, Ciesla, Roth, & Drake, 2014). Stressful events and circumstances both predict depressive episodes and symptoms (e.g., Stroud, Davila, & Moyer, 2008) and occur as a consequence of depression (Hammen, 2005). In considering the interactive effects of stress, depression, and health behaviors, it is important to consider two plausible directions of these interactions: 1) responding to stressful events and circumstances with poor health behaviors might increase subsequent depressive symptoms or negative affect, particularly for depressed individuals or individuals at elevated risk of developing depressive symptomatology; and 2) individuals with elevated depressive symptoms may be at heightened risk of responding to stressful circumstances and/or events with poor health behaviors relative to individuals without elevated depressive symptoms. Explication of these two pathways bears implications for better understanding, and therefore ameliorating, the firmly established interrelationship between depression and poor physical health.
Despite plausible associations between stress and health behaviors in the context of depressed mood, relatively little research has focused explicitly on these processes. A ten-year longitudinal study of individuals diagnosed with depression found that participants’ self-reported tendency to exercise to cope with stress, and their reported exercise levels, predicted decreased depression over time (Harris, Cronkite, & Moos, 2006). These results provide evidence that responding to stress with changes in health behaviors can influence subsequent mood, and specifically demonstrates that exercise as coping can be protective against poor mood among individuals diagnosed with depression. Nonetheless, less is known in about the mental health effects of responding to stress with negative changes to health behaviors (Park & Iacocca, 2014), particularly among individuals at elevated risk for developing depression. Changes to health behaviors in response to stress present a plausible pathway by which stressful circumstances are associated with increased depression among adolescents and young adults.

There is evidence that adolescents and young adults with heightened depressive symptoms or risk for depression utilize maladaptive coping strategies in response to stressful circumstances. A cross-sectional survey study demonstrated that higher stress and depression levels were associated with increased likelihood of disengagement coping strategies and smoking behaviors among university students (Sun, Buys, Stewart, & Shum, 2011). A study of adolescents exposed to stressors related to parental psychopathology revealed that this stress was related to adolescents’ symptoms of depression, which were in turn negatively correlated with secondary control engagement coping strategies (e.g., positive thinking, cognitive restructuring, acceptance and distraction) and positively correlated with involuntary engagement coping (e.g., rumination, intrusive thoughts, and emotional and physiological arousal) and involuntary disengagement coping (e.g., avoidance, denial, and wishful thinking; Jaser et al., 2010). Adolescents and young
adults with elevated depressive symptoms are at heightened risk of responding to stressful circumstances with maladaptive coping strategies, which could include deleterious effects on health behaviors, a coping response that seems particularly plausible in light of well-established associations between depression and a variety of poor health behaviors.

It is particularly important to understand the relationship between stress, mood, and health behaviors during adolescence and young adulthood, as these are critical periods in both the development of depressive disorders and behavior patterns that persist into adulthood with consequences for health later in life (Hedberg et al., 1999; Kessler et al., 2005). The majority of adult smokers began smoking in adolescence (Fiore, 1992). Certain health behaviors – including drinking, smoking, and exercise – occur at the highest rates among young adults, and are less prevalent with age (Vierck & Hodges, 2003). Furthermore, life course research indicates that the effects of stress on health behaviors vary with age, and young adults are particularly likely to use health behaviors (e.g., smoking, drinking, exercise) in response to stress (Umberson, Liu, & Reczek, 2008).

**Methodological Limitations Affecting Prior Studies of Depression, Stress, and Health Behaviors**

In addition to addressing theoretical and conceptual gaps in the existing literature on the relationship between depression, stress, and health behaviors, the current proposal seeks to improve upon several methodological shortcomings that have hindered previous work. First, the proposed studies will use an interview-based measure of stress which distinguishes between acute and chronic stress and allows for an interviewer-based, objective assessment of stressfulness (UCLA LSI; Hammen, Henry, & Daley, 2000). As outlined previously, chronic and acute stress have different effects on various aspects of mental and physical health (e.g., Thoits,
2010; Schneiderman, Ironson, & Siegel, 2005), however, many investigations of the relationship between stress and health have relied upon self-report or checklist measures of stress that fail to account for stress chronicity or context and typically involve subjective judgments of stressfulness, which are confounded with negative affect (e.g., Koval et al., 2000; Lund et al., 2009). Second, the presently proposed daily study will include baseline measures of participants’ typical health behavior practices. This will allow for calculation of within-person deviations from standard health behavior engagement, which is an improvement over studies failing to account for participants’ typical health behavior engagement (e.g., Goldschmidt et al., 2014; O’Grady, Harman, Gleason, & Wilson, 2012). Third, the present daily diary study will explicitly measure and test participants’ beliefs about health behaviors as coping rather than assuming that health behaviors occurring in tandem with daily stressors represent efforts to cope (Park & Iacocca, 2014). Fourth, the proposed studies will measure and control for participants’ past depressive episodes; given that individuals with a history of depression are known to exhibit behavioral and affective responses to stress that are similar to individuals with current elevations in depression, it is important to account for a history of prior mood episodes (Fritzsche et al., 2009; Leppanen, 2006). Finally, the present studies will include prospective evaluations of stress, affect, and health behaviors in both a longitudinal and daily diary sample, which will allow for testing of temporal associations that will extend the literature beyond correlational evaluations. These methodological improvements will allow the present investigation to make a unique contribution to our field’s understanding of the relationship between depression, stress, affect, and health behaviors.
PROJECT OVERVIEW

The proposed dissertation studies aim to clarify several key facets of the relationship between depression and poor health behaviors in young adulthood that remain poorly understand to date. First, these studies will seek to clarify the effects of stress chronicity on health behaviors, both in youth at elevated risk of developing depressive disorders and in individuals with and without elevated depressive symptoms. Previous health behaviors research has largely failed to differentiate between duration of stressors, and has not adequately considered the impact of daily stressors/hassles on health behaviors in the context of ongoing stress, despite evidence that chronically stressful conditions sensitize responsiveness to subsequent stressors (Monroe & Harkness, 2005). Second, these studies will examine whether individuals with elevated depressive symptoms and/or at heightened risk for developing depression are more likely than non-depressed individuals to respond to stressful events with poor health behaviors, a response consistent with established patterns of maladaptive coping responses in the face of stress among adolescents and young adults at elevated risk for depression (Jaser et al., 2010; Sun, Buys, Stewart, & Shum, 2011). Third, these studies will seek to examine negative changes to health behaviors in the face of stress as a pathway by which stress produces increases in depressive symptomatology and negative affect, a mechanism consistent with evidence that stressors tend to precipitate depressive episodes, and literature supporting a prospective effect of poor health behaviors on depression (e.g., Hammen, 2005; Allgower et al., 2001; Klungsoyr, Nygard, Sorensen, & Sandanger, 2005). Fourth, the second proposed study will seek to explicate the role of affect (both positive and negative) and coping beliefs in the daily relationship between stress and health behaviors, given that these have been previously understudied in the context of the depression-health behaviors relationship, despite established independent relationships with both
constructs (e.g., Anton & Miller, 2005; Farmer et al., 1988; Griffin, Friend, Eitel, & Lobel, 1993; Parker, Parker, Harford, & Farmer, 1987; Strong et al., 2009, Allgower, Wardle, & Steptoe, 2001).

The current dissertation seeks to address these key questions using two studies. Study 1 will involve secondary data analysis of an existing longitudinal dataset that is uniquely well-suited to study the impact of chronic and acute stress on several distinct health behaviors (exercise, alcohol consumption, cigarette use, and sleep) and subsequent increases in depressive symptoms over time among young adults at elevated risk of developing depression. Study 2 will involve original data collection designed for this dissertation to assess naturally occurring daily relationships between stress, affect, and health behaviors (exercise, alcohol consumption, cigarette use, sleep, and food intake) among college students with and without elevated depressive symptoms. These studies will address five primary questions, as outlined below, regarding the relationships between stress, depression, and health behaviors.

1. Does responding to stressors with changes to health behaviors influence subsequent mood?
   a. Study 1 will test a structural equation model of the impact of stress on health behaviors and subsequent increases in depressive symptoms in a longitudinal dataset of young adults oversampled for history of maternal depression (and thus at elevated risk for developing depression).
   b. Study 2 will utilize multilevel modeling to test the effect of responding to daily stress with negative changes to health behaviors on next-day negative affect among college students oversampled for elevated depressive symptoms.
2. Are individuals with elevated depressive symptoms more likely to respond to stress with changes to health behaviors than individuals without elevated depressive symptoms?
   a. Study 2 will examine whether depressive symptoms moderate the effects of stress on health behaviors among college students.
3. In what way are daily experiences of positive and negative affect associated with the relationship between depression and health behaviors?
   a. Study 2 will test daily negative and positive affect as mediators of the relationship between depressive symptoms and health behaviors.
   b. Study 2 will test daily negative and positive affect as moderators of the relationship between depressive symptoms and health behaviors.
4. Does the chronicity of stress differentially affect health behavior practices?
   a. Study 1 will compare the prospective effects of chronic and acute stress on smoking, alcohol consumption, and sleep among young adults.
   b. Study 2 will compare the effects of chronic stress, acute stress, and daily stress on cigarette use, alcohol consumption, sleep, exercise, and eating among college students. Study 2 will additionally examine the interactive effects of daily hassles and chronic stress on these daily health behaviors.
5. Is the relationship between stress and daily health behaviors moderated by beliefs about specific health behaviors as coping tools?
   a. Study 2 will examine baseline health-behavior coping beliefs as moderators of the relationship between stress and daily health behaviors.
CHAPTER 2: THE INFLUENCE OF CHRONIC AND ACUTE STRESS ON HEALTH BEHAVIORS AND SUBSEQUENT DEPRESSIVE SYMPTOMS AMONG YOUNG ADULTS (Study 1)

Abstract

The role of poor health behaviors in the relationship between stress and subsequent depressive symptoms in young adults has not been adequately examined. The current study examined the longitudinal relationships between stress and self-reported sleep, cigarette use, alcohol consumption, exercise, and subsequent changes to depressive symptoms, in a community sample of young adults at elevated risk for developing depression. Structural equation modeling was used to assess the impact of stress, both chronic and acute, at age 20, on depressive symptoms at ages 22-25, directly and through health behaviors at age 21. Results demonstrated significant indirect effects of stress on depressive symptoms through health behaviors, especially sleep, as one pathway by which stress influences later depressive symptoms ($\beta = .06, SE = .03, p = .02$). These findings highlight the mental health consequences of maladaptive health behaviors, particularly poor sleep, in response to stress. Findings underscore the importance of attending to sleep problems and other maladaptive health behaviors in young adults exposed to high levels of stress, or otherwise at elevated risk for developing depression.

Introduction and Hypotheses

Study 1 explored the effects of chronic and acute stress on health behaviors and subsequent changes to depressive symptoms in a longitudinal dataset of young adults, oversampled for history of maternal depression. Health behaviors were considered as a pathway by which stress leads to depressive symptoms, given their established associations with periods
of heightened stress and correlations with depression (e.g., Hammen, 2005; Allgower et al., 2001; Klungsoyr, Nygard, Sorensen, & Sandanger, 2005). A comprehensive, interview-based measure of objective levels of chronic and acute stress across multiple life domains was used in order to disentangle the relative effects of chronic and acute stress on specific health behaviors. Study 1 considered cigarette use, alcohol consumption, sleep, and exercise in young adulthood as all of these behaviors have known relationships with depression and stress, and are potentially amenable to behavioral intervention (Carek, Laibstain, & Carek, 2011; Luca, Luca, & Calandra, 2013).

1. It is predicted that both chronic and acute stress will predict negative health behaviors in young adulthood. In keeping with previous evidence of particularly potent effects of chronic stress on depressive symptoms and other mental and physical health outcomes in young adults (e.g., Hammen, 2005; Schneiderman, Ironson, & Siegel, 2005; Thoits, 2010), it is predicted that the relationship between chronic stress and health behaviors will be stronger and more consistent than the relationship between acute stress and health behaviors.

2. It is predicted that stress will influence later depressive symptoms in part through negative health behaviors, in keeping with prior evidence of a predictive relationship between health practices and subsequent depression (e.g., Strawbridge, Deleger, & Roberts, 2002).

1a and 2a. If sample size permits, the aforementioned hypotheses will be tested separately among men and women; otherwise, gender will be controlled for in the model to account for possible gender differences in stress, health behaviors, and mood.
Methods

Participants

The current study includes 439 young adults (231 females) drawn from a sample of 815 participants selected at age 15 from a larger birth cohort study in Brisbane, Australia intended to oversample for history of maternal depression (Hammen and Brennan, 2001; Keeping et al., 1989). The current sample is restricted to youth participating in study procedures at age 20 ($n = 439$). The current study utilizes data from youth at age 20, 21 ($n = 300$), and between the ages of 22 and 25 ($n = 285$).

Participants included in the sample of 439 did not differ from those not selected from the larger sample of 815 regard to maternal depression history at youth age 15 ($\chi^2(1, 815) = .08, p = .78$) or gender ($\chi^2(1, 815) = 3.32, p = .07$).

Participants retained at age 21 did not differ from those participating only at age 20 with regard to maternal depression history at youth age 15 ($\chi^2(1, 439) = .11, p = .75$), depressive symptoms at youth age 20 ($t(437) = .04, p = .97$), acute stress at age 20 ($t(437) = 1.25, p = .21$), or chronic stress at age 20 ($t(437) = .12, p = .91$). Youth not retained at age 21 were more likely to be male ($\chi^2(1, 439) = 17.13, p = .00$).

Participants retained at ages 22-25 did not differ from those lost after age 21 with regard to maternal depression history at youth age 15 ($\chi^2(1, 439) = 0.67, p = .41$), youth depressive symptoms at age 20 ($t(437) = .73, p = .47$), acute stress at age 20 ($t(437) = 1.06, p = .29$), chronic stress at age 20 ($t(437) = -.13, p = .90$), weekly vigorous exercise at age 21 ($t(298) = -.30, p = .77$), weekly less vigorous exercise at age 21 ($t(298) = -.56, p = .58$), weekly walking at age 21 ($t(299) = .46, p = .65$), or alcohol consumption at age 21 ($t(306) = -1.46, p = .15$). Youth not retained at age 22-25 were more likely to be male ($\chi^2(1, 439) = 14.53, p < .001$).
The sample was predominantly white (92% white, 4% Asian, 4% other/not reported). Median family income fell in the working/lower middle class.

**Procedure**

Participants and their mothers completed interviews and questionnaires in their homes at participant ages 20 and 21. Participants were re-contacted between ages 22 and 25 about completing additional study procedures, and those who agreed were sent consent forms, questionnaires and other study materials in the mail. All procedures were approved by Institutional Review Boards of the University of Queensland, University of California, Los Angeles, and Emory University. Participants provided written informed consent and were compensated for their time.

**Measures**

**Acute stress.** Youth completed the UCLA Life Stress Interview (LSI; Hammen, Henry, and Daley, 2000) at age 20. The LSI is a semi-structured interview that uses standard general probes to elicit specific life events in the past 12 months with follow-up questions to establish the timing and surrounding circumstances associated with each event. Rating teams blind to youths’ actual responses to the events were presented with narratives of each event written by the interviewers. The rating team provided a rating based on the impact this event would be expected to have on an average person in the same circumstances (contextual threat). Severity scores ranged from 1 (no impact) to 5 (extremely severe impact). Interrater reliability analyses in the present sample (for 89 cases) yielded intraclass correlations of 0.95 for severity ratings.

A total objective acute stress score for each participant was calculated by summing the rating team’s severity ratings across all reported acute events. The UCLA LSI is a reliable and
valid assessment of acute and chronic life stress in adolescents and young adults (Hammen et al., 1995).

**Chronic stress.** Youth chronic stress was also measured using the LSI at age 20. In addition to probing for specific events, interviewers provided an overall objective stress rating for each of several content domains (friends, family, romantic relationship, school and/or work, and finances) using behaviorally specific anchors. Ratings ranged from 1 (no stress; superior circumstances) to 5 (severe stress; major ongoing difficulties). Interrater reliabilities across domains in the present sample ranged from 0.76 to 0.82. A total chronic stress score was calculated by summing across all domains for each participant in the six months prior to the age 20 interview.

**Total stress burden.** Participants’ total stress burden was calculated by creating a composite score of recent acute stressors and ongoing chronically stressful circumstances. In keeping with previous research utilizing a comprehensive stress measurement, this composite was created by standardizing the acute and chronic stress variables and summing them (Hazel, Hammen, Brennan, & Najman, 2008; Turner & Turner, 2005).

**Depressive symptoms.** Self-reported depressive symptoms at ages 20 and 22-25 were assessed using the Beck Depression Inventory-II (BDI-II; Beck, Steer & Brown, 1996), a well-validated and widely used measure of severity of depressive symptoms. Coefficient alpha reliability for the current sample was $\alpha = 0.93$ at age 20, $\alpha = 0.94$ at ages 22-25.

**Health behaviors.** Cigarette use, exercise, alcohol consumption, and sleep were assessed via youth self-report questionnaires at age 21.

**Cigarette use.** Cigarette use was quantified as average daily number of cigarettes consumed in the past week (0, 1-9, 10-19, 20-29, 30-49, or 50+). Previous studies have utilized
self-report measures of average number of cigarettes smoked daily with young adults (e.g., Emery et al., 2012; Goodwin, Perkonigg, Hofler & Wittchen, 2012), and such items have demonstrated reliability with daily diary measures of cigarette consumption (Harris et al., 2009).

**Exercise.** A latent variable for exercise was created using three exercise-related questions that assessed average weekly frequency of vigorous exercise, less vigorous exercise, and walking over the past 6 months (not at all, 1-2 times per week, or 3 or more times per week). Previous studies have utilized adolescent/young adult self-report of weekly vigorous exercise, non-vigorous exercise, and walking (e.g., Sund, Larsson, & Wichstrom, 2011; van Poppel, Chinapaw, Mokkink, van Mechelen & Terwee, 2010), with demonstrated reliability and validity for such self-report measures (Booth, Okely, Chey, & Bauman, 2001).

**Sleep.** A latent variable for sleep behavior was created using three sleep-related questions that assessed weekly frequency of waking during the night, restlessness during sleep, and daytime drowsiness over the past month (less than 1 time per week, 1-2 times per week, or 3 or more times per week). Past-month assessment of frequency of sleep difficulties have previously been used in young adult samples (Thomee, Harenstam, & Hagberg 2011); furthermore, assessment of frequency of waking in the night and daytime sleepiness are similar to measures included in the Pittsburgh Sleep Quality Index, a well validated and widely used sleep survey (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989).

**Alcohol.** Alcohol consumption was measured as a rating of average daily alcoholic beverage consumption (0, 0-.5, .5-1, 1-3.5, 3.5 or more drinks per day). Self-reported average daily alcohol consumption is a standard measure of alcohol consumption with demonstrated reliability and validity (Leigh, 2000; Young, Connor, Ricciardelli & Sanders, 2006).
Maternal depression diagnoses. As the study sample was selected on the basis of maternal depression history (or absence of history) at youth age 15, maternal depression status was tested as a moderator of the model. Maternal depression was measured using the Structured Clinical Interview for DSM-IV Axis-I Disorders, Patient Edition (SCID; First et al., 1997), a reliable and well-validated semi-structured clinical interview. The SCID covers the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM-IV) criteria for adult Axis I psychopathology. The SCID was administered to mothers to assess lifetime and current depressive disorders (Major Depressive Disorder and dysthymia) at youth age 15. Mothers’ current or lifetime depressive disorders (weighted kappas = 0.87 and 0.84, respectively) at youth age 15 defined maternal depression history in the present analyses. In the present sample, 194 (44%) participants had mothers endorsing past or current depression at youth age 15.

Youth Past Depression. Youth past depression was included as a covariate in the model to control for the possible influence of depression history on effects of stress on health behaviors. Participants were administered a structured diagnostic interview at age 15 and 20. At age 15, youth current and past depressive disorders (Major Depressive Disorder and dysthymia) were assessed using the K-SADS-E (Orvaschel, 1995). In the present sample, 58 participants (13%) endorsed current or past depressive disorders at age 15. At age 20, youth completed the SCID-IV (First et al., 1997) to assess occurrence of past depressive disorders between ages 15 and 20.

Family Income. Family income was assessed using mothers’ ratings of annual income on a 7-point scale at youth age 15. Family income was included as a covariate of the model in order to assess whether effects of stress on subsequent health behaviors and depressive symptoms were better accounted for by socioeconomic status.

Data Analytic Procedures
A structural equation modeling (SEM) framework was used to examine the indirect effects of stress (total, chronic, and acute) at age 20 on depressive symptoms at ages 22-25, via health behaviors at age 21, and controlling for the role of depressive symptoms at age 20 (see Figure 1). Youth gender and maternal depression history by youth age 15 were controlled for in all paths in which they were significant predictors. All analyses were carried out in Mplus v5 (Muthén and Muthén, 1998-2007), using full information maximum likelihood methods to accommodate missing data (Allison, 2012). Due to univariate and multivariate non-normality of the data, robust maximum likelihood procedures were used to estimate standard errors. Overall model fit was evaluated using several standard fit indices, including the likelihood ratio chi-square test, the comparative fit index (CFI; Bentler, 1990), the root-mean-square error of approximation (RMSEA; Browne and Cudeck, 1993), and the standardized root mean-square residual (SRMR; Hu and Bentler, 1998).

A second model, identical to the first but including family income as a covariate in paths predicting health behaviors from total stress burden was run to test whether the effects of stress were largely accounted for by financial stress. Similarly, a third model including youth past depression as a covariate in paths predicting health behaviors from total stress burden was run to test whether the effects of stress were largely accounted for by youth past depression.

Additionally, gender and maternal depression were tested as potential moderators of the model using Wald Tests. These tests were conducted to explore whether there were differences of the effects of stress on health behaviors and subsequent depression for men and women, and for individuals with and without a history of maternal depression. Previous research supports an effect of gender and maternal depression on mood and stress (e.g., Hammen, Shih, & Brennan, 2004; Nolen-Hoeksema, 2001; Wilson, Pritchard, & Revalee, 2004). A significant Wald Test
would indicate that the model fit differs significantly for the groups or variables tested; in this case, this would indicate differences in the relationships amongst these variables for men and women, or for youth with and without a history of maternal depression.

**Results**

**Descriptive Statistics**

Descriptive statistics for age 20 chronic and acute stress, age 21 health behaviors, and BDI scores at ages 20 and 22-25, and bivariate zero-order correlations among the variables, are presented in Table 1. The single-item alcohol consumption measure was not significantly correlated with age 20 total stress \( (r = .01, p = .88) \), chronic stress \( (r = -.05, p = .41) \), acute stress \( (r = .06, p = .29) \) or age depressive symptoms at age 20 \( (r = .06, p = .32) \) or 22-25 \( (r = .13, p = .05) \) and therefore was not included in the structural equation model.

**Structural Equation Model: Total Stress Burden**

A structural equation model was run predicting smoking, exercise, and sleep from total stress burden, and predicting youth depressive symptoms at age 22-25 from each of the health behaviors (Figure 1). Fit indices indicated that overall the hypothesized model provided an adequate fit to the data \( \chi^2 (df = 44, n = 439) = 83.57, p = < .001; \ CFI = .92; \ RMSEA = .05 \ (90\% \ CI .03, .06); \ SRMR = .06. \) Factor loadings provided evidence that frequency of vigorous exercise \( (\beta = .50, SE = .08, p < .001) \), frequency of less vigorous exercise \( (\beta = .67, SE = .09, p < .001) \), and frequency of walking \( (\beta = .47, SE = .08, p < .001) \) were indicators of a single latent factor of exercise. In addition, factor loadings suggested that restless sleep \( (\beta = .75, SE = .04, p < .001) \), daytime drowsiness \( (\beta = .63, SE = .05, p < .001) \), and overall sleep quality \( (\beta = .76, SE = .04, p < .001) \) were indicators of a single latent factor of sleep quality.
Total stress burden at age 20 predicted more smoking (β = .19, SE = .07, p = .01) and worse sleep (β = .17, SE = .06, p = .01), but not less exercise (β = -.03, SE = .08, p = .67), at age 21 over and above the effects of depressive symptoms at age 20. Poorer sleep at age 20 predicted depressive symptoms at ages 22-25 (β = .35, SE = .07, p < .01). Depressive symptoms at ages 22-25 were not significantly predicted by smoking (β = .07, SE = .05, p = .20) or exercise (β = .12, SE = .07, p = .10) at age 20.

Tests of indirect effects indicated that there was a significant total indirect effect of stress burden at age 20 on depressive symptoms at ages 22-25 (controlling for depressive symptoms at age 20) through health behaviors at age 21 (β = .07, SE = .03, p = .02), which was largely accounted for by a significant unique indirect effect of sleep at age 21 (β = .06, SE = .03, p = .02). The effect sizes associated with the mediators were calculated in accordance with guidelines recommended by Preacher & Kelley (2011) and Kenny (2015); the product of the partial correlations associated with the paths from predictor to mediator (‘a’ paths) and mediator to outcome (‘b’ paths) were calculated and then compared to the squared traditional effect size estimates (thus, a small effect size is .01, medium is .09, and large is .25). Accordingly, sleep (r = .06) and smoking (r = .013) yield small effect sizes as mediators of the relationship between total stress burden and subsequent depressive symptoms.

**Comparing Chronic and Acute Stress**

In order to compare the individual and relative effects of chronic and acute stress in the model, three additional models were run. First, a model of the effect of chronic stress at age 20 on health behaviors at age 21 and depressive symptoms between ages 22 and 25 was run. The resulting model was very similar in model fit and path significance to the total stress burden model ($\chi^2 (df = 44, n = 439) = 83.47, p < .001; \text{CFI} = .92; \text{TLI} = 0.89; \text{RMSEA} = .05$ (90% CI
The pattern and significance of all direct and indirect paths were identical to the original model. Chronic stress was a significant predictor of smoking ($\beta = .22, SE = .07, p = .02$) and sleep ($\beta = .16, SE = .06, p = .01$), but not exercise ($\beta = -.11, SE = .08, p = .02$), over and above the effects of age 20 depressive symptoms, and there was a significant total indirect effect of chronic stress on depressive symptoms through health behaviors ($\beta = .06, SE = .03, p = .02$), which was accounted for by the specific indirect effects of sleep ($\beta = .06, SE = .03, p = .02$).

A second model looking at the effect of acute stress at age 20 on health behaviors at age 21 and depressive symptoms between ages 22 and 25 was run. The resulting model was very similar in model fit to both the total stress burden model and the chronic stress model ($\chi^2 (df = 44, n = 439) = 85.65, p = < .001; CFI = .92; TLI = 0.89; RMSEA = .05 (90% CI .03, .06); SRMR = .06$). Certain paths of the acute stress model, however, differed from those of the chronic stress model and total stress burden models. Acute stress alone was not significantly predictive of sleep ($\beta = .12, SE = .07, p = .07$), smoking ($\beta = .09, SE = .07, p = .16$), or exercise ($\beta = .04, SE = .08, p = .64$). Additionally, while there was still a significant total indirect effect of acute stress on depressive symptoms through health behaviors ($\beta = .05, SE = .02, p = .03$), none of the individual health behaviors emerged as significant unique mediators of the relationship.

Finally, a third model was run in which acute and chronic stress were both included as predictors, in order to compare their relative effects, over and above one another. As expected, the overall model fit did not differ from previous models ($\chi^2 (df = 49, n = 439) = 87.99, p = < .001; CFI = .92; TLI = 0.89; RMSEA = .04 (90% CI .03, .06); SRMR = .05$). When acute and chronic stress were included in the model as separate predictors, chronic but not acute stress was a significant predictor of sleep (Chronic: $\beta = .13, SE = .07, p = .04$; Acute: $\beta = .08, SE = .07, p = .
.21) and smoking (Chronic: $\beta = .20, SE = .07, p < .01$; Acute: $\beta = .04, SE = .06, p = .50$); neither was predictive of exercise (Chronic: $\beta = -.13, SE = .09, p = .15$; Acute: $\beta = .07, SE = .09, p = .42$). Tests of indirect effects indicated that, when included as separate predictors, neither chronic stress ($\beta = .05, SE = .03, p = .11$) nor acute stress ($\beta = .04, SE = .02, p = .09$) significantly predicted indirect effects on depressive symptoms through health behaviors.

**Financial Strain**

A model was run controlling for family income in the paths where total stress burden was a predictor, in order to test the unique effects of non-financial stressors on health behaviors, over and above the effects of financial hardship. Model fit did not differ from the original model, indicating adequate fit, $\chi^2 (df = 50, n = 439) = 87.33, p < .001$; CFI = .93; TLI = .90; RMSEA = .04 (90% CI .03, .06); SRMR = .06. The pattern and significance of all direct and indirect paths were identical to the original model. Total stress burden continued to be a significant predictor of smoking ($\beta = .19, SE = .07, p = .01$) and sleep ($\beta = .17, SE = .06, p = .01$), but not exercise ($\beta = -.04, SE = .08, p = .63$) over and above the effects of financial hardship and age 20 depressive symptoms.

**Maternal Depression**

The results of the Wald Test of Parameter Constraints indicated no significant differences in model fit among youth with and without a history of maternal depression (value = 11.70, $df = 12, p = .47$).

**Youth Gender**

The results of the Wald Test of Parameter Constraints indicated no significant differences of the model among men and women (value = 15.97, $df = 12, p = .19$).

**Youth Past Depression**
In order to ascertain whether or not the observed effects were attributable to youth having a history of depression, a model was run in which youth history of depression by age 15 was included as a covariate in paths between total stress burden at age 20 and health behaviors at age 21. Fit indices indicated that this model did not differ from the original model, and provided an adequate fit to the data, $\chi^2 (df = 52, n = 439) = 96.48, p < .001$; CFI = .91; TLI = .88; RMSEA = .05 (90% CI .03, .06); SRMR = .06. The pattern and significance of all direct and indirect paths were identical to the original model.

**Discussion**

The current study examined cigarette use, exercise, alcohol consumption, and sleep as indirect pathways from chronic and acute stress to depressive symptoms in a sample of young adults at elevated risk for depression by virtue of exposure to maternal depression. Total stress burden at age 20 predicted smoking and sleep at age 21, such that higher levels of stress were associated with higher levels of cigarette consumption and poorer sleep, over and above the effects of age 20 depressive symptoms. The relationship between total stress burden and exercise was not significant. There were significant indirect effects of total stress burden at age 20 on depressive symptoms at ages 22-25, which were largely accounted for by the indirect effect of sleep. These findings partially support study hypotheses, and indicate that stress levels in early adulthood (age 20) are predictive of smoking behavior and poor sleep a year later. Furthermore, poor sleep may serve as a mechanism by which higher levels of stress predict increased depressive symptoms over the course of young adulthood.

**Alcohol Consumption, Stress, and Depression**

Contrary to study hypotheses and previous research, alcohol consumption at age 21 was not significantly predicted by either type of stress at age 20, nor was it related to age 22-25.
depressive symptoms. It is possible that present findings differ from past research due to use of a single-item measure of alcohol consumption, rather than assessments of clinical diagnoses of alcohol abuse or dependence. This might be particularly problematic in a sample of young adults, a developmental stage during which alcohol consumption (as distinct from alcohol use disorders) is relatively prevalent and accepted (Schulenberg & Maggs, 2002).

Exercise, Stress, and Depression

Also contrary to study hypotheses, exercise did not emerge as significantly predicted by stress or predictive of changes to depressive symptoms in the structural equation model. In general, prospective associations of the relationship between stress and exercise and/or physical activity have demonstrated support for a negative effect of stress on exercise (Stults-Kolehmainen & Sinha, 2014), although the findings are not wholly consistent. A study of over 500 adolescents found that perceived stress was associated with lower exercise rates when measured at the same time point, but perceived stress did not predict exercise rates measured ten months later (Gerber, Lindwall, Brand, Lang, & Elliot, 2015). Notably, the present results do not indicate a lack of relationship between stress and exercise, as chronic stress at age 20 was associated with less exercise at age 21 in zero-order correlations. This suggests that the relationship between chronic stress and exercise was not as strong as those with smoking or sleep, and perhaps additional factors play a greater role in the prediction of exercise behaviors over time. Prior research indicates that certain individuals exercise more in response to heightened stress, this is particularly true for individuals who already exercise habitually and endorse other proactive coping styles (Cairney, Kwan, Velduizen, & Faulker, 2014). The effect of stress on exercise may have diminished in the model due in part to stronger associations between stress and other measured variables such as sleep, smoking, and depressive symptoms,
and in part to the slightly more complex relationship between stress and exercise relative to other health behaviors.

**Smoking, Stress, and Depression**

Results indicated that, as predicted, total stress burden and chronic stress, but not acute stress, at age 20 were predictive of smoking at age 21. This is consistent with previously demonstrated effects of stress, such as academic stress, on smoking behavior among college students (e.g., Steptoe, Wardle, Pollard, Canaan, & Davies, 1996). These results indicate the past year chronic stress, but not acute stressful life events, are associated with higher rates of smoking in young adults. Contrary to study predictions, smoking at age 21 was not predictive of increases in depressive symptoms at age 22-25 (controlling for age 20 depressive symptoms). This is somewhat inconsistent with previous literature demonstrating an effect of smoking on subsequent first depressive episode incidence and depressive symptoms (Boden, Fergusson, & Horwood, 2010; Klungsoyr, Nygard, Sorensen, & Sandanger, 2005). Importantly, although an effect of smoking on increased depressive symptoms was not supported, the present results indicate a relationship between cigarette consumption and depressive symptoms, given that correlations between cigarette consumption at age 21 and depressive symptoms at ages 20 and 22-25 were significant.

**Sleep, Stress, and Depression**

The present study demonstrated that stress, and in particular chronically stressful conditions, predict poor sleep one year later among young adults at elevated risk for developing depressive symptoms. These findings are consistent with research demonstrating that daily stress and worries predict nightly sleep quality (Akerstedt et al., 2012). Among adolescents, strategies for coping with stress predict daily sleep health, and in particular disengagement coping is
predictive of poor sleep-related measures and indices (Matthews, Hall, Cousins, & Lee, 2015). It is possible that similar mechanisms play out over the long-term, such that exposure to chronically stressful conditions, particularly in the absence of appropriate coping skills or styles, contributes to poor sleep quality over time. Additionally, youth exposed to high levels of chronic stress at age 20 likely continued to be exposed to elevated levels of chronic stress at age 21. Thus, some of the disruption to sleep may be explained by continued experience of stressful conditions.

The present results additionally indicate that one mechanism by which stressful circumstances predict increases in depressive symptoms is through poor sleep. This is consistent with previous research suggesting that sleep disruption may contribute to the development of and/or increase in depressive symptomatology (e.g., Lucassen, et al., 2012; Meerlo et al., 2009). Insomnia is associated with an increased likelihood of developing depression or having a depressive episode in people with and without a prior history of depression (Baglioni et al., 2011; Taylor et al., 2005). The effects of poor sleep on depression are posited to take place via mechanisms such as inhibited neurogenesis, increases in inflammation, or accumulation of oxidative stress (Lopresti, Hood, & Drummond, 2013; Lucassen et al., 2012). The present results highlight the importance of attending to disruptions in sleep among young adults, particularly for those at heightened risk for developing depression. In particular, young adults exposed to chronically stressful conditions may be especially susceptible to sleep disruptions and problems. Fortunately, interventions such as Cognitive Behavioral Therapy for Insomnia (CBT-I) have demonstrated efficacy in the treatment of sleep disorders in young adult and adolescent populations (e.g., de Bruin, Bogels, Oort, & Meijer, 2015; Taylor et al., 2014).

**Comparing Chronic and Acute Stress**


Comparisons of chronic and acute stress indicated that, as predicted, chronic stress yielded a stronger effect on health behaviors and subsequent depressive symptoms than acute stress. This is consistent with evidence that, although the body’s acute stress response is adaptive in dealing with threats, repeated or recurring activation of the body’s acute stress response produces maladaptive changes to the HPA system and cytokine response that have deleterious effects on physical health (Schneiderman, Ironson, & Siegel, 2005). Behavioral changes related to health may occur in tandem with physiological changes related to the body’s stress response, either as a cause or consequence. Jackson, Knight and Rafferty (2010) have suggested that people engage in negative health behaviors such as smoking, drinking, and poor eating in response to chronic and recurring stressors in daily living, which they argue puts members of racial minorities at increased risk for such changes to health behaviors. This perspective is consistent with the present finding of an effect of chronic, but not acute stress, on smoking behavior. Chronic stress has a well-documented effect on the development of addiction and vulnerability to addiction relapse (Sinha, 2008).

Prior research has failed to adequately measure or account for differential effects of chronic and acute stress on health behaviors. Given that the present investigation found support for an effect of chronic, but not acute, stress on sleep and smoking, it seems prudent to more closely attend to issues of chronicity when studying the relationship between stress and specific health behaviors. Furthermore, studies involving checklist measures of stressful life events may be unable to determine whether chronic or acute stressors are driving associations with or changes in health behaviors. Additionally, the present investigation provides initial evidence that health behaviors differ with regards to their relationship with stress, suggesting the importance of not aggregating different, though related, health behaviors and practices.
Stress-Health Behavior Effects on Subsequent Depression

Finally, although changes to health behaviors may be initiated in an effort to cope with stressful circumstances, the present findings tentatively indicate that such changes are in fact associated with elevations in subsequent depressive symptoms. Unfortunately, this suggests that stress-related negative health behaviors are part of a pernicious cycle of risk for worsening physical and mental health for youth at elevated risk for developing depressive disorders. These findings support the importance of interventions aimed at helping adolescents and young adults cope with stress adaptively.

Strengths and Limitations

The present investigation is bolstered by its use of a longitudinal design and consideration of multiple health behaviors in a period of developmental importance to mental and physical health outcomes. The use of an interview-based assessment of chronic and acute stress across a variety of domains allowed for comparison of the relative contributions of the nature of stress. Additionally, efforts were made to ensure that the noted effects were not due solely to family financial strain, by demonstrating the influence of stress over and above participants’ family income. Furthermore, youth depressive episode history and maternal depression were tested as moderators of the proposed model, indicating that the demonstrated effects of stress on health behaviors and subsequent depressive symptoms did not differ based on participants’ past depression or maternal depression status.

Several limitations should be kept in mind, however, when interpreting the results. First, the present study did not contain multiple assessments of health behavior engagement over time. The relationships between health behaviors and depressive symptoms are likely transactional and bi-directional across the lifespan. Future research should therefore include multiple assessments
of stress, health behavior, and depression over time to more precisely model these developmental processes. Health behaviors were assessed via self-report questionnaire items, and replication of the present findings with an improved, multi-method measurement of such behaviors would be beneficial. Additionally, the present study was limited to consideration of sleep, cigarette consumption, exercise, and alcohol consumption, but future research should consider the relative impact of chronic and acute stress on other health behaviors such as eating habits. Finally, the current study is limited by its use of a predominantly Caucasian sample; there is some evidence to suggest differential impact of stress on health behaviors by race (e.g., Jackson, Knight, & Rafferty, 2010; Mezuk et al., 2010).

Conclusions

In light of the well-established effects of stress on physical and mental health outcomes, and the present support for the role of health behaviors in the relationship between stress and depressive symptoms, further research in this area is warranted. Precisely why stress influences health behaviors such as smoking, exercise, and sleep remains unknown. A cross-sectional study of the association between stress and health behaviors among dementia caregivers indicated that total objective stress, but not caregiving self-efficacy or belief in one’s ability to control one’s health, impacted negative changes to behaviors including exercise, sleep patterns, diet, smoking, and alcohol consumption (Gallant & Connell, 1998). The authors concluded that perceived time and resource restraints were therefore likely influencing health behavior engagement in this sample. Elucidation of such beliefs – regarding the utility of health practices, the stress-relieving properties of drug and alcohol consumption, and the resource limitations restricting healthy behavior practices such as exercise and balanced eating – is critical to understanding and intervening in the relationship between stress and health behaviors.
The key contributions of the present study are twofold. First, chronic and acute stress differentially impact health behaviors, and health behaviors, particularly sleep, in turn influence subsequent depressive symptoms, in young adulthood. This underscores the importance of measuring and distinguishing between chronic and acute stress in studies of stress and health behaviors. Second, one pathway by which stress predicts depressive symptoms in at-risk youth is via health behaviors, such as impaired sleep. This pernicious cycle portends worsened physical and mental health during a critical developmental period. Better understanding of this cycle may yield interventions aimed at specifically preventing stress-related changes to health behaviors in adolescents and young adults.
CHAPTER 3: DAILY EFFECTS OF STRESS AND DEPRESSIVE SYMPTOMS ON HEALTH BEHAVIORS IN COLLEGE STUDENTS (Study 2)

Abstract

Stress and depression are associated with maladaptive health behaviors such as unhealthy eating, sedentary behavior, insufficient sleep, and substance use. The interplay between stress, mood, and health behavior behaviors is particularly important to understand in adolescence and young adulthood, as these are critical periods in the development of mental and physical health patterns with consequences for the lifespan. The present study tested several aspects of the relationship between stress, mood, and health behaviors in a daily diary study of 127 college students oversampled for elevated depressive symptoms. Results, which were obtained using multilevel modeling techniques, indicated that depressive symptoms, and chronic and daily stress, but not acute stressful life events, were significantly associated with a composite score of daily maladaptive health behavior engagement (depressive symptoms = .04, SE = .01, p < .01; chronic stress, b = .12, SE = .04, p < .01; daily stress, b = .05, SE = .02, p = .03). Contrary to study hypotheses, youth with elevated depressive symptoms were not more likely to respond to stress with maladaptive health behaviors than were youth without elevated depressive symptoms. Results indicated that depressive symptom levels influence daily health behaviors in part through daily fluctuations in positive (b = 0.04, SE = 0.01, p <.01) and marginally through negative affect. These results bear implications for intervention during a crucial period in the development of mental and physical health.

Introduction and Hypotheses

Study 2 utilized a daily diary methodology to assess naturally occurring relationships between stressors, affect, and health behaviors in college students with and without elevated
depressive symptoms. A daily diary approach was used as it provides several benefits over other study methods that are critical to the aims of the present investigation: 1) daily diary approaches allow for immediate, rather than delayed, recall of daily events, which reduces recall bias; 2) they permit modeling of within-person differences in health behavior practices; 3) they permit modeling of between-person differences in baseline levels of depressive symptoms and ongoing stress; and 4) they allow for assessment of temporal relationships between the variables of interest (Affleck, Zautra, Tennen, & Armeli, 1999; O’Connor, Jones, & Conner, 2011).

Furthermore, although there are concerns about participant bias and socially desirable reporting associated with all self-report methodologies, prior studies of daily diary methodology in young adult samples have provided evidence against the presence of fatigue effects and socially desirable reporting (Gillmore et al., 2001). Study 2 included an objective, interview-based assessment of chronic and acute stress at study baseline, allowing for comparison of the effects of chronic, acute, and daily stress on health behaviors in students with and without elevated depressive symptoms. Previous research on health behaviors has failed to adequately measure and examine the effects of chronicity of stress on health behaviors and practices, and it remains unknown whether daily stressors exhibit effects on health behaviors over and above ongoing chronically stressful conditions. It is particularly important to unravel these processes in the context of depression, as chronic stress is a particularly potent predictor of depression (e.g., Hammen, 2005).

Study 2 included several secondary aims in order to further address key gaps in the literature. As many previous studies of the relationship between stress and health behaviors have failed to explicitly test whether or not changes to health behaviors are undertaken in an effort to cope with stress (Park & Iacocca, 2014), Study 2 tested baseline coping beliefs as moderators of
the relationship between stress and daily health behaviors. Additionally, given that depression is associated with high levels of negative affect and low levels of positive affect (Strong et al., 2009), and that daily positive and negative affect have previously established relationships with daily health behaviors (e.g., Allgower, Wardle, & Steptoe, 2001; Anton & Miller, 2005; Griffin, Friend, Eitel, & Lobel, 1993), Study 2 tested positive and negative affect as mediators and moderators of the relationship between depressive symptoms and health behaviors.

1. Chronic stress, acute stress, and daily stress will predict maladaptive health behavior engagement. Furthermore, individuals with elevated depressive symptoms will show a stronger effect of stress on maladaptive health behaviors than those without elevated depressive symptoms. This will be the case with ongoing chronic stress, ongoing acute stress, and daily stressful life events. This is in keeping with previous research showing elevated rates of poor health behaviors and maladaptive coping strategies among individuals with elevated depressive symptomatology, and research demonstrating effects of stress on various health behaviors (e.g., Allgower, Wardle, & Steptoe, 2001; Jaser et al., 2010; Klungsoyr, Nygard, Sorensen, & Sandanger, 2005; O’Connor, Jones, Conner, McMillan, & Ferguson, 2008; Sun, Buys, Stewart, & Shum, 2011).

   a. In keeping with previous research demonstrating particularly potent effects of chronic stress on depression and other physical and mental health outcomes (e.g., Hammen, 2005; Schneiderman, Ironson, & Siegel, 2005; Thoits, 2010), it is predicted that chronic stress will more strongly predict poor health behaviors than acute stressors or daily hassles.

2. It is predicted that there will be an interaction between chronic stress and daily stressful events on health behaviors, such that daily stressful events experienced in the context of
ongoing chronic stress will have a stronger negative impact on health behavior than either type of stressor alone. This is in keeping with stress sensitization and kindling models of susceptibility to stress in depression, which suggests that repeated exposure to stressors over time lowers the threshold at which stressors elicit negative neurobiological, cognitive, and behavioral responses (e.g., Monroe & Harkness, 2005).

3. It is predicted that baseline measures of coping beliefs will moderate the relationship between daily stress and health behaviors, such that individuals who endorse beliefs of health behaviors as coping strategies will be more likely than those who do not to respond to daily stress with health behavior change. This is in keeping with previous work demonstrating an effect of coping beliefs in stress-health behavior relationships (Harris, Cronkite, & Moos, 2006; Park, Armeli, & Tennen, 2004).

4. In keeping with prospective associations between poor health behaviors and negative mood (e.g., Strawbridge, Deleger, & Roberts, 2002), it is predicted that responding to daily stress with negative health behaviors will predict subsequent increases in negative affect.

5. It is predicted that positive and negative affect will serve as both mediators and moderators of the relationship between depressive symptoms and health behaviors. Previous research provides evidence that individuals with depressive symptoms exhibit maladaptive coping strategies in response to both negative and positive affect (Beblo, Fernando, Klocke, Griepenstroh, & Ashenbrenner, 2012; Werner-Seidler, Banks, Dunn, & Moulds, 2013; Johnson, McKenzie, & McMurrich, 2008), which is consistent with a model in which the presence of affect moderates the impact of depressive symptoms on health behaviors. Additionally, the established relationship between depression and affect
(e.g., Strong et al., 2009), and affect on health behaviors (e.g., Allgower, Wardle, & Steptoe, 2001; Griffin, Friend, Eitel, & Lobel, 1993) supports a model in which daily affect serves as a mechanism by which depressive symptoms influence health behaviors.

Methods

Participants

One-hundred and twenty-seven participants were enrolled in the study. Participants were undergraduate students enrolled in psychology courses at the University of California, Los Angeles who received course credit for study completion. Of the 127 participants, 100 (75.2%) were female, 26 (20.5%) were male, and 1 (.8%) identified as other/preferred not to answer. Participants were between 18 and 24 years of age (mean age = 19.11 years, SD = 1.13). The sample was diverse with respect to race: 39.4% Asian, 29% Caucasian, 15% Latino/Hispanic, 2.4% African-American/Black, 2.4% Middle Eastern, and 11.8% Other/Biracial/Multiracial. Participants reported on their families’ annual income and the sample was relatively diverse with regards to income: 24.4% under $40,000; 7.1% $40,000-$59,000; 12.6% $60,000-$79,000; 3.1% $80,000-$99,000; 40.9% $100,000 or more, 11% Decline to Answer.

Prior to study enrollment, participants completed a pre-screening questionnaire to determine study eligibility (see Appendix A for pre-screening questionnaire). The pre-screening questionnaire included the Patient Health Questionnaire 9 (PHQ-9), a well-validated and reliable measure of depressive symptomatology and severity (Kroenke, Spitzer, & Williams, 2001). The participant sample was over-selected for depressive symptoms, such that at least 1/3 of participants invited to enroll exhibited elevated symptoms on the PHQ-9 and met criteria for at least mild depression on the basis of the BDI-II (score of 14 or higher). The pre-screening questionnaires assessed whether participants had ever been diagnosed with or treated for bipolar disorder or any psychotic disorder; participants endorsing either of these disorders were excluded.
from the current study in keeping with previous daily diary investigations of depression (e.g., Starr & Davila, 2012). Participants were also excluded if they reported that they did not have regular access to a computer at night, as this would hinder their ability to complete the daily diaries. Additionally, participants were required to be comfortable reading and speaking in English, as study interviews and written measures were conducted in English.

**Procedure**

Students selected from the initial screening procedures were contacted by email or phone and invited to participate in the in-person baseline visit. Participants were informed that the study would consist of one in-person baseline assessment lasting approximately 2 hours and 14 days of daily diary completion online (taking approximately 5-8 minutes daily). Fourteen days is a standard length of time for daily diary investigations of the relationship between stress, affect, and health behaviors, and allows for naturally occurring fluctuations in students’ schedules between weekends and weekdays (e.g., Butler, Dodge, & Faurote, 2010; Todd, 2004). During the study, participants received an email each evening reminding them to complete their daily questionnaire between 8:00 PM and 2:00 AM. The emails contained a link to the online questionnaire. Participants were informed that they would only receive participation credit if they completed the baseline assessment and a minimum of 12 of the 14 daily questionnaires. Participants providing informed consent completed the baseline interview and self-report measures and began daily diary assessments the evening of their baseline study visit.

**Measures**

**Baseline Measures**

**Chronic stress.** The UCLA Life Stress Interview (LSI; Hammen *et al.*, 1987) was used to measure ongoing chronic stress over the past 6 months across a variety of life domains
(school, family, friends, romantic relationships, finances, and health). The LSI is a semi-structured interview that uses standard general probes to elicit typical and ongoing conditions across a number of life domains, scoring each on behaviorally anchored scales independent of the participant’s subjective perception of stressfulness. The scales each ranged from 1 (exceptionally positive conditions) to 5 (extremely difficult, negative conditions). The UCLA LSI is a reliable and valid assessment of acute and chronic life stress in adolescents and young adults (Hammen et al., 1995). The average total chronic stress score across all domains in the present sample was 22.00 (SD = 2.82, range 17.00-31.00); higher scores indicate higher levels of overall stress (see Table 2 for descriptive statistics by domain of stress).

**Acute stress.** The LSI was also used to assess acute stressful life events in the 3 months preceding the interview. In addition to assessing ongoing conditions across a variety of domains, the LSI uses standard general probes to elicit specific life events in the past 3 months with follow-up questions to establish the timing and factors associated with each event that determine the context of the person’s life in which the event occurred. Rating teams blind to youths’ actual emotional reactions to the events were presented with narratives of each event written by the interviewers. The rating team then assigned a severity rating indicating the impact this event would be expected to have on an average person in the same circumstances. Severity scores range from 1 (no impact) to 5 (extremely severe). A total objective acute stress score was calculated for each participant by summing the rating team’s severity ratings across all events. The average total objective acute stress score was 2.09 (SD = 2.73, range 17-31).

**Depressive disorders.** Current and past major depressive disorder (MDD) was assessed using the Structured Clinical Diagnostic Interview for Axis I Disorders (SCID-I/P for DSM-IV-TR Patient Edition; First, Spitzer, Miriam, & Williams, 2002) based on Diagnostic and Statistical
Manual Fourth Edition (DSM-IV) criteria. The SCID-I has good reliability and validity for assessment of MDD diagnosis (e.g., Basco et al., 2000; Zanarini & Frankenburg, 2001; Zanarini et al., 2000). In the present sample, 12 participants (9%) met criteria for a current Major Depressive Episode. Forty-nine participants (38.6%) met criteria for a past major depressive episode (see Table 3).

**LSI and SCID reliability.** The baseline study assessments (LSI and SCID) were carried out by the graduate student principal investigator and three undergraduate volunteer research assistants who were formally trained in the administration of these measures. Following training, but prior to running participants, the research assistants were required to meet reliability criteria for the SCID and LSI administration using mock interview data (all chronic and acute stress ratings required to be within .5 points of one another across raters and total concurrence required for depressive disorder diagnosis). In order to assess interrater reliability on scores of chronic stress and assessment of depressive episodes, each of the four interviewers provided ratings for a randomly selected subset (10%, n = 13) of the interviews (LSI and SCID) conducted. Interviews were randomly selected for inclusion in interrater reliability testing, with stratification such that the selected sample contained at least 2 interviews by each of the 4 interviewers. The average interrater reliability across domains of chronic stress was excellent (ICC = 0.91); interrater reliability across the 10 domains of chronic stress ranged from 0.76 to 0.96 (see Table 2 for reliability by individual domain). Interrater reliability was strong for both current (ICC = .89) and past (ICC = .95) depressive episodes.

**Depressive symptoms.** Depressive symptom severity was assessed using the Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996). The BDI-II includes 21 questions with a four-point rating scale ranging from 0 to 3. The BDI-II has been well-validated
and is widely used among college student samples (Storch, Roberti, & Roth, 2004). The average BDI score in the present sample was 11.00 (range 0-35, SD = 8.24). Percentage of scores by clinical threshold were as follows: 66.9% minimal symptoms (scores 0-13); 18.1% mild symptoms (scores 14-19); 11.8% moderate symptoms (scores 20-28); 4% severe symptoms (scores 29-63). Internal consistency on the BDI was good (α = 0.89).

Anxiety symptoms. Symptoms of anxiety were assessed using the Beck Anxiety Inventory (BAI; Beck & Steer, 1993), a well-validated self-report inventory of common anxiety symptoms. The average BAI score was 11.55 (range 0-37, SD = 8.91). Percentage of scores by clinical threshold were as follows: 40.2% minimal symptoms (scores 0-7); 30.7% mild symptoms (scores 8-15); 20.5% moderate symptoms (scores 16-25); 8.3% severe symptoms (26-63). Internal consistency on the BAI was good (α = 0.89).

Baseline physical health. Physical health at baseline was assessed using the SF-36 Health Survey, a widely used and well validated measure of ongoing physical health and functioning, which has been frequently used in college student populations (SF-36; Ware & Maruish, 1999). The average score for the physical functioning subscale (PCS-12) in the current sample was 52.96 (SD = 5.27, range 38.13-62.14). The mental health subscale (MCS-12) was also administered and the average score was 44.31 (SD = 44.31, range 18.86-62.35). The average score for both subscales in the standard U.S. population is 50 (SD = 10) and higher scores indicate better health and functioning (Ware, Kosinski, & Keller, 1996).

Body mass index. Participants’ self-reported height and weight were used to calculate their body mass index (BMI). The average BMI among participants was 22.89 (SD = 5.31, range 15.62-46.64). Classification by BMI categories were as follows: 62% normal weight, 14% underweight, 16% overweight, and 8% obese.
Baseline health behaviors. Participants’ engagement in various health behavior practices was assessed prior to initiating the daily diary assessments. Baseline assessments were similar to those used on a daily basis in order to allow for testing of within-person deviations from usual health behavior practices. Additionally, participants were screened for alcohol use disorders, nicotine dependency, and disordered eating at baseline.

Sleep. The Pittsburgh Sleep Quality Index (PSQI; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) was used to assess baseline past-month sleep duration and quality. The PSQI has good reliability, validity, and specificity and is widely used to assess sleep among college students (PQSI; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989; Carney, Edinger, Meyer, Lindman, & Istre, 2006; Lund, Reider, Whiting, & Prichard, 2010). The average number of hours of sleep reported per night was 6.8 (range 3-9; SD = 1.12; n = 116). The average latency to sleep was 22.77 minutes (range 1-120 minutes; SD = 21.77, n = 127). Sixty-two percent of participants reported good sleep quality and 38% of participants reported poor sleep quality.

Cigarette use. Number of days smoked in the past 30 days and average number of cigarettes smoked on days smoked in the past 30 days were used to establish baseline smoking levels (Dierker & Mermelstein, 2010; Heinz, Kassel, Berbaum, & Mermelstein, 2010). Previous studies have utilized self-report measures of average number of cigarettes smoked daily with young adults (e.g., Emery et al., 2012; Goodwin, Perkonigg, Hofler & Wittchen, 2012), and such items have demonstrated reliability comparable with daily diary measures of cigarette consumption (Harris et al., 2009). In the present sample, the average number of days smoked in the past 30 was 0.92 (range 0-27; SD = 3.77). Eighty-seven percent (n=111) of participants reported that they had not smoked on any days in the past 30. Nine percent (n = 11) smoked on between 1 and 5 days, and 4% (n = 5) smoked on between 10 and 27 days. Of the 16 participants
who reported smoking in the past 30 days, 11 (69%) reported typically smoking 1-2 cigarettes, 4 (25%) reported smoking 3-6, and one (6%) reported smoking 35 cigarettes on days smoked. Participants also reported on number of cigarettes typically smoked on days on which they smoked in the past 30; the average number reported was .53 (range 0 – 35; SD = 3.20).

The Fagerstrom Test for Nicotine Dependence (Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991) was used to establish baseline levels of nicotine dependency. The Fagerstrom Test for Nicotine Dependence has adequate reliability and validity relative to alternative biological and questionnaire assessments of nicotine dependency (Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991; Pomerleau, Carton, Lutzke, Flessland, & Pomerleau, 1994). Results from this measure indicated that 116 participants (91.3%) had no nicotine dependence, while 11 participants (8.7%) had low nicotine dependence.

**Drinking.** Number of days on which participants consumed alcohol in the past 30 days and average number of alcoholic beverages consumed on days in which drinking occurred in the past 30 days were used to establish baseline alcohol consumption; this is consistent with assessments of drinking quantity and frequency used in previous studies (e.g., Young, Connor, Ricciardelli & Sanders, 2006), which have demonstrated sound validity (Leigh, 2000). Participants reported on the number of days out of the past 30 on which they drank alcohol; the average number was 4.44 (range 0-20; SD = 4.58). The average number of drinks participants reported drinking on days on which they drank was 2.79 (range 0-20; SD = 3.44). The Alcohol Use Disorders Identification Test: Self-Report Version (AUDIT) was used to screen for alcohol use disorders. The AUDIT has good reliability and validity and is commonly used to screen for alcohol use disorders among college students (Babor, Higgins-Biddle, Saunders, & Monteiro, 2001; Kokotailo et al., 2004). The average AUDIT score in the current sample was 4.44 (n =
27% of participants had a score of 8 or above, which is indicative of possible hazardous or harmful drinking (Babor, Higgins-Biddle, Saunders, & Monteiro, 2001).

**Eating.** Several facets of participants’ typical eating habits over the past thirty days were assessed. In keeping with standard measures of daily eating habits, participants were asked to report on their average daily numbers of portions consumed of fruits, vegetables, sweets, fats, and number of between-meal snacks (Conner, Brookie, Richardson, & Polak, 2014). Participants reported consuming an average of 1.82 portions of fruit (range 0–8, SD = 1.24), 2.14 portions of vegetables (range 0–8, SD = 1.66), 1.74 between-meal snacks (range 0–5, SD = 0.99), 1.30 servings of high-fat foods (range 0–6, SD = 1.10), and 1.31 servings of sweets (range 0–5, SD = 0.99). Twenty-nine percent of participants reported consuming the recommended daily intake of five or more daily servings of fruits and vegetables (WHO). The Eating Attitudes Test-26 (EAT-26) was used to assess baseline symptoms of disordered eating; the EAT-26 has good reliability and validity and is widely used to screen for symptoms of disordered eating (Garner, Olmsted, Bohr, & Garfinkel, 1982; Mintz & O’Halloran, 2000). On this measure, 10.2% of participants (n = 13) had scores of 20 or higher, indicative of possible disordered eating (Garner, Olmsted, Bohr, & Garfinkel, 1982; Mintz & O’Halloran, 2000).

**Exercise.** Participants’ typical exercise behavior over the past 30 days was measured with the following question to assess frequency of exercise: “In the past 30 days, on approximately how many days did you exercise? Please enter a whole number between 0 and 30.” This was followed by the question “What type of exercise did you typically engage in?” with the response options “1 = Mild/Gentle (e.g., walking, yoga), 2 = Moderate (e.g., dancing, brisk walking), 3 = Vigorous (e.g., running, fast swimming or cycling, moving heavy loads)” to assess intensity of typical exercise. A final question, “For how many minutes did you typically engage in this type
of exercise?” assessed duration of typical exercise. These assessments of intensity and duration of exercise are in line with established exercise guidelines as outlined by the World Health Organization (WHO; “Global Recommendations on Physical Activity for Health,” 2015). Self-reports of mild, moderate, and vigorous physical activity have demonstrated good reliability and validity (Godin, Jobin, & Bouillon, 1986). Participants reported exercising on an average of 13.33 days out of the past 30 (range 0-30; SD = 8.70). Participants reported that on days exercised, they exercised for an average of 52.61 minutes (range 0-180, SD = 33.61). Nineteen percent (n = 25) reported participating in mild or gentle exercise, 22% (n = 28) reported engaging in moderate exercise, 55.1% (n = 70) reported engaging in vigorous exercise, and 3.1% (n = 4) reported engaging in no exercise in the past month. Fifty-five percent of participants reported meeting weekly recommended exercise levels of either 75 minutes of vigorous exercise or 150 minutes of moderate exercise (WHO; “Global Recommendations on Physical Activity for Health,” 2015).

Coping styles. Participants’ general strategies for coping with stress were assessed using the BriefCOPE, a 28-item self-report measure that assesses various types of coping strategies (e.g., “I turn to work or other activities to take my mind off things;” “I get emotional support from others,” Carver, 1997). The BriefCOPE has good reliability and validity and has been used in a variety of samples (Carver, 1997). The BriefCOPE, rather than the full length measure, was used to reduce participant burden at baseline. Fourteen coping styles were assessed, with higher average scores in each of these domains indicating a greater reliance on that particular strategy. Mean ratings for the fourteen styles are reported in Table 4.

Additionally, the Emotional Approach Coping Scale (EAC; Stanton, Kirk, Cameron, & Danoff-Burg, 2000) was used to test coping through emotional approach. This scale is well-
validated, has high internal consistency and test-retest reliability, and has previously been used in undergraduate samples (Stanton, Kirk, Cameron, & Danoff-Burg, 2000). The two subscales of the EAC were Emotional Processing (mean = 10.20, SD = 3.46, range 4-16) and Emotional Expression (mean = 9.59, SD = 3.43, range = 4.16), with higher scores indicating greater use of emotional coping.

**Beliefs about health behaviors as coping mechanisms.** Participants’ specific endorsement of utilizing health behaviors (e.g., eating, smoking, drinking, and exercising) to cope with stress and/or negative affect was assessed at baseline.

**Alcohol as coping.** The coping motive subscale of Cooper’s Drinking Motives Questionnaire-Revised (DMQ-R; Cooper, 1994) was used to assess participants’ coping motives for alcohol use. The coping motives subscale includes five questions that assess participants’ frequency of drinking in order to cope with difficulties and/or improve mood (e.g., “I drink to forget my worries;” “I drink to cheer up when I am in a bad mood”). This particular subscale has previously demonstrated adequate to strong reliability in college student samples (Hussong, Galloway, & Feagans, 2005; MacLean & Lecci, 2000). Only the coping motives subscale of the DMQ-R was used as it is the only subscale directly relevant to the study hypotheses and efforts were made to decrease participant burden at the baseline visit. The average score on the subscale in the current sample was 9.05 (range 5-22, SD = 4.63); higher scores indicate a stronger endorsement of using alcohol to cope with stressful circumstances and/or improve mood. Internal consistency on the coping motive subscale items was good (α = 0.88).

**Cigarette use as coping.** The 7-item negative reinforcement subscale of the Short Form Smoking Consequences -Questionnaire (S-SCQ; Myers, McCarthy, MacPherson, & Brown, 2003) was used to assess participants’ beliefs about tension and negative affect reducing
properties of cigarettes (e.g., “Cigarettes help me deal with anxiety or worry;” “Cigarettes help me reduce or handle tension”). The S-SCQ has previously demonstrated excellent reliability and validity in young adult samples (Brandon & Baker, 1991). Only the negative reinforcement subscale of the S-SCQ was used as it is the only subscale pertinent to the study hypotheses and in order to reduce participant burden at baseline. The average score on the subscale in the present sample was 10.06 (range 0-52, SD = 15.32), with higher scores indicating stronger endorsement of using cigarettes to cope with stressful circumstances and/or improve mood. Internal consistency on the negative reinforcement subscale items was excellent (α = 0.97).

**Eating as coping.** The Emotion and Stress-Related Eating subscale of the Eating and Appraisal Due to Emotions and Stress Questionnaire (EADES; Ozier et al., 2007), which contains 24 questions, was used to assess the extent to which individuals use food to cope with emotions and/or stressors (e.g., “I eat to avoid dealing with problems;” “I comfort myself with food”). The EADES has previously been validated in a sample of university students and this particular subscale has excellent internal consistency (Ozier et al., 2007). The Emotion and Stress-Related Eating subscale, rather than the scale in its entirety, was administered as it is the only subscale directly relevant to study aims and in an effort to reduce participant burden. The Emotion and Stress-Related Eating subscale of the Eating and Appraisal Due to Emotions and Stress Questionnaire (EADES; Ozier et al., 2007), which contains 24 questions, was used to assess the extent to which individuals use food to cope with emotions and/or stressors. The average score for these subscales was 81.36 (range 38-115, SD = 17.94), with higher scores indicating a greater reliance on eating to cope with stress and negative emotions. Internal consistency on the EADES was excellent (α = 0.95). The Palatable Eating Motives Scale (PEMS, Boggiano, 2016) was also used to assess motives for eating tasty but unhealthy foods. The PEMS
has demonstrated good convergent and incremental validity and was selected for inclusion in the current study because it is directly comparable to the DMQ-R (Burgess, Turan, Lokken, Morse, & Boggiano, 2014). The mean scores for each of the four PEMS subscales in the current sample were as follows (higher scores indicate higher motives in that domain): Coping Motives, mean = 1.83 (range 1-4, SD = 0.87); Reward Enhancement Motives, mean = 2.23 (range 1-3.8, SD = 0.95); Social Motives, mean = 2.50 (range 1-3.8, SD = 1.02); Conformity Motives, mean = 1.61 (range 1-3.4, SD = 0.69). Overall internal consistency on the PEMS was excellent (α = 0.93) and internal consistency for each of the four subscales was good (α range 0.80-0.90).

**Exercise as coping.** The 4-item Stress Management Subscale of the Exercise Motivations Inventory – 2 (EMI-2; Markland & Ingledew, 1997) was used to assess the extent to which participants use (or would use) exercise to cope with stress and tension (e.g., “I exercise (or would exercise) because it helps me reduce tension;” “I exercise (or would exercise) to give me space to think,”). The EMI-2 has been validated among exercisers and non-exercisers (Markland & Ingledew, 1997), and the Stress Management Subscale has demonstrated excellent internal consistency (Ingledew, Markland, & Medley, 1998). The Stress Management subscale, rather than the full EMI-2, was administered as it is directly relevant to study aims and in an effort to reduce participant burden. The 4-item Stress Management Subscale of the Exercise Motivations Inventory – 2 (EMI-2; Markland & Ingledew, 1997) was used to assess the extent to which participants use (or would use) exercise to cope with stress and tension. The mean subscale score was 12.83 (range 0-20, SD = 5.75, higher scores indicate a stronger endorsement of coping with stress/tension as motivation for exercise). Internal consistency on the stress management subscale was excellent (α = 0.93).

**Daily Diary Measures**
Daily stress. Daily stressful life events were assessed using a checklist of 24 events likely to be encountered by college students on a regular basis (e.g., “Had a conflict or disagreement with a friend;” “Did poorly on or failed an exam or project”). This list is based on several existing measures of daily stressors/hassles, including the Daily Stress Inventory (DSI; Brantley, Waggoner, Jones, & Rappaport, 1987), the Hassles and Uplifts Scale (DeLongis, Folkman, & Lazarus, 1988), The Inventory of College Students’ Recent Life Experiences (Kohn, Lafreniere, & Gurevich, 1990), and additional interpersonally-focused items that have been shown to have predictive utility over and above existing measures in college students (Maybery & Graham, 2001). Such measures have previously demonstrated good reliability, validity, and acceptable internal consistency (Brantley, Waggoner, Jones, & Rappaport, 1987; Lay & Safdar, 2003). The checklist also contained spaces for participants to identify up to two stressors not included in the list. The average number of stressors reported in the current sample was 2.10 (range 0-17, SD 2.13; see Appendix B for complete list of questions).

Daily affect. Daily negative and positive affect were assessed using the brief version of the Positive and Negative Affect Scales (PANAS; Watson, Clark & Tellegen, 1988). Participants were asked to rate the extent to which they experienced twenty different emotions (e.g., irritable, proud) in the past day from 1 (very slightly or not at all) to 5 (extremely). The PANAS is a well-validated and widely used measure of positive and negative affect (Watson, Clark, & Tellegen, 1988) and has regularly been used to assess daily affect (e.g., Kuiper & Martin, 1988). On both the positive and negative PANAS scales scores can range from 10-50, with higher scores indicating more affect in that domain. In the present sample, participants’ average daily positive affect score was 22.51 (range 10-47, SD = 8.57). Participants’ average daily negative affect score
was 16.31 (range 10-45, SD = 6.25). Internal consistency was excellent for the positive affect scale ($\alpha = .92$) and good for the negative affect scale ($\alpha = .85$).

**Daily cigarette use.** Daily cigarette use was assessed using the question, “How many cigarettes have you smoked today?” Self-reported number of cigarettes smoked daily is a standard measure of smoking in daily diary assessments of health behaviors (e.g., Colder et al., 2006; Gillmore et al., 2001; Jackson, Colby, & Sher, 2010), and online assessments of daily smoking quantity have previously demonstrated good reliability and validity among adolescent groups (Ramo, Hall, & Prochaska, 2011).

**Alcohol consumption.** Daily alcohol consumption was assessed using the question “How many drinks containing alcohol have you consumed today (1 drink = 1 12 oz beer, 1 glass of wine, or 1.5 oz. of hard alcohol)?” Self-report of drinks consumed is a standard measure of daily drinking in college students and young adults (Jackson, Colby, & Sher, 2010; Hoeppner et al., 2012; Magid, Colder, Stroud, Nichter, & Nichter, 2009). Prospective daily reports of alcohol consumption have demonstrated adequate reliability and validity, and are considered stronger measures than single-time quantity/frequency estimates (e.g., Del Boca & Darkes, 2003; Dollinger & Malmquist, 2009).

**Exercise.** Daily exercise was assessed using the question, “Did you exercise today?” If participants endorse a “yes” response, they were prompted to respond to the question, “What type of exercise did you engage in?” with the options “1 = Mild/Gentle (e.g., walking, yoga), 2 = Moderate (e.g., dancing, brisk walking), 3 = Vigorous (e.g., running, fast swimming or cycling, moving heavy loads)” and “For how many minutes did you exercise?” Participants were then asked whether they engaged in a second type of exercise, with the same question and answer choices appearing a second time. These assessments of intensity and duration of exercise are in
line with established exercise guidelines as outlined by the World Health Organization (WHO; “Global Recommendations on Physical Activity for Health,” 2015) and such questions are standard assessments of daily exercise, with established reliability and validity (e.g., Godin, Jobin, & Bouillon, 1986; Jacobs, Ainsworth, Hartmana, & Leon, 1993).

**Sleep.** Daily sleep was measured using 4 questions assessing sleep latency, duration, and quality derived from the Pittsburgh Sleep Quality Index, which is consistent with daily sleep evaluations used previously in college student populations (e.g., Taylor & Bramoweth, 2010; Tsai & Li, 2004). The PSQI has good reliability, validity, and specificity and is widely used to assess sleep among college students (PQSI; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989; Carney, Edinger, Meyer, Lindman, & Istre, 2006; Lund, Reider, Whiting, & Prichard, 2010).

**Eating.** Participants’ eating behavior was assessed using five questions reflective of both adaptive and maladaptive eating practices. “How many portions of fruit did you eat today (1 portion = 1 cup of fresh fruit (e.g., 1 small apple, 1 large banana or orange), canned fruit, or frozen fruit or 100% fruit juice, or ½ cup of dried fruit)?”; “How many portions of vegetables did you eat today? (1 portion = 1 cup of fresh/raw (e.g., 1 large pepper, 1 large ear of corn, 1 large tomato) frozen, canned/dehydrated, or 100% vegetable juice, or 2 cups of raw leafy greens”;

“How many snacks did you eat in between meals today?”; “How many portions of sweets did you eat today? (1 portion = 1 large cookie or brownie, 1 serving size of candy or chocolate)”; and “How many portions of high-fat foods did you eat today? (1 portion = 1 serving size of chips or fries, 1 pat of butter)”. These questions are consistent with previous daily diary investigations of eating behaviors (e.g., Conner, Brookie, Richardson, & Polak, 2014; White, Horwath, & Conner, 2013). Definitions of portion sizes and examples are in accordance with the United States Department of Agriculture (USDA; “ChooseMyPlate.gov” 2015) guidelines. Self-report
measures of fruit and vegetable servings/portions are a standard assessment of food consumption in daily diary studies and have demonstrated high correlations with validated food frequency questionnaires and adequate test-retest reliability (Stadler, Oettingen, & Gollwitzer, 2010).

**Daily health behaviors composite scores.** A composite score of daily maladaptive health behaviors was constructed in accordance with previous studies of maladaptive and/or risky health behaviors (e.g., Ford & Collins, Shwartz et al., 2011; see Appendix C for full index details). Maladaptive health behavior index scores range from 0-12, with higher scores indicating a greater degree of maladaptive health behaviors. The composite score included consumption of fats and sweets at or above recommended daily intake levels (per World Health Organization 2015 guidelines), alcohol and cigarette use, sedentary behavior (defined as lack of any exercise, including mildly vigorous exercise such as walking), and inadequate (or too much) sleep (as defined by National Sleep Foundation, 2015). Similarly, a composite score of daily adaptive health behaviors was constructed in accordance with previous studies of adaptive/positive health behaviors (e.g., Ryon & Gleason, 2014). Adaptive health behavior index scores range from 0-8, with higher scores indicating a greater degree of adaptive health behaviors. The composite score included consumption of fruits and vegetables (both below or at daily intake levels, WHO 2015), exercise (both below or at daily recommended levels, WHO 2015), and obtaining adequate sleep (as defined by National Sleep Foundation, 2015). The maladaptive and adaptive indices are similar to the positive and negative health behavior scales in the 69-item Multidimensional Health Profile-Health Functioning scale (MHP-H), which has previously been used in college student populations (e.g., Visser & Hirsch, 2014) and demonstrated good test-retest reliability and validity with other health behavior measures (Karoly, Reuhlman, & Lanyon, 2005).
present composites are, by design, shorter than the MHP-H in order to maximize feasibility for daily use.

The average daily maladaptive health behavior composite score in the present sample was 4.34 (SD = 1.99, range 0-12) and the average daily adaptive health behaviors composite score was 4.43 (SD = 1.85, range 0-8), with higher scores indicating more (maladaptive or adaptive) behaviors.

**Data Analysis**

Primary study hypotheses were examined using hierarchical linear modeling (HLM), which is appropriate for research designs in which participants are observed at multiple timepoints. HLM allows for nesting of data at multiple timepoints within individuals by estimating both within-person (Level 1) and between-person (Level 2) error variances. Models for testing interactional and meditational effects in HLM follow guidelines established by Preacher, Curran, & Bauer (2015, quantpsy.org) and Zhang, Zyphur, & Preacher (2009).

HLM functions for each of the hypotheses are outlined below. The “HealthBehaviors” outcome is a composite score of maladaptive daily health behaviors as described above. Level 1 predictors, such as DAILYSTRESS\(i\), were person-mean centered, such that DAILYSTRESS\(i\) represents the difference between the number of daily stressors occurring on day \(t\) for individual \(i\) and that individual’s average level of daily stressors (Mroczek & Almeida, 2004; Sholz, Kliegel, Luszczynska, & Knoll, 2012). Level 2 variables were group-centered such that they represent an individual’s standing on a given variable, for example, amount of chronic stress, relative to other participants. In the below models, gender was included as a Level 2 covariate in order to control for possible effects of gender on stress, affect, and health behaviors. Given the small number of male participants (n = 26), tests separated by gender were not conducted.
History of past depressive episodes was also included in the models as a Level 2 covariate where appropriate.

**Hypotheses 1 and 1a.** Stress (chronic, acute, and daily) and depressive symptoms will predict daily health behaviors. Additionally, the effect of stress (chronic, acute, and daily) on daily health behaviors will be moderated by depressive symptoms using a series of three HLM functions as follows:

*Daily stress* (a Level 1 random effect by a Level 2 covariate)

Level-1: HealthBehavior<sub>ij</sub> = β<sub>0j</sub> + β<sub>ij</sub>DAILYSTRESS<sub>1ij</sub> + r<sub>ij</sub>

Level-2: β<sub>0j</sub> = γ<sub>00</sub> + γ<sub>01</sub> w<sub>1j</sub> + u<sub>0j</sub>

β<sub>ij</sub> = γ<sub>10</sub> + γ<sub>11</sub> w<sub>1j</sub> + u<sub>ij</sub>

where HealthBehaviors<sub>ij</sub> represents the composite score of maladaptive health behaviors and DAILYSTRESS<sub>1ij</sub> represents the same day daily stress score. The effect of depressive symptoms (w<sub>1ij</sub>) will be tested in Level 2.

*Chronic/Acute Stress* (Both Predictors in Level 2)

Level-1: HealthBehavior<sub>ij</sub> = β<sub>0j</sub> + r<sub>ij</sub>

Level-2: β<sub>0j</sub> = γ<sub>00</sub> + γ<sub>01</sub> w<sub>1j</sub> + γ<sub>02</sub> w<sub>2j</sub> + γ<sub>03</sub> w<sub>1j</sub> w<sub>2j</sub> + u<sub>0j</sub>

where HealthBehaviors<sub>ij</sub> represents the composite score of maladaptive health behaviors, w<sub>1j</sub> represents depressive symptoms, w<sub>2j</sub> represents chronic or acute stress, and w<sub>1j</sub> w<sub>2j</sub> represents their interaction.

**Hypothesis 2.** The presence of an interaction between daily stressful events and chronic stress on daily health behaviors will be tested using the following HLM function:

Level-1: HealthBehavior<sub>ij</sub> = β<sub>0j</sub> + β<sub>ij</sub>DAILYSTRESS<sub>1ij</sub> + r<sub>ij</sub>

Level-2: β<sub>0j</sub> = γ<sub>00</sub> + γ<sub>01</sub> w<sub>1j</sub> + u<sub>0j</sub>
\[ \beta_{ij} = \gamma_{10} + \gamma_{11} w_{ij} + u_{ij} \]

where HealthBehavior\text{ij} represents the composite score of maladaptive health behaviors and DAILYSTRESS\text{ij} represents the same day daily stress score. \( \Theta_{ij} \) represents chronic stress, which will be tested in Level 2.

**Hypothesis 3.** The presence of an interaction between daily stressful events and coping beliefs will be tested using a series of 4 HLM equations (one each for 4 health behaviors: eating, drinking, smoking, and exercise):

**Level-1:** HealthBehavior\text{Individual}\text{ij} = \beta_{0j} + \beta_{1j}DAILYSTRESS\text{ij} + r_{ij}

**Level-2:**

\[ \begin{align*}
\beta_{0j} &= \gamma_{00} + \gamma_{01} w_{ij} + u_{0j} \\
\beta_{1j} &= \gamma_{10} + \gamma_{11} w_{ij} + u_{ij}
\end{align*} \]

where HealthBehavior\text{Individual}\text{ij} represents each health behavior (eating, drinking, smoking, and exercise) and DAILYSTRESS\text{ij} represents the same day daily stress score. \( \Theta_{ij} \) represents each coping belief (eating as coping, drinking as coping, smoking as coping, and exercise as coping), which will be tested in Level 2. A three-way interaction between chronic stress, daily stress, and coping beliefs will additionally be examined.

**Hypothesis 4.** The presence of an interaction between daily health behaviors and daily stressful events on negative affect will be tested by the following HLM function:

**Level-1:** NextDayNegAffect\text{ij} = \beta_{0j} + \beta_{1j}x_{1ij} + \beta_{2j}x_{2ij} + \beta_{3j}x_{1ij}x_{2ij} + r_{ij}

**Level-2:**

\[ \begin{align*}
\beta_{0j} &= \gamma_{00} + u_{0j} \\
\beta_{1j} &= \gamma_{10} + u_{ij} \\
\beta_{2j} &= \gamma_{20} + u_{0j} \\
\beta_{3j} &= \gamma_{30} + u_{0j}
\end{align*} \]
where the outcome is next day Negative Affect, $x_{1ij}$ is the covariate for Level 1 daily stress and $x_{2ij}$ is the covariate for Level 1 daily health behaviors, and $x_{1ij}x_{2ij}$ is the interaction between them. Additionally, $\beta_{0j}$ is the intercept, $\beta_{1j}$ is the main effect of daily stress, $\beta_{2j}$ is the main effect of health behaviors, and $\beta_{3j}$ is the within-level interaction between $x_{1ij}$ and $x_{2ij}$.

**Hypothesis 5.** The relationship between depression status and daily affect (positive and negative) on same-day health behaviors in depressed will be assessed as follows.

Moderation will be assessed using the following HLM function, repeated for positive and negative affect:

Level-1: \[
\text{HealthBehavior}_{ij} = \beta_{0j} + \beta_{1j}\text{AFFECT}_{1ij} + r_{ij}
\]

Level-2: \[
\beta_{0j} = \gamma_{00} + \gamma_{01} w_{ij} + u_{0j}
\]
\[
\beta_{1j} = \gamma_{10} + \gamma_{11} w_{ij} + u_{1j}
\]

where HealthBehaviors$_{ij}$ represents the composite score of maladaptive health behaviors and AFFECT$_{1ij}$ represents same day affect (2 equations, one including positive affect and one including negative affect). The effect of depression group status ($w_{ij}$) will be tested in Level 2.

Mediation will be assessed using the following HLM function, repeated for positive and negative affect:

Level 1: \[
\text{HealthBehaviors}_{ij} = \beta_{0j} + \beta_{1j}(M_{ij} - M_{j}) + r_{ij}
\]

Level 2: \[
\beta_{0j} = \gamma_{00} + \gamma_{01} x_{ij} + \gamma_{02} M_{j} + u_{0j}
\]
\[
\beta_{1j} = \gamma_{10}
\]

where HealthBehaviors$_{ij}$ represents the composite score of maladaptive health behaviors and $M_{j}$ is the mean affect rating (separate for positive and negative) for group j, $M_{ij}$ is the daily affect for the individual (separate for positive and negative), $M_{j}$ is the mean daily affect rating for the
individual and $\gamma_{02}$ and $\gamma_{10}$ are the between-group and within-group coefficients of affect, respectively. $X_i$ is the depression group status, which is accounted for at Level 2.

**Sample Size**

Given that the present study seeks to test a variety of hypotheses involving fixed effects, variance components, and cross-level interactions without previously established effect sizes, it is challenging to conduct an a priori power analysis (Scherbaum & Ferreter, 2009). Nonetheless, guidance provided by previous simulation studies of power analyses in multilevel modeling have identified total samples of 50/20 (1,000 data points total; Hox, 1998) and 30/30 (900 data points total; Kreft, 1996); and the present study exceeds both of these estimates (127/14, 1,778 total data points). Additionally, this sample size has previously proven sufficient to detect daily relationships between stress, mood, and health behaviors (e.g., Carney, Armeli, Tennen, Affleck, & O’Neil, 2000; Gartland, O’Connor, Lawton, & Ferguson, 2014; Kiene, Barta, Tennen, & Armeli, 2009).

**False Discovery Rate Control Analysis**

Due to the large number of a priori tests conducted ($N = 20$), the false discovery rate control (FDC) procedures outlined by Benjamini and Hochberg (1995) were employed to correct for the potential false discovery of significant results associated with multiple tests. This method is particularly useful when testing scientifically-driven hypotheses and is not associated with many of the limitations accompanying other methods of controlling the rate of false positive findings, such as the Bonferroni correction (Glickman, Rao & Schultz, 2014). For the present analyses, the false discovery rate was set to .05, such that at most 5% of the significant findings could be mistakenly concluded to be true positives.

**Results**
Descriptive Statistics

Correlations among all primary study variables are presented in Table 5. Descriptive statistics for baseline and daily measures are provided in Tables 4 and 6.

Daily Diary Completion

The average number of daily diaries completed was 12.86 out of 14 (range 3-14, SD 1.64), which is comparable to or better than other daily diary studies using college student samples (e.g., Covault, et al., 2007; Ford & Collins, 2013; Sahl, Cohen, & Dasch, 2009). Fifty-two participants (41%) completed 14 daily diaries, 43 (34%) completed 13, 19 (15%) completed 12, 9 (7%) completed 10-11, and 4 (3%) completed fewer than 10. Participants completing fewer than 50% (n = 2) of the 14 daily diaries were excluded from the daily diary analyses, in keeping with previous literature (e.g., Ford & Collins, 2013; Seacat, Dougal, & Roy, 2014).

Hypothesis 1: Effects of Stress and Depression on Daily Health Behaviors

Chronic stress. Chronic stress had a significant main effect on daily maladaptive health behaviors ($b = .12, SE = .04, p < .01$), controlling for gender (see Table 8). When chronic stress and depressive symptoms were included in the same model, chronic stress, but not depressive symptoms, predicted daily maladaptive health behaviors (see Table 7); however this effect was not significant using the FDC corrected significance level (observed $p$ value = 0.03, FDC $p$ value = 0.015). Including past depressive episodes as a covariate on level 2 of these models did not alter results; past depressive episode presence was not a significant predictor of daily maladaptive health behaviors in either model. Gender was also not a significant predictor in either of the models.

Acute stress. Acute stress did not have a significant main effect on daily maladaptive health behaviors (see Tables 7 and 8).
Daily stress. Daily stress predicted higher same-day maladaptive health behaviors (see Table 9). Person-mean centered daily stress was marginally significant \((p = .051)\) in predicting same-day maladaptive health behaviors, demonstrating a marginally significant effect of changes to a person’s typical daily stress on their maladaptive health behaviors. These models controlled for individuals’ baseline maladaptive health behavior composite scores on Level 2, thus demonstrating effects of daily stress on changes to a person’s typical health behavior engagement.

When depressive symptoms and daily stress were included in the same model, both were significant in predicting same-day maladaptive health behaviors (Table 8). As before, person-centered daily stress was marginally significant in these models (Table 8). Controlling for presence of past depressive episodes on Level 2 did not alter any of the models. When baseline maladaptive health behavior composite scores were included on Level 2, both daily stress \((b = .05, SE = .03, p = .06)\) and person-mean centered daily stress \((b = .05, SE = .02, p = .051)\) were marginally significant predictors of daily maladaptive health behaviors, and depressive symptoms were no longer significant in either model.

Depression. Depressive symptoms at baseline had a significant main effect on daily maladaptive health behaviors, controlling for gender (see Table 7). The main effect of depressive symptoms at baseline on daily maladaptive health behaviors held when controlling for history of past depressive episodes \((b_{\text{depressive symptoms}} = .04, SE = .01, p < .01; \text{past depressive episodes were non-significant})\). When depressive symptoms were replaced with current depressive disorder diagnoses \((n = 12 \text{ meeting current diagnostic criteria for a Major Depressive Episode})\), diagnoses did not have a significant main effect on daily maladaptive health behaviors \((b = -.01, SE = .40, p = .87)\).
**Interactions.** Depressive symptoms did not moderate the effects of stress (chronic, acute, or daily) on daily maladaptive health behaviors, nor was the effect of depressive symptoms on daily maladaptive health behaviors mediated by experiences of daily stress.

**Relative effects.** In order to compare the independent effects of stress and depression on daily maladaptive health behaviors, a model was run in which chronic stress, acute stress, and depressive symptoms were included in Level 2 and daily stressors were included in Level 1. In this model, acute stress and depressive symptoms were not independently significant in predicting maladaptive daily health behaviors; daily stress was significant ($b = .06, SE = .02, p = .01$) or marginally significant when person-mean centered ($b = .05, SE = .02, p = .051$), and chronic stress was significant ($b = .09, SE = .04, p = .04$) in predicting daily maladaptive health behaviors. When additionally controlling for participants’ baseline maladaptive health behavior scores, daily stress was the only independently significant predictor of daily maladaptive health behavior changes ($b$, uncentered $= .05$, SE $= .02$, $p = .04$; $b$, person mean centered $= .05$, SE $= .02$, $p = .051$).

**Effect sizes.** While there is no standard method of calculating effect sizes in multilevel modeling, one estimation of the magnitude of effects is the *proportional reduction in variance* statistic (PRV), which estimates the reduction in variance associated with individual predictors (e.g., Peugh, 2010; Nezlek, 2012). The PRV is calculated by subtracting the variance of the model with the predictor from the variance of a model without a predictor (the “base” model), and dividing the difference by the variance of the base model. The resulting statistic provides an estimate of the percentage of the residual variance that has been explained by the predictor. Previous researchers have urged interpreting this result with caution, and noted particular concern about using it to estimate effects of Level 1 predictors, in part because in multilevel
models, unlike ordinary least squares models, it is possible for significant Level 1 predictors to not influence Level 1 residual variance (e.g., Nezlek, 2012).

Using the PRV to estimate the percentage of residual variance explained by Level 2 predictors compared to a base model in the estimation of daily health behavior practices, it is estimated that 7% of residual variance was explained by a participant’s baseline level of chronic stress and 5% was explained by a participant’s baseline level of depressive symptoms. The strongest Level 2 predictor of a person’s daily health behavior practices was their baseline level of health behaviors, which accounted for 24% of the variance in daily health behaviors between participants.

**Hypothesis 1 summary.** Chronic stress and depressive symptoms, but not acute stress, at baseline, and daily stress, predicted higher levels of daily maladaptive health behaviors. Interactions between stress and depressive symptoms were not significant in predicting maladaptive health behaviors. In models combining all predictors, daily stress emerged as the most potent independent predictor of maladaptive health behaviors.

**Hypothesis 2: Effects of the Interaction of Daily and Chronic Stress on Daily Health Behaviors**

The interaction of daily stressors and baseline chronic stress was not significant in predicting daily maladaptive health behaviors \((b = .01, SE = .01, p = .19)\). As noted above, chronic stress and daily stress were, however, significant predictors of daily maladaptive health behaviors when included in both separate and combined models. Daily stress was additionally tested as a mediator of the relationship between baseline chronic stress and daily maladaptive health behaviors; it was not significant (Sobel’s Z for the product of coefficients = 1.50, \(SE = 0.01, p = 0.13\)). Thus, while both chronic stress and daily stress are predictive of maladaptive
health behavior practices, the present findings do not support a model in which chronic stress affects health behaviors through daily stress, or only in the context of daily stress.

**Hypothesis 3: Coping Beliefs**

**Drinking.** The coping belief subscale of the DMQR did not exert a significant main effect on daily alcohol consumption. The two-way interaction between drinking-coping beliefs and daily stress was marginally significant in predicting daily drinks (see Table 10). The two-way interaction between drinking-coping beliefs and chronic stress at baseline significantly predicted daily drinks (see Table 11); this finding held when controlling for gender. Furthermore, there was a significant three-way interaction between chronic stress, drinking-coping beliefs, and daily stress in predicting daily drinks, controlling for baseline daily drink consumption (see Table 12); however, this effect was not significant using the FDC corrected significance level (observed $p$ value = 0.03, FDC $p$ value = 0.018).

**Eating.** The Eating and Appraisal Due to Emotions and Stress (EADES) exerted a significant main effect on daily consumption of fats and sweets ($b = -0.02$, SE = 0.01, $p < .01$); unexpectedly, higher scores on the EADES were predictive of less fat and sweet consumption (this held when controlling for gender). Scores on the Palatable Eating Motives Questionnaire (PEM) did not exhibit a significant main effect on daily consumption of fats and sweets. There was no significant effect of the interaction between the EADES or PEM and daily or chronic stress in predicting daily fat and sweet consumption (see Tables 10, 11, and 12 for EADES results).

**Smoking.** The 7-item negative reinforcement subscale of the Short Form Smoking Consequences–Questionnaire (S-SCQ) did not exert a significant main effect on daily cigarette
consumption, nor was it a significant predictor of daily cigarette consumption in interaction with daily or chronic stress (see Tables 10, 11, and 12).

**Exercise.** The 4-item Stress Management Subscale of the Exercise Motivations Inventory – 2 exerted a significant main effect on daily minutes of vigorous and moderate exercise ($b = 0.75$, $SE = 0.32$, $p < .02$). There was a significant effect of the interaction between exercise-coping beliefs and daily stress in predicting daily vigorous and moderate exercise, controlling for average daily vigorous and moderate exercise at baseline (see Table 10). However, this effect was not significant using the FDC corrected significance level (observed $p$ value = 0.02, FDC $p$ value = 0.01). The two-way interaction between chronic stress and exercise-coping beliefs in predicting daily vigorous and moderate exercise was not significant (see Table 11). Furthermore, there was a significant three-way interaction between chronic stress, exercise-coping beliefs, and daily stress in predicting daily vigorous and moderate exercise (see Table 12). These two- and three-way interaction effects held when controlling for gender.

**Hypothesis 3 summary.** For alcohol consumption and exercise, but not smoking and eating, there were significant effects of the interaction between stress and coping beliefs on engagement in these specific health behaviors. Specifically, endorsement of coping-related beliefs interacted with daily and chronic stress to predict higher levels of drinking and exercise.

**Hypothesis 4: Health Behaviors, Daily Stress, and Next-Day Affect**

Daily stress (person-centered) was marginally predictive of next-day negative affect ($b = 0.19$, $SE = 0.10$, $p = 0.06$), although this effect was not significant when controlling for same-day negative affect (see Table 13). Person-centered same-day negative affect significantly predicted next-day negative affect ($b = 0.13$, $SE = 0.04$, $p = .01$). Neither maladaptive health behaviors nor their interaction with daily hassles was significant in predicting next-day negative affect (see
Table 13). Thus, engaging in maladaptive health behaviors on a given day did not predict negative affect the next day. The most potent predictor of next-day negative affect was same-day negative affect.

**Hypothesis 5: Depression, Health Behaviors, and Same-Day Affect**

**Daily affect on health behaviors.** Daily maladaptive health behaviors were significantly associated with both daily negative affect and changes to daily negative affect relative to an individual’s average level of negative affect (person-mean centered; see Table 14), such that higher negative affect was associated with more maladaptive health behaviors. Additionally, daily maladaptive health behaviors were significantly associated with daily positive affect and changes to daily positive affect, such that higher levels of positive affect were associated with fewer maladaptive health behaviors (see Table 14). These analyses controlled for individuals’ baseline levels of maladaptive health behavior engagement, and held when controlling for gender and past depressive episodes.

**Interaction between daily affect and depression.** There was a significant interaction between baseline depressive symptoms and negative affect in predicting daily maladaptive health behaviors, which remained significant when controlling for gender and past depression ($b = .002, SE = .00, p = .03$). However, this interaction was not significant when controlling for baseline maladaptive health behaviors (see Table 15). Interactions between baseline depressive symptoms and positive affect were not significant in predicting daily maladaptive health behaviors (see Table 15).

**Mediation.** The effect of depressive symptoms at baseline on daily maladaptive health behaviors was significantly mediated by daily positive affect (see Table 16 for results and Sobel’s Z tests). The effect of depressive symptoms at baseline on daily maladaptive health
behaviors was additionally mediated by daily negative affect; however, this effect was only marginally significant using the FDC corrected significance level (observed \( p \) value = 0.02, FDC \( p \) value = 0.0125). In accordance with guidelines established by Zhang, Zyphur, & Preacher (2009), these analyses controlled for both within and between subject effects of the level one mediator (daily affect). Thus, the results indicate that the effect of depression on maladaptive health behaviors took place through changes to an individual’s daily level of both positive and negative affect. This mediation was classified as complete rather than partial as the effect of depression on maladaptive health behaviors \( (b = 0.04, SE = 0.01, p < .01) \) became non-significant when the mediator was included in the model. Additionally, these analyses controlled for participants’ baseline levels of maladaptive health behavior engagement, indicating that these meditational effects accounted for increases (in the case of negative affect) or decreases (in the case of positive affect) in participants’ relative maladaptive health behavior engagement.

**Hypothesis 5 summary.** Daily negative and positive affect were associated with increases and decreases in daily maladaptive health behaviors, respectively. Furthermore, the effect of depressive symptoms on maladaptive health behaviors took place in part through daily experiences of positive affect and negative affect (although this was marginally significant).

**Adaptive Health Behavior Composite**

Identical models were run using the adaptive health behavior composite where appropriate. Chronic stress exhibited a significant main effect on daily adaptive health behaviors, such that higher levels of chronic stress predicted lower levels daily adaptive health behaviors \( (b = -0.11, SE = 0.04, p = 0.01) \); this finding held when controlling for gender. Acute stress, depressive symptoms, and daily stress did not exert a significant main effect on daily adaptive health behaviors; thus, additional tests of their interactions were not conducted. Daily affect was
predictive of daily adaptive health behaviors. Daily adaptive health behaviors were significantly predicted by daily positive affect \((b = 0.02, SE = 0.01, p < .011)\) and changes to daily positive affect \((b = 0.02, SE = 0.01, p = 0.01)\) (controlling for each individual’s average level of adaptive health behavior). Additionally, daily negative affect \((b = -0.02, SE = 0.01, p = 0.01)\) and changes to daily negative affect \((b = -0.03, SE = 0.91, p < .01)\) were negatively predictive of daily adaptive health behaviors (controlling for each individual’s average level of adaptive health behavior). These findings held when controlling for gender, depressive symptoms, and history of depression. The interaction between daily affect (positive and negative) and depressive symptoms was not significant in predicting daily adaptive health behaviors. Daily adaptive health behaviors were not predictive of next-day positive or negative affect, either alone or in interaction with same-day affect or daily stress.

**Discussion**

The present study sought to examine the impact of depressive symptoms and stressors of varying chronicity on daily self-reported health behaviors among college students. The results were consistent with previous literature in demonstrating that depressive symptoms, chronic stress, and daily stress are associated with maladaptive health behaviors (e.g., Aldridge-Gerry et al., 2011; Allgower, Wardle, & Steptoe, 2001; Boardman & Alexander, 2011). Although depressive symptoms, chronic stress, and daily stress were individually predictive of maladaptive health behaviors in the present study, hypothesized interactions between depressive symptoms and stress were not supported. However, the effect of depressive symptoms at baseline on daily maladaptive health behavior engagement appeared to take place in part through daily experiences of heightened negative affect and/or diminished positive affect. These findings are consistent with previous studies demonstrating effects of both increased negative affect and reduced
positive affect on health behaviors (e.g., Allgower, Wardle, & Steptoe, 2001; Anton & Miller, 2005; Griffin, Friend, Eitel, & Lobel, 1993), and suggest that the effect of elevated depressive symptoms on health behaviors is not a static process, but rather one that fluctuates in connection with daily mood changes.

A secondary aim of the present study was to test whether college students’ beliefs about the stress-relieving properties of various health behaviors predicted their engagement in said behaviors under conditions of heightened chronic and daily stress. While previous studies have frequently examined health behavior engagement in the context of stress and interpreted such findings to indicate coping, fewer studies have explicitly tested whether coping beliefs moderate these relationships (Park & Iacocca, 2013). Partial support was garnered for predictions related to coping beliefs, such that, for exercise and alcohol consumption, but not eating and smoking, individuals endorsing beliefs about the coping properties associated with these behaviors were likelier to drink alcohol and/or exercise when experiencing higher levels of daily and/or chronic stress. Study results and their implications are discussed in further detail below in terms of effects of depressive symptoms and daily affect, type and duration of stress, and coping beliefs.

**Effects of depressive symptoms and affect on health behaviors**

The primary aim of the present study was to examine the effects of depressive symptoms and stress on daily health behaviors, and changes to daily health behaviors, among college students. Correlations between depressed mood and poor health behaviors such as inactivity, irregular sleep hours, smoking, and alcohol consumption in adolescence and young adulthood are well established (e.g., Allgower et al., 2001; Fulkerson et al., 2004; Katon et al., 2010). Nonetheless, the daily circumstances and mechanisms associated with the impact of depression on health behavior engagement are less well understood. Additionally, as previous literature on
the subject has largely been limited in its measurement of stress, the present study sought to measure and clarify the independent and interactive effects of chronic, acute, and daily stress on health behavior engagement.

The present results are consistent with previous literature showing that higher levels of depressive symptoms predict a greater degree of maladaptive health behavior engagement. This is consistent with prior ecological momentary assessment and daily diary studies demonstrating that adults with elevated depressive symptoms report more frequent daily binge eating and less physical activity than adults without elevated depressive symptoms (Goldschmidt et al., 2014; Hopkin & Mullane, 2008). The present findings corroborate previous correlational studies demonstrating that college students with elevated depressive symptoms are at risk for engaging in worse health behavior practices relative to their peers with low levels of depressive symptomatology. Notably, the present observed relationship between depression and poor health practices was demonstrated with depressive symptoms; relatively few of the participants (n = 11) met full diagnostic criteria for a current major depressive episode. These findings are consistent with previous evidence that depressive symptoms alone, without necessarily achieving full diagnostic threshold for depressive disorders, are sufficient to affect health behavior practices (e.g., Allgower, Wardle, & Steptoe, 2001; Halperin, Smith, Heiligenstein, Brown, & Fleming, 2010; Hopko & Mullane, 2008). The fact that depressive symptoms alone can influence health behavior engagement is particularly problematic given prior evidence that poor health behaviors such as smoking, alcohol consumption, and poor sleep in turn predict worsened mood among adolescents and adults over time (e.g., Boden & Fergusson, 2011; Gregory et al., 2011; Steuber & Danner, 2006). This suggests that individuals already at risk of developing a major depressive
episode by virtue of having elevated depressive symptoms may face an additional risk of worsening mood in part through their health behavior practices.

Notably, however, the hypothesized effect of maladaptive health behaviors on next-day affect was not born out in the present sample, as maladaptive health behaviors did not predict next-day negative affect. This is at odds with previous research demonstrating negative effects of alcohol consumption (relative to placebo) on next-day mood (Howland et al., 2010), and daily diary research showing increases in next-day positive affect following fruit and vegetable consumption (White, Horwath, & Conner, 2013). Results from a recent sedentary-behavior randomized control trial demonstrated that induced sedentary behavior for one week resulted in increased depressive symptoms in participants (who were otherwise generally active; Edwards & Loprinzi, 2016). There have been inconsistencies in results of previous literature; for example, a prior study of affect within 180 minutes following exercise indicated that exercise predicted an increase in positive affect but had no effect on negative affect (Wichers et al., 2012). It is possible that the effects of maladaptive health behaviors on mood are not straightforward or linear, particularly when considering health behavior engagement in aggregate rather than as separate behaviors. Engagement in maladaptive health behaviors such as smoking, drinking, or eating unhealthy food may in fact alleviate stress and/or improve mood in the short term, with potential for deleterious effects over the longer term. For example, some support has been garnered for a self-medication hypothesis of alcohol consumption, such that alcohol use is associated with lower levels of anxiety immediately surrounding use in experience sample studies (Swendsen et al., 2000), although longitudinal studies support prospective associations between alcohol use and development of mood dysregulation and psychopathology (e.g., Boden & Fergusson, 2011; Mason et al., 2008).
The present study attempted to further clarify the nature of the relationship between depressive symptomatology and daily maladaptive health behavior engagement by testing several hypotheses related to the possible mediators and moderators of this relationship. First, it was hypothesized that there might be interactive effects of depression and stress on maladaptive health behavior engagement. While this has not been thoroughly tested in the literature, it is consistent with cross sectional associations between stress, depressive symptoms, disengagement coping, and smoking among college students (Sun, Buys, Stewart, & Shum, 2011). The present results indicated that chronic and daily stress had a main effect on negative health behaviors, but neither chronic stress nor daily stress significantly moderated the effects of depressive symptoms. Thus, in the present study, individuals with elevated depressive symptoms were not likelier than those without elevated depressive symptoms to respond to chronic or daily stress with worsened health behaviors. This finding is somewhat incongruous with prior evidence of heightened degrees of maladaptive stress-coping responses among individuals with depression. For example, depression has previously been associated with ruminative coping, and negatively associated with problem-focused and distractive coping (Li, DiGiuseppe, & Froh, 2006). Additionally, among adolescents, depressive symptoms are inversely related to use of secondary control strategies such as acceptance and coping in response to family stress (Jaser et al., 2007).

In the present study, it seemed that chronic and daily stress had a negative influence on health behaviors in all individuals, regardless of levels of depressive symptoms. Furthermore, while depressive symptoms also predicted higher levels of maladaptive health behaviors in the present sample, evidence from models containing stress and depressive symptoms simultaneously suggested that chronic and daily stress more strongly predicted maladaptive health behavior engagement compared to depressive symptoms. While it may be the case that
chronic and daily stress are strong predictors of maladaptive health behavior engagement regardless of levels of depressive symptoms, it is also possible that characteristics of the present sample prevented detection of the hypothesized effects. Although the present sample was over-selected for participants with elevated depressive symptoms, relatively few of the participants actually met diagnostic criteria for a depressive disorder. It is possible that in a sample with more individuals meeting diagnostic criteria for depression, differential responses to stress among depressed and non-depressed individuals would have been more pronounced.

Similarly, the impact of depressive symptoms on maladaptive health behaviors was not moderated by experiences of daily affect. However, there was evidence in support of a role of daily affect as a mediator of the effect of depression on daily health behaviors: baseline depressive symptoms influenced daily maladaptive health behaviors in part through daily experiences of increased negative affect and diminished positive affect. Importantly, these analyses controlled for individual participants’ baseline maladaptive health behavior engagement and average level of positive and/or negative daily affect. Thus, the results indicate that depressive symptoms influence changes to an individual’s poor health practices through fluctuations in experiences of daily positive and negative affect, relative to their own baseline affect and health behavior practices. These findings suggest that the influence of depressive symptoms on health behavior engagement is not a stable or static process, but rather, one that is dynamic and changes in association with daily fluctuations in affect.

The findings concerning the mediational role of negative affect, in particular, should be interpreted with caution given that the finding was no longer significant when the false discovery rate control analysis was implemented. Thus, these findings require replication in an independent sample in order to ascertain their validity. Nonetheless, the importance of daily fluctuations in
affect among college students with elevated levels of depressive symptomatology has previously been identified. For example, in a previous daily diary study, it was found that elevated depressive symptoms were associated with a stronger relationship between daily negative affect and daily experiential avoidance (Shahar & Herr, 2011). The present findings are also consistent with previous survey studies demonstrating that both distress tolerance and beliefs about the utility of substances to alleviate negative affect serve as mediators of the relationship between depressive symptoms and substance use in college students (Buckner, Keough, & Schmidt, 2007; Schleicher, Harris, Catley, & Nazir, 2009). These findings, though correlational, are consistent with the present study: daily fluctuations in negative affect may affect health behavior engagement because they are also associated with distress/discomfort intolerance. Individuals with elevated depressive symptoms who experience increased negative affect may engage in poor health behaviors in an effort to reduce distress and/or because they believe doing so will reduce discomfort.

Interestingly, the present findings provide tentative support for a mediational role of negative and positive affect. The reasons that positive affect mediates the effect of baseline depressive symptoms on daily health behaviors, however, plausibly differ from those associated with negative affect. It has previously been demonstrated that daily positive affect is positively associated with increased fruit and vegetable consumption and inversely related to sleep problems (Steptoe, O’Donnell, Marmot, & Wardle, 2008; White, Horwath, & Conner, 2013). Additionally, trait levels of positive affect are associated with higher self-reported exercise levels (Garcia & Archer, 2014). Previous studies have consistently shown associations between positive affect and adaptive health behavior engagement, and the present study extends these
findings to suggest that daily decreases in individual positive affect are one mechanism by which elevated depressive symptoms influence maladaptive health behavior engagement.

The current results have important implications for health outcomes among college students. Students with chronically stressful lives, higher loads of daily stress, and depressive symptoms are at increased risk for engaging in daily maladaptive health behaviors. Furthermore, one mechanism by which depressive symptoms influence daily health behaviors is through daily fluctuations in positive and negative affect. The present findings reinforce that physicians and healthcare providers ought to attend to the physical health practices of college students with elevated depressive symptoms and heightened stress levels. It is crucial to improve understanding of the relationships between depression, stress, and health behaviors among young adults in part due to well-established relationships between depression and poor physical health outcomes. Health behaviors have previously been shown to mediate the relationship between depression and cardiovascular disease (Whooley et al., 2007), and may play an important role in the relationship between depression and other physical health conditions. Furthermore, estimates of the proportion of college students who exhibit problematic or disordered health-related practices are high; for example, up to 39% of college students endorse binge drinking in the past year, and up to one-third of college students use inappropriate compensatory dieting strategies such as self-induced vomiting or excessive exercise (Quick & Bredbrenner, 2013; SAMHSA, 2013). The present findings corroborate previous evidence that individuals with elevated depressive symptomatology are at risk of worse health behaviors than individuals with low levels of depressive symptoms. The results additionally suggest that, regardless of levels of depressive symptoms, chronic and daily stress are associated with increased maladaptive health behaviors. Given that depressed individuals experience higher levels of stressful life events that are at least
partially dependent upon their own actions per the *stress generation* theory (Hammen, 1991), the health behaviors of youth at risk for or suffering from depression may be doubly at risk by virtue of exposure to both depressed mood and increased stressful life circumstances.

Furthermore, these findings highlight the need for psychotherapeutic interventions targeting mechanisms by which individuals with elevated depressive symptoms engage in poor health behavior practices. The present study provides tentative support that one such potential target would be individuals’ responses to daily fluctuations in positive and negative affect. Therapeutic interventions that target affect-regulation skills have been shown to improve psychotherapy outcomes generally (Berking *et al.*, 2008). Results from a preliminary pilot study suggest that a 4-week long resilience training program can improve coping strategies, increase positive affect, and decrease negative affect in college students (Steinhardt & Dolbier, 2010). Young adults suffering from depression, or at risk of developing depression by virtue of elevated depressive symptoms, may benefit from emotion-regulation training that targets response to daily experiences of negative affect/emotion and facilitates use of healthy coping responses over maladaptive health behavior engagement. The present study advances understanding of how depressive symptoms affect health behavior engagement day-to-day, and suggests that daily changes in positive and negative affect may be a fruitful target of intervention with potential implications for mental and physical health.

The present study was conducted with currently enrolled college students ages 18-25. It is important to consider whether results would generalize to similarly aged non-college-attending young adults. Prior research indicates that overall rates of psychiatric disorders are similar between college-attending and non-attending same-age individuals, although college-attending young adults are at higher risk for alcohol use disorders and lower risk for drug or tobacco
dependence (Blanco et al., 2008; Slutske, 2005). The transition from college to post-collegiate life is associated with decreased drinking and drinking-related problems (Perkins, 1999). Peer influences affect alcohol consumption in both college-attending and non-attending adolescents/young adults (White, Fleming, Kim, Catalano, & McMorris, 2008). Rates of overweight and obesity increase over the course of young adulthood in both groups, but the effects are more dramatic among college-attending young adults than non-college-attending young adults (Mokdad et al., 1999). While the nature and type of stressors affecting college-attending and non-college-attending young adults is likely to differ (e.g., academic versus job stress), both are transitional periods associated with life changes such as moving away from family of origin and establishment of new relationships. Given prior research demonstrating effects of stress on health behaviors and depression across a wide variety of populations, it seems likely that the relationship between stress, mood, and health behaviors would be similar across young adults, regardless of their college status. Nonetheless, patterns associated with specific health behaviors might differ somewhat between these groups, with, for example, college-attending young adults more likely to engage in heightened binge drinking and non-college-attending young adults more likely to use tobacco.

**Duration of Stress**

As outlined above, an additional aim of the current study was to differentiate the effects of stressors of varying chronicity on health behaviors. Improved understanding of how type and duration of stressors impact the health behavior practices of young adults will not only advance theoretical understanding of the relationship between stress and health, but will also potentially yield useful implications for interventions. In the present study, acute stressful life events in the past three months, unlike chronic stress and daily hassles, were not significantly associated with
daily maladaptive health behavior engagement. These findings are somewhat inconsistent with previous research showing an effect of life events on health behaviors; for example, stressful life events have been shown to predict objective measures of sleep (Kim &Dimsdale, 2007) and acute experimental stressors such as the Trier Stress Test predict increased urges to smoke and worsened sleep (Childs & de Wit, 2010; Kim &Dimsdale, 2007). Notably, though, prior research on the effect of stress on health behaviors has often failed to differentiate between acute and chronic stress and has utilized measurements such as perceived stress, or life events such as divorce and job loss, that may in fact conflate chronic and acute conditions (e.g., Koval, Pederson, Mills, McGrady, & Carvajal, 2000; Krueger & Chang, 2008; Lund, Reider, Whiting, & Prichard, 2010). In the present study, use of a semi-structured interview designed to differentiate, to the extent possible, between acute and chronic stress, provided evidence that ongoing, but not discrete, stressors influence maladaptive health behavior engagement.

While the present results may indicate that chronic, but not acute, stress affects health behaviors, it is also possible that a certain severity of life event is required to affect health behavior engagement, and the acute life events reported by participants in the current sample were not severe enough to elicit the effects noted in previous studies. Examples of common acute stressful life events reported by participants in the current study included romantic relationship break-ups, changing academic major, or a fight/disagreement with a roommate or friend. Prior studies demonstrating an effect of acute stressful life events on health behavior engagement may have generally been capturing more severe stressors. In a study of HIV-positive patients, for example, major stressful life events (e.g., death of a close friend, new job, law violation) were associated with higher levels of substance use coping, alcohol and cocaine use, and medication non-adherence (O’Clerigh, Ironson, & Smits, 2007). Evidence from epidemiological literature
indicates that stressful life events such as divorce and job loss increase risk of alcohol use disorders (Keyes, Hatzenbuehler, & Hasin, 2011). In addition to severity, the nature or type of acute stressor may impact the effect on health behavior engagement. A systematic review of life events and physical activity demonstrated that the effect of life events on physical activity varied by type of event, with certain events (e.g., beginning work, getting married) predicting a decrease in physical activity and others (e.g., starting a new personal relationship) predicting an increase in physical activity (Engberg et al., 2012).

The present findings suggest that the measurement of stress in studies of health behavior engagement is important. A few previous studies of stress and health behavior have used multiple measurements of stress, and similarly noted differential effects based on type of stress measured. For example, a survey study of college students found an inverse association between physical activity and daily hassles, but no significant relationship between physical activity and perceived stress (Nguyen-Michel, Unger, Hamilton, & Spruijt-Metz, 2005). In their review of human and animal studies examining stress and eating, Torres & Nowson (2007) suggested that while chronic stress might yield increased food consumption, particularly of fats and sweets, acute stressors may actually suppress appetite.

The present finding of an impact of chronic, but not acute, stress on health behaviors is consistent with evidence that chronic stress is a stronger and more consistent predictor of a variety of mental and physical health outcomes, including depressive episodes, than is acute stress (Hammen, 2005; Thoits, 2010; Schneiderman, Ironson, & Siegel, 2005). Chronic stressors may precipitate longer-lasting changes to the body’s stress response system that concurrently elicit behavioral changes. The present finding of an effect of chronic stress on maladaptive health behaviors is consistent with a large body of evidence showing associations between chronic
conditions such as low socioeconomic status, perceived discrimination, and lack of social and emotional support on poor health behaviors such as smoking, drinking, poor sleep, and physical inactivity (e.g., Pampel, Krueger, & Denney, 2011; Pascoe & Smart Richman, 2009; Strine, Chapman, Balluz, & Mokdad, 2007). In the present study, recent acute stressors may have disrupted health behavior engagement briefly in a way that was not captured by the daily diary methodology. It is possible that acute stressors affect health behavior engagement only temporarily, which would be consistent with the present study’s findings of daily fluctuations in health behaviors occurring in tandem with daily stressors.

In the present study, daily stressors emerged as the strongest predictor of daily maladaptive health behavior engagement, over and above depressive symptoms, chronic stress, and participants’ baseline levels of health behavior engagement. These findings are consistent with multiple prior studies indicating an effect of daily stress on a wide range of health behavior practices including sleep, smoking, drinking, and consumption of fruits, vegetables, and sweets (Aldridge-Gerry et al., 2011; O’Connor, Jones, Conner, McMillan, & Fergusson, 2008; Soffer-Dudek & Shahar, 2011; Todd, 2004). These results indicate that daily health behaviors fluctuate in association with daily stressors. Notably, the daily stressors captured in the present study – e.g., having an exam, misplacing a needed item, having a disagreement with a roommate – were relatively minor and common occurrences, and yet they were influential enough in aggregate to affect health behavior practices. In the current sample, relative increases in daily stress (i.e., models controlling for a participants’ baseline level of daily hassles) were marginally associated ($p = .051$) with daily maladaptive health behaviors. This is notable in that, even changes to typical amounts of daily stress may be associated with changes to daily health behavior practices. It is important to note that the present daily diary methodology precludes a definitive assessment
of the direction of the association between daily health behaviors and daily hassles. It is possible that poor health behaviors elicit daily hassles; this is particularly plausible when considering that, for example, alcohol consumption might put someone at greater risk for subsequent psychosocial stressors such as arguments or losing property. While it is certainly reasonable to assume some degree of bi-directionality between daily stress and health behavior engagement, it seems that at least some of this effect is likely to be accounted for by an effect of stressors on health behaviors. This is most plausible when considering, for example, directionality between academic events like exams and projects, and changes to eating, exercising, and sleeping.

The association between daily stressors and maladaptive health behaviors may be due to several different reasons. First, consistent with previous literature and present hypotheses, increases in maladaptive health behaviors on days involving more stressors may reflect an effort on the part of participants to cope with/and or regulate distress or negative affect associated with stressful events. Certainly, such a model is consistent with findings from the present study that daily negative affect was also associated with daily maladaptive health behaviors. Concurrently or alternatively, it could be the case that daily hassles drain resources – such as time, or mental and/or physical energy – that would or could be put towards engagement in adaptive health behaviors.

The present findings indicate that daily stressors are a particularly important and unique predictor of daily maladaptive health behaviors relative to chronic stress and depressive symptoms. It did not seem to be the case in the present analyses that daily stressors were solely reflective of ongoing chronic conditions, as they did not serve to mediate the effect of chronic stress on maladaptive health behaviors (although, as expected, higher levels of chronic stress were correlated with a higher number of daily hassles). Nor was there a significant effect of the
interaction between chronic and daily stress on maladaptive health behavior. These findings, along with findings from previous studies, demonstrate an effect of daily hassles on health behaviors among college students, regardless of their baseline levels of depressive symptoms and/or chronic stress. Prior research demonstrates that there are significant long-term effects of how individuals respond to daily stress. For example, greater affective response to daily stress has been associated with increased likelihood of reporting a chronic physical health problem ten years later (Piazza et al., 2013); it is possible this association is due in part to behavioral changes occurring in response to or in tandem with affective responses.

In light of the association between daily stress and maladaptive health behaviors demonstrated in present and prior research, and the potential for daily behavioral and affective responses to influence long-term outcomes, it is important to consider interventions that might mitigate these processes. There is evidence that interventions can successfully target and alter responses to daily stressors. For example, a study of cognitive therapy for depression demonstrated that after only 6 sessions, participants demonstrated reduction in experiences of negative affect in response to stressors (Parrish et al., 2009). Previous research has also demonstrated that facets of conscientiousness moderate the effect of daily hassles on daily vegetable consumption, smoking, and exercise, such that participants with low self-efficacy generally exhibit worse health behaviors on days in which they experienced a greater number of hassles (O’Connor, Conner, Jones, McMillan, & Ferguson, 2009). Interventions that bolster conscientiousness and self-efficacy may mitigate the effects of daily stress on college students’ health behaviors. Additionally, mindfulness-based interventions have been shown to improve sleep quality, physical activity, and healthy eating, and decrease smoking (Bowen & Marlatt, 2009; Caldwell et al., 2010; Michie, Abraham, Whittington, McAteer, & Gupta, 2009). Although
daily stressors are associated with maladaptive health behavior change in college students, interventions that enhance mindfulness and bolster students’ self-efficacy regarding their ability to engage in healthy behavior may be useful in mitigating these effects.

**Coping Beliefs and Expectancies**

In order to better determine whether changes to maladaptive health behavior engagement that occurred in association with higher levels of chronic and/or daily stress reflected attempts to cope with these stressors, participants’ coping beliefs and expectancies about various health behaviors were measured at study baseline. Previous research on stress and health behaviors has frequently interpreted maladaptive health behaviors that take place in the context of stress as efforts to cope, without explicitly measuring or testing beliefs and/or motives (Park & Iacocca, 2014). The results partially supported study hypotheses and demonstrated that beliefs about the ability of drinking and exercising to facilitate coping moderated the relationship between stress and maladaptive health behavior engagement.

The present findings regarding alcohol consumption are consistent with previous daily diary and experience sampling research demonstrating that college students endorsing higher initial coping-depression motives were likelier to consume alcohol on days in which they had more depressed and/or sad mood (Grant, Stewart, & Mohr, 2009; Hussong 2007). Similarly, these results are consistent with previous work demonstrating that the effect of avoidant coping on drinking behavior was mediated by participants’ beliefs that alcohol reduces tension (Hasking, Lyvers, & Carlpio, 2011). Notably, tension reduction and/or coping beliefs are not the only trait-level predictors of daily drinking; social enhancement motives are also important predictors of drinking (Arbeau, Kuiken, & Wild, 2011; Armeli, Conner, Cullum, & Tennen, 2010). Fortunately, beliefs that individuals hold about positive and negative effects of alcohol
consumption can be challenged and modified (Labbe & Maisto, 2011). For example, alcohol expectancy challenges utilize laboratory paradigms in which participants are given either placebo or alcohol and then receive didactic information about the impact of alcohol-related beliefs and expectations on their behavior and perceptions of others’ behaviors (Labbe & Maisto, 2011). Alcohol expectancy interventions are effective in changing college students’ alcohol consumption (Scott-Sheldon, Terry, Carey, Garey, & Carey, 2012).

Exercise-related coping beliefs also served to moderate the impact of chronic and daily stress on daily exercise engagement in the current study, such that individuals endorsing beliefs about the coping properties of exercise were likelier to exercise in response to stress. This is notable in part because, generally in the current study, as well as previous research, stress has a deleterious effect on daily exercise (Steptoe, Wardle, Pollard, Canaan, & Davies, 1996). Responding to stressful events with exercise may be protective against adverse mental and physical health outcomes. In a longitudinal study, physical activity and exercise coping mitigated the effects of stressful life events on depression (Harris, Cronkite, & Moos, 2006). Exercise-related beliefs such as exercise self-efficacy and intention to exercise are modifiable, and thus it may be possible to facilitate exercise-coping in college students (Beauchamp, Rhodes, Kreutzer, & Rupert, 2011; Hurley, Walsh, Bhavnani, Britten, & Stevenson, 2010). It is important to note, however, that responding to stressful circumstances with exercise is not always healthy: a survey study found that college students who endorsed exercising in response to negative affect were also likelier to report poor body image, low self-esteem, and disordered eating (De Young & Anderson, 2009). Thus, it may not be helpful to encourage exercise-coping in students with poor body image or otherwise at risk for disordered eating.
Beliefs related to eating and smoking did not act as moderators of the effect of stress on these behaviors in the present study. This may reflect differences in processes affecting engagement in unhealthy eating and smoking following stress, or may be reflective of relatively low base rates of smoking behavior and/or unhealthy eating practices in the present sample.

Limitations

Several limitations of the present study should be kept in mind when interpreting the results. Although the use of daily diary collection allowed for modeling of day-to-day effects of stress and affect on health behaviors, the data do not allow for more precise modeling of the within-day directionality of stressors on health behaviors and affect. Studies involving technology such as Ecological Momentary Assessment (EMA) would allow for greater precision in assessing the specific influence of daily hassles on subsequent health behaviors and affect within a given day. Additionally, the present sample involves a relatively healthy sample of college students. A community sample, or a sample over-selected for particular physical health problems, would likely show a wider range of daily maladaptive health behavior engagement. The present study is also limited by the fact that 75% of the participants were women and therefore results may not fully generalize to men. Previous literature supports gender differences in the effects of stress and depression on health behaviors (e.g., Saladin et al., 2012; Todd, 2004). Efforts were made to reduce the impact of potential gender differences by controlling for gender in all analyses; results demonstrated that gender was not a significant predictor when included as a control in analyses examining effects of stress and depression on maladaptive health behaviors. Finally, the study is limited by its use of self-report measures of daily mood, stress, and health behavior engagement. While there is evidence that such self-report measures demonstrate high degrees of concordance with objective measurements, it is not possible to
eliminate the potential confounds of socially desirable reporting and/or conflation with current mood state. For example, depressed individuals may perceive higher levels of daily and/or ongoing stress than their non-depressed peers; prior evidence supports correlations between depression severity and measures of perceived stress (Farabaugh, Mischoulon, Fava, Green, Guyker, & Alpert, 2004). Although efforts were made to limit the conflation of mood state with reporting of stress by utilizing an interview measure of chronic and acute stress, as well as a checklist of discrete daily stressors rather than general perceived stress levels, it is still possible that individuals with elevated depressive symptoms were biased in their reporting of stressful events.

**Strengths**

The current study possesses many strengths that bolster the results. First, measurement of chronic, acute, and daily stress allowed for identifying and differentiating chronicity of stress in a way that has not previously been done in depression-health behavior literature. This proved to be an important distinction, given that chronic and daily, but not acute stress, predicted maladaptive health behavior engagement. Additionally, measurement of coping beliefs allowed for explicit testing of whether individuals endorsing beliefs about the coping properties of specific health behaviors (eating, smoking, drinking, and exercising) were likelier to engage in such behaviors in response to stress. This represents an advancement over previous studies examining health behaviors and stress. The use of a daily diary design is also a strength as it enables testing of both within and between person effects of stress and mood on health behaviors. Analyses of daily health behavior change controlled for participants’ typical health behavior engagement as reported at baseline.

**Conclusions**
The primary contributions of the current study are three-fold. First, the study supports careful measurement of stress in studies of health behavior engagement, as chronic and daily stress, but not acute stressful life events, were shown to have an impact on maladaptive health behavior engagement. Second, the study supports prior research showing an effect of depressive symptoms on maladaptive health behavior engagement and suggests that one mechanism of this effect is via daily fluctuations in positive and negative affect. Furthermore, the present results indicate that, for some health behaviors (in this case, alcohol consumption and exercise), beliefs about the effectiveness of these behaviors to alleviate stress moderate the effect of stress on said behaviors. Overall, the present results point to fluctuations in daily affect and coping-beliefs as potential targets of intervention for promoting healthy behaviors in college students with and without elevated depressive symptoms. The current study advances previous research on the relationship between stress and health behaviors by measuring and assessing the relative impact of depressive symptoms and stressors of varying chronicity on health behavior, and examining potential mediators and moderators of the stress-depression-health behavior relationship during young adulthood, a critical period in the development of both mental and physical health.
CHAPTER 4: GENERAL DISCUSSION

The present dissertation sought to clarify several aspects of the relationship between depression and poor health behaviors in young adulthood using longitudinal and daily diary methodologies. Young adulthood is a critical period in the development of mental and physical health outcomes, and presents a risk period for the development of health behavior practices that influence long-term health (Hedberg et al., 1999; Kessler et al., 2005). Clarification of the mechanisms by and circumstances under which stress and depression affect health behaviors daily and over time in young adulthood will inform interventions with implications for mental and physical health. Findings from the present longitudinal and daily diary studies will be integrated in discussion of each of the initial study aims below.

**Does responding to stressors with changes to health behaviors influence subsequent mood?**

Studies 1 and 2 sought to examine whether maladaptive health behaviors that take place following stress are related to subsequent changes in mood. Study 1 tested this hypothesis by examining whether the effect of stress on increases in depressive symptoms over a 5 year period was mediated by specific health behaviors. Study 2 tested this hypothesis by examining whether daily stress interacted with daily maladaptive health behaviors to predict next-day affect (controlling for same-day affect). Study 1 generated support for an effect of total stress burden at age 20 on increases in depressive symptoms at ages 22-25 through poor health behaviors, primarily sleep, at age 21. Study 2 did not find support for an effect of responding to daily stress with maladaptive health behaviors on next day negative or positive affect. Although health behaviors were not predictive of next-day affect in Study 2, there were significant associations between maladaptive health behaviors and same-day positive and negative affect, such that higher negative affect and lower positive affect were associated with maladaptive health
behaviors. Taken together, these results provide partial support for an effect of stress and poor health behaviors on depressed mood over time, while indicating that this effect is not necessarily captured by the effects of health behaviors on next-day affect.

The demonstrated effects of stress and maladaptive health behaviors on depressed mood over time are consistent with previous longitudinal and prospective work demonstrating effects of stress, sleep, smoking, exercise, and alcohol abuse on subsequent depression (Boden & Fergusson, 2011; Conn, 2010; Hammen, 2005; Klungsoyr, Nygard, Sorensen, & Sandanger, 2005; Lucassen et al., 2010; Meerlo et al., 2009). The present results extend previous research demonstrating bidirectional associations between stress, health behaviors, and depressed mood to suggest that health behaviors, especially sleep, serve as one mechanism by which stress influences the development of depressed mood over time. Prior research also demonstrates long-term physical effects of health behavior practices, for example, an overview of systematic reviews demonstrated that sedentary behavior is associated with obesity, all-cause mortality, and diabetes (de Rezende, Lopes, Rey-Lopez, Matsudo, & Luiz, 2014).

Although there was not support in Study 2 for an impact of responding to daily stress with maladaptive health behaviors on increases in next-day negative affect, there were significant associations between same-day stress, negative affect, and maladaptive health behaviors. Same-day correlations amongst these variables may have important implications for longer-term outcomes. In a previous study of daily stressors and negative affect in over 700 adults, higher average daily negative affect and higher affective reactivity to daily stress were associated with increased likelihood of having a depressive disorder ten years later (Charles, Piazza, Mogle, Sliwinski, & Almeida, 2013). In considering a health behaviors-as-coping model, it may be that case that maladaptive health behaviors (particularly drinking, smoking, and
eating fats and sweets) undertaken in response to increased negative affective, do, in fact, provide temporary reduction in negative affect. This is consistent with prior research demonstrating that alcohol use is associated with lower levels of anxiety immediately surrounding use in experience sample studies (Swendsen et al., 2000). Maladaptive health behaviors undertaken in the context of stress may produce deleterious mental or physical health consequences only following repeated or cumulative engagement over time.

Additionally, or alternatively, the hypothesized effect of responding to stress with maladaptive health behaviors on next-day negative affect may not have been demonstrated in Study 2 because the models were testing for increases in next-day negative affect (by controlling for same-day negative affect). Higher levels of daily negative affect and daily stress were associated with same-day maladaptive health behaviors, thus, a ceiling effect may have precluded detection of increases in next-day negative affect.

Overall, the results of the present dissertation provide support for an impact of stress on maladaptive health behaviors on subsequent depressed mood over time. The results indicate, however, that changes to health behaviors in association with daily stressors do not predict increases in next-day negative affect. Nonetheless, these findings underscore the potential mental health ramifications of responding to stress with negative changes to health behavior practices in the long-term. The role of stress in predicting depression is well-established (e.g., Hammen, 2005), and the present findings extend this research to suggest that health behaviors, particularly sleep, may be one mechanism by which stress predicts subsequent depression. These effects might be mitigated by interventions that promote adaptive coping with stress. Meta-analytic investigations demonstrate that cognitive, behavioral, and mindfulness interventions aimed at
reducing stress in college students lower symptoms of anxiety and depression (Regeher, Glancy, & Pitts, 2013).

Are individuals with elevated depressive symptoms more likely to respond to stress with changes to health behaviors than individuals without elevated depressive symptoms?

Study 2 examined the relationship between depressive symptoms and health behaviors, both in terms of main effects of depressive symptoms on health behaviors and in terms of the role of depressive symptoms as a moderator of the effect of stress on health behaviors. Consistent with study hypotheses, Study 2 indicated a significant, positive association between depressive symptoms at study baseline and engagement in daily maladaptive health behaviors. Contrary to study hypotheses, Study 2 results indicated that depressive symptoms did not moderate the effects of stress on health behaviors. To our knowledge, this specific hypothesis has not previously been tested. It is possible that the hypothesized effect was not found due to a relatively low percentage of the sample meeting diagnostic criteria for a current depressive episode; differential effects of stress on health behaviors may have been more pronounced in a sample with a greater severity of depression.

Although the hypothesized interaction between stress and depression was not demonstrated in Study 2, depressive symptoms measured at baseline were associated with greater daily engagement in maladaptive health behaviors. Thus, the results of Study 2 corroborate prior research demonstrating an effect of depressive symptoms on health behaviors among young adults, and suggest that college students with elevated levels of depressive symptomatology may be at greater risk of engagement in maladaptive health behaviors including smoking, drinking, sedentary behavior, and poor eating habits (e.g., Allgower, Wardle, & Steptoe, 2001; Halperin, Smith, Heiligenstein, Brown, & Fleming, 2010; Hopko & Mullane,
2008), although this effect is seemingly not due to increased levels of maladaptive health behaviors in response to stress relative to their non-depressed peers.

Studies 1 and 2 demonstrated that chronic and daily stress are associated with maladaptive health behaviors in young adults with and without elevated depressive symptoms. These findings indicate that all young adults, regardless of their risk for developing depression as indicated by markers including elevated depressive symptoms, past depressive episodes, or maternal depression history, are susceptible to effects of stress on health behaviors. Health-promoting interventions, and interventions promoting adaptive responses to stress, are therefore relevant to youth with and without elevated risk of developing depressive disorders.

Taken together, Studies 1 and 2 reveal a pernicious cycle of physical and mental health whereby stress and depressive symptoms facilitate worsened health behaviors, which in turn predict worsened depressive symptoms over time. The presence of depressive symptoms does not alter the effects of stress on health behaviors, instead, both stress (chronic and daily) and depressive symptoms increases risk of maladaptive health behaviors in young adults.

In what way are daily experiences of positive and negative affect associated with the relationship between depression and health behaviors?

Study 2 sought to examine potential mechanisms of the effect of depressive symptoms on maladaptive health behaviors. Given that depression is associated with heightened negative affect and diminished positive affect on a daily basis (Clark, Beck, & Stewart, 1990), daily fluctuations in affect were examined as mediators and moderators of the relationship between baseline depressive symptoms and daily maladaptive health behaviors. Study 2 provided tentative support for a role of positive and negative affect as mediators of the relationship between baseline depressive symptoms and daily health behaviors. It is important to note that
replication of these findings is necessary, because negative affect was no longer a significant mediator once the false discovery rate correction for multiple analyses was implemented. Nonetheless, these findings indicate that depressive symptoms affect daily maladaptive health behavior engagement in part through increases in daily negative affect and decreases in daily positive affect. Notably, Study 2 did not support a model of daily fluctuations in affect as moderators of the relationship between depressive symptoms and maladaptive health behaviors. Thus, it does not seem to be the case that depressive symptoms interact with occurrences of daily affect to influence maladaptive health behavior engagement.

The identification of mechanisms by which depression influences daily behavior can inform the development and implementation of interventions aimed to mitigate these effects. Although fluctuations in daily affect have not previously been considered in the depression-health behaviors relationship, the role of negative affect in connection with daily stressors and depressive symptoms/disorders has previously been identified. For example, ecological momentary assessment studies demonstrate that negative affect mediates the effects of daily stressors on cortisol levels (Jacobs et al., 2007). Individuals at elevated risk for developing a depressive disorder by virtue of having a twin diagnosed with depression show greater negative affect reactivity to minor stressors in daily life than individuals without a genetic risk of depression (Wichers et al., 2007). Interventions targeting responses to fluctuations in daily negative and positive affect specifically may help to mitigate these effects. For example, mindfulness-based cognitive therapy increases experiences of positive affect, and reduces depressive symptoms and negative affect (Geeschwind, Peeters, Drukker, van Os, & Wichers, 2011; Schroevers & Brandsma, 2010). It may be the case that mindfulness-based stress reduction
interventions focused on enhancing awareness of shifts in and responses to daily experiences of affect could promote adaptive health behavior practices.

**Does the chronicity of stress differentially affect health behavior practices?**

A significant aim of the present dissertation was to disentangle the relative effects of chronic, acute, and daily stress on health behaviors among college students. Previous stress-health behaviors research has largely failed to differentiate chronicity of stress, and common assessments of stress such as checklists and ratings of global perceived stress may conflate various types and durations of stressors (e.g., Koval, Pederson, Mills, McGrady, & Carvajal, 2000; Lund, Reider, Whiting, & Prichard, 2010; Krueger & Chang, 2008). Studies 1 and 2 utilized an objective interview measure of acute and chronic stress, allowing for comparison of the relative effects of chronic and acute stress on health behaviors over the course of a year (Study 1) and day-to-day (Study 2) in the same developmental period. Chronic stress reflected general, ongoing conditions across several life domains in the 6 months preceding the interview, and acute stress was defined as significant life events in the 3 months preceding the interview.

The results were consistent between the studies and indicated an effect of chronic, but not acute, stress on health behaviors using both longitudinal and daily measures. These results are consistent with prior research showing stronger and more consistent effects of chronic stress, relative to acute stress, on a variety of mental and physical health outcomes (Hammen, 2005; Thoits, 2010; Schneiderman, Ironson, & Siegel, 2005). The results of Studies 1 and 2 suggest that recent acute life events do not yield residual or enduring effects on health behavior practices several months after their occurrence. To our knowledge the issue of stress chronicity has not been previously addressed previously in the stress-health behaviors literature. These results suggest that researchers ought to carefully attend to issues related to measurement and chronicity
in studies of the relationship between stress and health behavior practices. While some previous work demonstrates an effect of acute stressors or significant life events on health behavior practices, it may be that these studies were actually capturing effects of life stressors with chronic, or ongoing, ramifications (such as, for example, job loss resulting in chronic financial stress, or the dissolution of a relationship as reflective of ongoing interpersonal difficulties).

While high degrees of ongoing, chronic stress are associated with maladaptive health behaviors, possibly undertaken in an effort to cope with heightened negative affect arising from such conditions, individual acute stressors may not have lasting effects on health behavior engagement.

Study 2 additionally examined the impact of daily stress on maladaptive health behavior engagement and the results indicated that daily stressors were associated with daily changes in maladaptive health behavior engagement. These findings are consistent with previous research demonstrating effects of daily stressors on a variety of health behavior practices. For example, there are significant, positive associations between daily stressors and same-day increased snack intake, poor sleep, increased smoking and drinking, and decreased consumption of fruits and vegetables (Aldridge-Gerry et al., 2011; Newman, O’Connor, & Conner, 2007; O’Connor, Jones, Conner, McMillan, & Fergusson, 2008; Soffer-Dudek & Shahar, 2011; Todd, 2004). Overall, the present results indicate that ongoing, chronic stress is associated with higher levels of overall maladaptive health behavior engagement, and daily stressors predict daily fluctuations in health behaviors. Furthermore, daily stress is not solely reflective of chronically stressful conditions, as daily stress did not mediate or moderate the effects of chronic stress on maladaptive health behavior engagement in Study 2. Recent acute stressful life events were not associated with maladaptive health behavior engagement in Studies 1 or 2. It is possible that acute stressful life
events influence health behavior engagement on the day or days in which the events occur; this is especially plausible given the present findings of effects of fluctuations in daily stressors on health behavior practices. However, acute stressors, unlike chronic stressors, do not seem to elicit lasting changes in overall health behavior engagement. It seems prudent for health professionals to attend to the potentially deleterious effects of both chronic and daily stress on health behaviors in young adults. This is particularly important in light of the effects of responding to chronic stress with maladaptive health behaviors on subsequent increases in depressive symptoms demonstrated in Study 2, as well as previously established physical health ramifications of maladaptive health behavior engagement (Kessler et al., 2005; Mulye et al., 2009).

**Is the relationship between stress and daily health behaviors moderated by beliefs about specific health behaviors as coping tools?**

An additional aim of the present dissertation was to assess in Study 2 whether or not participants endorsing stronger beliefs about the coping properties of health behaviors were more likely to engage in these behaviors under conditions of heightened stress. These analyses were undertaken in order to address a gap in previous literature: associations between stress and health behaviors are often interpreted as efforts to cope without explicit measurement of coping intents or beliefs (Park & Iacocca, 2013). Study 2 demonstrated mixed evidence in support of coping beliefs moderating the relationship between stress and health behavior engagement. In the case of alcohol consumption and exercise, but not smoking and eating, individuals endorsing stronger beliefs about the coping properties of these behaviors were more likely to engage in them when experiencing higher levels of chronic and daily stress. Previous research has demonstrated the importance of beliefs about health behavior engagement behavior and practices in predicting
actual behavior (e.g., Grant, Stewart, & Mohr, 2009; Hussong, 2007). The results of Study 2 support interpretation of increased exercise and alcohol in response to stress as efforts to cope with stress (e.g., Agyapong, 2013; Harris, Cronkite, & Moos, 2006). It is important to note, however, that coping beliefs were measured at study baseline and not daily; thus it is not possible to know with certainty whether an individual instance of maladaptive health behavior engagement reflected an intentional effort to cope. Nonetheless, these findings are consistent with health behaviors-as-coping models in the case of alcohol and exercise.

The lack of support for health-behaviors-as-coping models with eating and smoking could suggest that beliefs about these behaviors are inconsistently predictive of their use. Previous research has demonstrated mixed results in terms of the relationship between smoking beliefs, motivation to quit smoking, and actual smoking behaviors (e.g., Heinz, Kassel, Berbaum, & Mermelstein, 2010; Lipkus & Prokhorov, 2007; McEachan, Conner, Taylor, & Lawton, 2009). In Study 2, neither beliefs about the stress-reduction properties of smoking nor chronic or daily stress were significantly correlated with smoking behaviors. These findings may also be attributable to low base rates of smoking in the sample overall, as 87% of participants denied past-month cigarette use, and only 4% of participants endorsed regular cigarette use. It is possible that samples of regular smokers would reveal significant patterns of the relationships amongst stress, beliefs about the stress-relieving properties of cigarettes, and cigarette use that were not applicable to or detectable in the present sample.

With regards to consumption of fats and sweets, daily hassles, but not chronic stress, were associated with consumption of fats and sweets. The measure of motivation for eating palatable foods was not predictive of daily fat and sweets consumption and, unexpectedly, higher scores on a measure of emotion and stress related eating were inversely related to daily
consumption of fats and sweets. Beliefs about the importance of healthy food and consumption of healthy food in college students has previously been demonstrated (Sun, 2008). Although less research has been conducted on the effects of beliefs about eating unhealthy foods, the present results are incongruous with prior research demonstrating that beliefs about palatable eating motivations are associated with body mass index and are higher among obese individuals relative to non-obese individuals (Burgess, Turan, Lokken, Morse, & Boggiano, 2014). Additionally, previous studies have demonstrated that beliefs about palatable eating motivations predict moment-to-moment motives for eating in ecological momentary assessment studies (Boggiano et al., 2015). Given that Study 2 utilized daily diary rather than ecological momentary assessment analyses, it is possible that the timing was not precise enough to detect interactive effects between stress and beliefs about the stress-relieving properties of food on likelihood of eating fats and sweets.

Measures of coping beliefs were, unfortunately, not included in Study 1 as it was a secondary analysis of a dataset not originally designed to address such questions. It would be interesting to know whether beliefs about the stress reduction properties of various health behaviors moderate the effects of stress on long-term health behavior engagement; presumably, based on the results of Study 2, this would be the case, at least for alcohol and exercise. Explication of the role of beliefs is important in part because, as outlined in the discussion of Study 2, previous interventions have proven to be successful in changing beliefs (e.g., Labbe & Maisto, 2011). Additionally, as demonstrated in the present results, beliefs can promote adaptive health behavior engagement in response to stress, such as with exercise.

Specific Health Behaviors
Although the present dissertation focused on the effects of stress and depression on maladaptive health behavior engagement in aggregate, the results point to certain trends in the relationships between depression, stress, and specific health behaviors. In Study 1, the indirect effect of stress on depression through health behaviors was largely accounted for by sleep. Sleep also emerged as one of the strongest correlates of depressive symptoms and stress in Study 2. The importance of the relationship between sleep and depression is not surprising, given that sleep disruption (either in the form of hypersomnia or insomnia) is a common symptom of Major Depressive Disorder (Germain & Kupfer, 2008). Importantly, in Study 1, stress-related changes to sleep predicted increases in depressive symptomatology among young adults at elevated risk for depression. This is consistent with previous research demonstrating that adolescent girls at risk for developing depression by virtue of maternal depression history reported worse subjective sleep quality than same-age peers without maternal depression (Chen, Burley, & Gotlib, 2011). Sleep seems to be an especially important health behavior to consider in the stress-depression relationship, as sleep-related changes may both precipitate and follow the onset of depressive disorders (Lustberg & Reynolds, 2000).

The relationships amongst depression, stress, and substance use, particularly smoking and alcohol use, were more tenuous in the present studies. In Study 1, the single-item measure of alcohol consumption was unexpectedly not correlated with measures of stress and depression. In Study 2, however, participants’ drinking motives beliefs and scores on a measure of alcohol dependency were significantly associated with depressive symptoms, daily stress, acute stress, and (marginally) chronic stress. Participants’ scores on measures of nicotine dependence were not associated with any form of stress, but were significantly associated with depressive symptoms. On average, participants reported consuming fewer than one cigarette (range 0-8) and
one alcoholic beverage (range 0-20) per day on the daily diary measures. The relatively low base rates of these behaviors may have masked trends that would be more apparent in samples of regular smokers and/or drinkers in terms of daily predictors of smoking and drinking.

Relationships between depression, stress, and exercise and eating varied based on the specific measure of exercise or food consumption used, but generally indicated strongest effects of stress and depression on consumption of fats and sweets (over fruits and vegetables), and vigorous/moderate exercise (over mild exercise). While the purpose of the present investigation was to examine effects of stress and depression on maladaptive health behaviors in aggregate, future studies should consider the impact of stress and depression on individual health behaviors and subsequent affect.

**The Role of Gender and Race/Ethnicity**

The present dissertation sought, to the extent possible, to clarify possible differences in the relationships amongst stress, health behaviors, and depression among men and women. In Study 1, model fit did not differ significantly between men and women. In Study 2, the sample distribution (three-quarters female) precluded meaningful analysis of gender differences, but inclusion of gender as a control variable did not alter results. Prior research indicates that there may be differential effects of stress and depression on health behaviors among men and women. Although there is support for a bidirectional relationship between mental and physical health among both men and women, the specific mental health markers/expressions may be somewhat gendered, with heavy drinking featuring more prominently among men and depression among women (Read, Porter, & Gorman, 2016). In a prior experience sampling study, men were more likely to consume alcohol when nervous than were women (Swendsen et al., 2000).
Study 1 of the dissertation was limited in its use of a predominantly Caucasian sample. The sample in Study 2 was heterogeneous with respect to race/ethnicity, and including race/ethnicity as a predictor in models of the effects of stress and depression on health behaviors did not alter results. Previous studies examining potential effects of race/ethnicity on health behavior engagement have been mixed. A study of stress trajectories among adolescents found no difference in the effects of stress on health behaviors among black and white youth (Boardman & Alexander, 2011). Other studies, however, have demonstrated that among blacks, maladaptive health behavior engagement can actually be protective against major depression, while among whites the opposite is true (e.g., Jackson, Rafferty, & Knight, 2010; Mezuk et al., 2010). While the current dissertation did not demonstrate specific effects of race, this issue should continue to be considered in future studies of the relationships amongst stress, depression, and health behaviors.

**Implications for Intervention**

The current dissertation provides evidence that maladaptive health behavior engagement among young adults is influenced by ongoing, chronic life stress (Studies 1 and 2), daily stressors (Study 2), and depressive symptomatology (Study 2). Previous researchers have noted the importance of adolescence and young adulthood as determinants of adult health behaviors and patterns and thus critical periods for interventions aimed at improving health (Sawyer et al., 2012). The transition from adolescence to young adulthood has been identified as a developmental period that is important in the establishment of behavioral risk factors for obesity including maladaptive changes in diet and physical activity (Nelson, Story, Larson, Neumark-Sztainer, & Lytle, 2008). Fortunately, a number of empirical studies support the effectiveness of various interventions in the promotion of specific adaptive health behavior practices during this
critical developmental period. Mindfulness-based interventions have been demonstrated to reduce cigarette consumption among undergraduate smokers (Bowen & Marlatt, 2009). Prevention efforts, motivational interviewing, and alcohol expectancy challenges have been shown to lower alcohol consumption, high-risk drinking, and drinking consequences among college students (Turrisi et al., 2009; Wood, Capone, Laforge, Erickson, & Brand, 2007). College students who participate in nutrition education programs, including online programs, increase their fruit and vegetable consumption relative to those who do not (Eun-Jeong & Caine-Bish, 2009; Franko et al., 2008). Given the present findings, it may be particularly beneficial to target such interventions (e.g., mindfulness, motivational interviewing, and psycho-education) to young adults who endorse higher levels of stress and depressive symptoms. Furthermore, results of Study 2 suggest that, at least for alcohol and exercise, beliefs about health-behavior engagement influence the likelihood of engaging in such behaviors in response to stressful circumstances. Thus, interventions targeting beliefs may prove useful in altering how individuals respond to and/or attempt to cope with stressful circumstances (Beauchamp, Rhodes, Kreutzer, & Rupert, 2011; Hurley, Walsh, Bhavnani, Britten, & Stevenson, 2010; Labbe & Maisto, 2011). Finally, in terms of mitigating the effects of depressive symptoms on health behavior engagement, Study 2 provides tentative support that interventions targeting responses to and regulation of daily fluctuations in affect may be beneficial.

**Limitations and Future Directions**

Several limitations of the current dissertation should be kept in mind when interpreting the present results. First, assessments of health behaviors in Studies 1 and 2 were via self-report and verification or corroboration by medical reports or biological measures such as actigraphy and pedometer would be useful. Although self-report measures of health behavior practices are
widely used and well validated (e.g., Godin, Jobin, & Bouillon, 1986; Harris et al., 2009; Leigh, 2000), they are nonetheless subject to potential misreporting due to mood-related bias, impression management, or inaccurate estimations of daily behaviors.

A second limitation of the current study pertains to the samples under consideration. While both studies used young adult samples in an effort to better understand the development of stress, mood, and health behaviors during a critical developmental period, the present results may not generalize to other age groups, or samples with more severe mental and/or physical health problems. The effects of depression on subsequent health behaviors would likely be more pronounced in samples with more individuals meeting diagnostic criteria for major depressive disorders. In particular, it is possible that in a sample with more individuals meeting diagnostic criteria for Major Depressive Disorder, differences in responding to stress with maladaptive health behaviors among individuals with and without current depression may have been significant, whereas in Study 2 they were not.

While the present studies were focused on differentiating effects of stressor chronicity on health behaviors and subsequent mood, it would also be important in future studies to assess how other aspects of stress may differentially affect health behavior engagement. For example, previous research has found stronger effects of interpersonal stress relative to non-interpersonal stress on depression and outcomes related to depression in adolescence and young adulthood (e.g., Shih, Eberhart, Hammen, & Brennan, 2006; Sumner et al., 2011). Alternatively, or concurrently, it may be the case that stressors reflecting a greater drain on time (e.g., academic stressors such as preparing for an exam, having to work an extra shift at work unexpectedly) exert a greater impact on health behaviors relative to those that are not necessarily demanding of time (e.g., a romantic rejection, failing an exam).
Study 2 is also somewhat limited by its use of daily diary methodology. Although daily diary approaches allow for modeling of both within and between person relationships between the variables of interest, they do not allow for precise assessment of the timing of daily events. Thus, the present study is not able to draw definitive conclusions about the directionality of the relationship between daily affect, stress, and health behavior engagement. It would be useful to design future studies that might further refine some of the present questions and hypotheses using assessment methods such as experience sampling or ecological momentary assessment. Such designs would permit, for example, testing of whether in vivo changes to health behaviors were undertaken to deliberately alleviate negative affect associated with specific stressors.

Numerous researchers have noted the role of biological processes such as inflammation as a connection between depression and physical health problems (Slavich & Irwin, 2014). For example, a recent study found that among women, but not men, the inflammatory potential of individuals’ diets predicted increases in recurrent depressive symptoms (Akbaraly et al., 2016). Future studies ought to continue to integrate biological and behavioral perspectives of health behavior engagement as they relate to stress and depression. For example, it would be useful to clarify the nature of the relationship between health behaviors and inflammatory processes associated with stress. It is possible that maladaptive health behaviors follow inflammatory reactions to stressors, and/or (as may the case with diet, in particular) maladaptive health behaviors undertaken following stress promote inflammatory processes.

Finally, it might be interesting to combine the designs of the two studies and assess whether responding to chronic and daily stressors as assessed via daily diary or ecological momentary assessment contributes to increased depressive symptoms over a shorter period of time (e.g., a few months). While Study 1 provided evidence that health behaviors mediate the
effect of stress on depressive symptoms over time, utilizing a daily sampling methodology would permit testing of whether actual changes to health behavior practices affect depressive symptoms during a critical developmental period.

**Strengths and Summary**

Despite the above-mentioned limitations, the current studies have several strengths that bolster the findings and therefore contribute significantly to the existing literature. First, both studies utilized a comprehensive, interview-based measure of stress that allowed for differentiation of chronic and acute stressors. Previous literature on the stress-health behaviors-depression relationships has failed to consistently and adequately consider differential effects of stress chronicity on health behavior engagement, and the current findings suggest that chronic and daily, but not acute, stress have an impact on maladaptive health behavior engagement. Additionally, the current studies considered mental health ramifications of health behaviors, which is something that has been previously identified as lacking in prior literature (Park & Iacocca, 2014). The results of Study 1 suggest that stress affects depressive symptoms over time in part through maladaptive health behavior engagement, although, per the findings of Study 2, this does not seem to be by virtue of daily increases in negative mood following stress/maladaptive health behavior exposure. Another significant advantage of the current dissertation was measurement and testing of beliefs about health behaviors-as-coping as moderators of the stress-health behavior relationship; these analyses provided support for a moderating effect of beliefs about drinking and exercising, but not smoking and eating, on the relationship between stress and specific health behavior engagement.

Overall, the present dissertation confirms previous research demonstrating effects of stress and depressive symptoms on maladaptive health behavior engagement among young
adults. Furthermore, it extends prior research by demonstrating that maladaptive health behaviors, especially sleep, serve as one pathway by which stress predicts increases in depressive symptoms. These findings underscore the importance of attending to maladaptive health behaviors among individuals at risk for, and suffering from, depressive disorders and/or elevated depressive symptoms. The association between depression and poor physical health outcomes is well-documented (Jaycox et al., 2009; Luppino et al., 2010; Meyer, Armenian, & Eaton, 2004; Whooley et al., 2008; Van der Kooy et al., 2007), and the current dissertation highlights the important potential role of health behaviors in this relationship. Fortunately, health behavior engagement in response to stress is modifiable, as previous studies have shown and, per the current results, may also be responsive to changes in coping-related beliefs and/or interventions promoting adaptive responses to fluctuations in daily affect.
Appendices

Appendix A. Study 2 Psychology Pool Pre-Screening Questionnaire

What is your gender?
- Female
- Male
- Other

What is your age?

What is your year in school?
- 1st year
- 2nd year
- 3rd year
- 4th year

Do you have regular access to a computer (or internet-enabled smartphone) in the evening (anytime between 8:00 pm and 2:00 AM)?
- Yes
- No

To your knowledge, have you ever been diagnosed with or treated for any of the following conditions?

- Bipolar Disorder
  - Yes
  - No

- Any Psychotic Disorder (e.g., Schizophrenia)
  - Yes
  - No

Appendix B: Study 2 Daily Hassles Questionnaire

Daily Hassles

Please identify whether any of the following have happened to you in the past day (or since you last completed one of the online daily questionnaires).

<table>
<thead>
<tr>
<th>Happened</th>
<th>Did not happen</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

120
<table>
<thead>
<tr>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Had a conflict or disagreement with a friend.</td>
</tr>
<tr>
<td>Had a conflict or disagreement with a family member.</td>
</tr>
<tr>
<td>Had a conflict or disagreement with a roommate/housemate.</td>
</tr>
<tr>
<td>Had a conflict or disagreement with a significant other.</td>
</tr>
<tr>
<td>Had a conflict or disagreement with a professor or teaching assistant.</td>
</tr>
<tr>
<td>Had a conflict or disagreement with a coworker.</td>
</tr>
<tr>
<td>Made a request for help or assistance that was rejected.</td>
</tr>
<tr>
<td>Misplaced or lost something.</td>
</tr>
<tr>
<td>Did not have time to do the things I wanted or needed to do.</td>
</tr>
<tr>
<td>Was rejected by someone.</td>
</tr>
<tr>
<td>Had a problem at work.</td>
</tr>
<tr>
<td>Did not have enough money for something I needed (e.g., tuition, food, rent).</td>
</tr>
<tr>
<td>Did not have enough money for something I wanted (e.g., going out with friends).</td>
</tr>
<tr>
<td>Had a health-related problem (e.g., headache, cramps, or cold, not due to a chronic health condition).</td>
</tr>
<tr>
<td>Did poorly on or failed an exam or project.</td>
</tr>
<tr>
<td>Had to prepare for an exam or important paper/project.</td>
</tr>
<tr>
<td>Had a problem with transportation (e.g., bus or ride was late/hindered by traffic which caused lateness to a class or event, couldn’t get a ride when needed).</td>
</tr>
<tr>
<td>Was criticized by someone.</td>
</tr>
<tr>
<td>Property was damaged or stolen.</td>
</tr>
<tr>
<td>Was embarrassed in public.</td>
</tr>
<tr>
<td>Friends were not available when I wanted to socialize.</td>
</tr>
<tr>
<td>Personal item broke or malfunctioned and interrupted daily activities (e.g., phone, computer, or laptop problem interfering with schoolwork).</td>
</tr>
<tr>
<td>Was ignored by others.</td>
</tr>
<tr>
<td>------------------------</td>
</tr>
<tr>
<td>Performed poorly at a task</td>
</tr>
<tr>
<td>Other hassle or stressor? Please describe:</td>
</tr>
<tr>
<td>Other hassle or stressor? Please describe:</td>
</tr>
</tbody>
</table>

**Appendix C: Study 2 Composite Score Construction**

Maladaptive Health Behaviors Composite Score

Consumption of Fats
0 = 0 servings of fat
1 = 1-2 servings of fat
2 = 3 or more servings of fat

Consumption of Sweets
0 = 0 servings of sweets
1 = 1 serving of sweets
2 = 2 or more servings of sweets

Consumption of Alcohol
0 = 0 servings of alcohol
1 = 3 or fewer servings of alcohol
2 = More than 3 servings of alcohol

Consumption of Cigarettes
0 = 0 cigarettes
1 = Any cigarettes

Sedentary Behavior.
0 = Any exercise (including mild)
1 = No exercise

Lack of Fruit and Vegetables
0 = No fruits or vegetables consumed
1 = Any fruits or vegetables consumed

Inadequate Sleep
0 = 7-9 hrs of sleep
1 = 6 OR 10 hrs of sleep
2 = <6 or >10 hrs of sleep

Adaptive Health Behaviors Composite Score

Consumption of Vegetables
0 = No vegetables
1 = 1-3 servings of vegetables
2 = 3 or more servings of vegetables
Consumption of Fruit
0 = No fruits
1 = 1 serving of fruit
2 = 2 or more servings of fruits
Exercise
0 = No exercise
1 = Some exercise
2 = Recommended daily exercise
Adequate Sleep
0 = <6 or >10 hrs of sleep
1 = 6 or 10 hrs of sleep
2 = 7-9 hrs of sleep
Table 1. Intercorrelations, means, standard deviations, and ranges of primary study variables in Study 1. *p<.05, **p<.01

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
<th>Range</th>
<th>Missing</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Total Stress</td>
<td>.00</td>
<td>1.63</td>
<td>-.77-.3</td>
<td>0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Age 20 Chronic Stress</td>
<td>20.27</td>
<td>4.25</td>
<td>10-36</td>
<td>0%</td>
<td>.81</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Age 20 Acute Stress</td>
<td>7.23</td>
<td>4.66</td>
<td>0-30</td>
<td>0%</td>
<td>.81</td>
<td>.32</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. BDI Age 20</td>
<td>7.05</td>
<td>8.40</td>
<td>0-52</td>
<td>0%</td>
<td>.41</td>
<td>.45</td>
<td>.21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. BDI Age 22-25</td>
<td>7.63</td>
<td>8.63</td>
<td>0-48</td>
<td>35%</td>
<td>.37</td>
<td>.31</td>
<td>.29</td>
<td>.55</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Cigarettes/Day</td>
<td>1.65</td>
<td>.97</td>
<td>1-6</td>
<td>31%</td>
<td>.25</td>
<td>.28</td>
<td>.13</td>
<td>.23</td>
<td>.24</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Vig. Exercise/Wk</td>
<td>1.95</td>
<td>.80</td>
<td>1-3</td>
<td>30%</td>
<td>-.10</td>
<td>-.12</td>
<td>.00</td>
<td>-.09</td>
<td>-.11</td>
<td>-.13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Less Vig. Exercise/Wk</td>
<td>1.92</td>
<td>.72</td>
<td>1-3</td>
<td>30%</td>
<td>-.04</td>
<td>-.07</td>
<td>.01</td>
<td>-.01</td>
<td>.06</td>
<td>-.06</td>
<td>.34</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Walking/Wk</td>
<td>1.80</td>
<td>.77</td>
<td>1-3</td>
<td>31%</td>
<td>.04</td>
<td>.01</td>
<td>.05</td>
<td>.00</td>
<td>.03</td>
<td>-.12</td>
<td>.24</td>
<td>.32</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Restless Sleep/Wk</td>
<td>1.67</td>
<td>.76</td>
<td>1-3</td>
<td>33%</td>
<td>.23</td>
<td>.26</td>
<td>.11</td>
<td>.28</td>
<td>.41</td>
<td>.13</td>
<td>-.05</td>
<td>-.01</td>
<td>.03</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Daytime Drowsiness/ Wk</td>
<td>1.83</td>
<td>.77</td>
<td>1-3</td>
<td>33%</td>
<td>.22</td>
<td>.19</td>
<td>.17</td>
<td>.27</td>
<td>.31</td>
<td>.10</td>
<td>-.06</td>
<td>-.03</td>
<td>-.47</td>
<td>.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Sleep Quality</td>
<td>2.03</td>
<td>.69</td>
<td>1-4</td>
<td>30%</td>
<td>.23</td>
<td>.22</td>
<td>.15</td>
<td>.33</td>
<td>.36</td>
<td>.10</td>
<td>-.11</td>
<td>-.11</td>
<td>-.10</td>
<td>.58</td>
<td>.47</td>
<td></td>
</tr>
<tr>
<td>13. Alcohol Consumption</td>
<td>2.92</td>
<td>1.14</td>
<td>1-5</td>
<td>30%</td>
<td>.01</td>
<td>-.05</td>
<td>.06</td>
<td>.06</td>
<td>.13</td>
<td>.23</td>
<td>-.21</td>
<td>.06</td>
<td>.03</td>
<td>.03</td>
<td>.08</td>
<td></td>
</tr>
</tbody>
</table>

* *p<.05, **p<.01
Table 2. Descriptive statistics and intraclass correlation coefficients for Life Stress Interview domains (Study 2).

<table>
<thead>
<tr>
<th>Life Stress Interview</th>
<th>Close Friendship</th>
<th>Social Life</th>
<th>Romantic</th>
<th>Family</th>
<th>Neighborh ood</th>
<th>School</th>
<th>Work</th>
<th>Finances</th>
<th>Health of Self</th>
<th>Health of Family</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICC</td>
<td>.92</td>
<td>.92</td>
<td>.84</td>
<td>.96</td>
<td>.85</td>
<td>.89</td>
<td>.76</td>
<td>.85</td>
<td>.94</td>
<td>.87</td>
</tr>
<tr>
<td>Mean</td>
<td>2.05</td>
<td>2.33</td>
<td>2.27</td>
<td>2.36</td>
<td>2.13</td>
<td>2.21</td>
<td>2.06</td>
<td>2.06</td>
<td>2.21</td>
<td>2.42</td>
</tr>
<tr>
<td>S.D.</td>
<td>0.58</td>
<td>0.63</td>
<td>0.56</td>
<td>0.68</td>
<td>0.48</td>
<td>0.61</td>
<td>0.50</td>
<td>0.61</td>
<td>0.40</td>
<td>0.64</td>
</tr>
<tr>
<td>Range</td>
<td>1-4.50</td>
<td>1-4.00</td>
<td>1-4.00</td>
<td>1-4.0</td>
<td>1.5-4.0</td>
<td>1-4.0</td>
<td>1-3.50</td>
<td>1-4.0</td>
<td>1-3.50</td>
<td>1.5-5</td>
</tr>
</tbody>
</table>
Table 3. Proportions of sample meeting diagnostic and/or clinical thresholds on various measures (Study 2).

<table>
<thead>
<tr>
<th>Measure</th>
<th>Percentage of Sample Meeting Criteria, or Above Threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depressive Symptoms (BDI)</td>
<td>33.1% (18.1% mild, 11.8% moderate, 4% severe symptoms)</td>
</tr>
<tr>
<td>Anxiety Symptoms (BAI)</td>
<td>28.5% (20.5% moderate, 8.3% severe symptoms)</td>
</tr>
<tr>
<td>Current Major Depressive Episode (SCID)</td>
<td>9% met current MDE criteria</td>
</tr>
<tr>
<td>Past Major Depressive Episode (SCID)</td>
<td>38.6% met past MDE criteria</td>
</tr>
<tr>
<td>Poor Sleep Quality (PSQI)</td>
<td>37.8% above threshold for poor sleep quality</td>
</tr>
<tr>
<td>Nicotine Dependence (Fagerstrom)</td>
<td>8.7% low dependence (0% moderate or high dependence)</td>
</tr>
<tr>
<td>Alcohol Use Disorders (AUDIT)</td>
<td>27% above threshold for possible hazardous or harmful drinking</td>
</tr>
<tr>
<td>Disordered Eating (EAT)</td>
<td>10.2% above threshold for possible disordered eating</td>
</tr>
<tr>
<td>BMI</td>
<td>14% underweight, 16% underweight, and 8% obese</td>
</tr>
</tbody>
</table>
Table 4. Descriptive statistics for baseline measures in Study 2.

<table>
<thead>
<tr>
<th>Baseline Measure</th>
<th>N (out of 127)</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Possible Range</th>
<th>Observed Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depressive Symptoms (BDI)</td>
<td>127</td>
<td>11.00</td>
<td>8.24</td>
<td>0-63</td>
<td>0-35</td>
</tr>
<tr>
<td>Anxiety Symptoms (BAI)</td>
<td>127</td>
<td>11.55</td>
<td>8.91</td>
<td>0-63</td>
<td>0-37</td>
</tr>
<tr>
<td>Chronic Stress (LSI)</td>
<td>127</td>
<td>22.00</td>
<td>2.82</td>
<td>10-50</td>
<td>17-31</td>
</tr>
<tr>
<td>Acute Stress (LSI)</td>
<td>127</td>
<td>3.09</td>
<td>2.73</td>
<td>NA</td>
<td>0-12.50</td>
</tr>
<tr>
<td>BMI</td>
<td>126</td>
<td>22.89</td>
<td>5.31</td>
<td>NA</td>
<td>15.62-46.64</td>
</tr>
<tr>
<td>Physical Health (SF-12 PCS)</td>
<td>125</td>
<td>52.96</td>
<td>5.27</td>
<td>0-100</td>
<td>38.13-62.14</td>
</tr>
<tr>
<td>Mental Health (SF-12 MCS)</td>
<td>125</td>
<td>44.31</td>
<td>10.48</td>
<td>0-100</td>
<td>18.86-62.35</td>
</tr>
<tr>
<td>Hours of Sleep</td>
<td>116</td>
<td>6.81</td>
<td>1.12</td>
<td>NA</td>
<td>3-9</td>
</tr>
<tr>
<td>Sleep Quality (PSQI)</td>
<td>111</td>
<td>5.09</td>
<td>2.61</td>
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<tr>
<td>Avg. Days Smoked (of past 30)</td>
<td>127</td>
<td>0.92</td>
<td>3.77</td>
<td>0-30</td>
<td>0-27</td>
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<td>Avg. Cigarettes/Day</td>
<td>127</td>
<td>0.53</td>
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<tr>
<td>Nicotine Dependence</td>
<td>127</td>
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<td>Alcohol Use Disorders (AUDIT)</td>
<td>124</td>
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<td>Avg. Drinks/Day (when drinking)</td>
<td>127</td>
<td>2.79</td>
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<tr>
<td>Avg. Days Drank (of past 30)</td>
<td>127</td>
<td>3.24</td>
<td>4.23</td>
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<tr>
<td>Eating Attitudes (EAT)</td>
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<td>9.86</td>
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<td>Days Exercised (of past 30)</td>
<td>127</td>
<td>13.33</td>
<td>8.70</td>
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<td>Min Exercise/Days Exercised</td>
<td>126</td>
<td>52.61</td>
<td>33.26</td>
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<tr>
<td>Emotional Processing (EAC)</td>
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<td>10.20</td>
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<td>Emotional Expression (EAC)</td>
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<td>3.43</td>
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<td>Self-Distraction Coping (BriefCOPE)</td>
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<tr>
<td>Active Coping (BriefCOPE)</td>
<td>127</td>
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<td>1.52</td>
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<tr>
<td>Denial Coping (BriefCOPE)</td>
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<td>0.97</td>
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<td>Substance Use Coping (BriefCOPE)</td>
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<td>Emotional Support Coping (BriefCOPE)</td>
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<td>Instrumental Support Coping (BriefCOPE)</td>
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<td>Behav. Disengag. Coping (BriefCOPE)</td>
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<td>Venting Coping (BriefCOPE)</td>
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<td>4.37</td>
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<tr>
<td>Pos. Reframe Coping (BriefCOPE)</td>
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<td>5.10</td>
<td>1.81</td>
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<td>Planning Coping (BriefCOPE)</td>
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<td>Humor Coping (BriefCOPE)</td>
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<td>Acceptance Coping (BriefCOPE)</td>
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<td>Religion Coping (BriefCOPE)</td>
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<td>Self Blame Coping (BriefCOPE)</td>
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<td>Alcohol as Coping (from DMQR)</td>
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<td>Eating as Coping (from EADES)</td>
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<td>81.36</td>
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<td>Eating Treats as Coping (PEM)</td>
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<td>1.83</td>
<td>0.87</td>
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<td>Eating Treats as Reward (PEM)</td>
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<td>Exercise as Coping (from EMI-2)</td>
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<td>12.83</td>
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<td>22.</td>
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<tr>
<td>23.</td>
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<td>26.</td>
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<td>27.</td>
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<tr>
<td>28.</td>
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</tr>
<tr>
<td>29.</td>
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<tr>
<td>30.</td>
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</tr>
</tbody>
</table>

**Table 5. Correlations among primary study variables in Study 2. *p<.05, **p<.01**
Table 6. Descriptive statistics for daily measures in Study 2.

<table>
<thead>
<tr>
<th>Measure</th>
<th>n (out of 1778)</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Possible Range</th>
<th>Observed Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Hassles</td>
<td>1629</td>
<td>2.10</td>
<td>2.13</td>
<td>0-25</td>
<td>0-17</td>
</tr>
<tr>
<td>Daily Positive Affect (PANAS)</td>
<td>1579</td>
<td>22.51</td>
<td>8.57</td>
<td>10-47</td>
<td>10-50</td>
</tr>
<tr>
<td>Daily Negative Affect (PANAS)</td>
<td>1587</td>
<td>16.31</td>
<td>6.25</td>
<td>10-45</td>
<td>10-50</td>
</tr>
<tr>
<td>Daily Cigarettes</td>
<td>1619</td>
<td>0.08</td>
<td>0.46</td>
<td>NA</td>
<td>0-8</td>
</tr>
<tr>
<td>Daily Drinks</td>
<td>1617</td>
<td>0.36</td>
<td>1.49</td>
<td>NA</td>
<td>0-20</td>
</tr>
<tr>
<td>Daily Minutes of Exercise (1)</td>
<td>1511</td>
<td>36.13</td>
<td>41.07</td>
<td>NA</td>
<td>0-240</td>
</tr>
<tr>
<td>Daily Sleep Hours</td>
<td>1608</td>
<td>6.90</td>
<td>1.88</td>
<td>NA</td>
<td>0-8</td>
</tr>
<tr>
<td>Daily Sleep Latency</td>
<td>1615</td>
<td>15.90</td>
<td>19.63</td>
<td>NA</td>
<td>0-180</td>
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<tr>
<td>Daily Sleep Quality (from PSQI)</td>
<td>1623</td>
<td>0.95</td>
<td>0.67</td>
<td>0-3</td>
<td>0-2</td>
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<tr>
<td>Daily Fruit</td>
<td>1617</td>
<td>1.37</td>
<td>1.34</td>
<td>NA</td>
<td>0-9</td>
</tr>
<tr>
<td>Daily Vegetables</td>
<td>1618</td>
<td>1.49</td>
<td>1.46</td>
<td>NA</td>
<td>0-9</td>
</tr>
<tr>
<td>Daily Snacks</td>
<td>1613</td>
<td>1.14</td>
<td>1.22</td>
<td>NA</td>
<td>0-9</td>
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<tr>
<td>Daily Sweets</td>
<td>1615</td>
<td>1.05</td>
<td>1.12</td>
<td>NA</td>
<td>0-9</td>
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<td>Daily Fats</td>
<td>1613</td>
<td>1.11</td>
<td>1.24</td>
<td>NA</td>
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<tr>
<td>Daily Maladaptive HB Composite</td>
<td>1562</td>
<td>4.34</td>
<td>1.99</td>
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<td>0-12</td>
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<td>Daily Adaptive HB Composite</td>
<td>1483</td>
<td>4.43</td>
<td>1.85</td>
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</table>
Table 7. Effects of baseline stress and depression on maladaptive daily health behaviors (Study 2).

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<tr>
<th>Predictor</th>
<th>Chronic Stress</th>
<th>Acute Stress</th>
<th>BDI (alone)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Intercept, Intercept</td>
<td>4.00 0.30 &lt;.01</td>
<td>4.01 0.342 &lt;.01</td>
<td>3.99 0.31 &lt;.01</td>
</tr>
<tr>
<td>Sex</td>
<td>0.27 0.22 0.21</td>
<td>0.26 0.04 0.42</td>
<td>0.28 0.24 0.24</td>
</tr>
<tr>
<td>Predictor (Stress or BDI, as indicated)</td>
<td>0.12 0.04 &lt;.01</td>
<td>0.03 0.04 0.26</td>
<td>0.04 0.01 &lt;.01</td>
</tr>
</tbody>
</table>
Table 8. Relative effects of stress and depression on maladaptive daily health behaviors (Study 2).

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Chronic Stress</th>
<th>Acute Stress</th>
<th>Daily Stress</th>
<th>Changes to Daily Stress (Person-Centered)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$b$</td>
<td>$SE$</td>
<td>$p$</td>
<td>$b$</td>
</tr>
<tr>
<td>Overall Intercept</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>3.99</td>
<td>0.30</td>
<td>&lt;.01</td>
<td>3.99</td>
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<tr>
<td>Depressive Symptoms</td>
<td>0.02</td>
<td>0.02</td>
<td>0.21</td>
<td>0.04</td>
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<tr>
<td>Sex</td>
<td>0.28</td>
<td>0.22</td>
<td>0.20</td>
<td>0.28</td>
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<tr>
<td>Stress ($Chronic$, $Acute$, or $Daily$, as Indicated)</td>
<td>0.09</td>
<td>0.04</td>
<td>0.03</td>
<td>0.00</td>
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Table 9. Effects of daily stress on maladaptive daily health behaviors (Study 2).

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Daily Stress</th>
<th>Changes to Daily Stress (Person-Centered)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>$b$</td>
<td>$SE$</td>
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<tr>
<td>For Overall Intercept,</td>
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<tr>
<td>Intercept</td>
<td>3.68</td>
<td>0.30</td>
</tr>
<tr>
<td>Baseline Maladaptive HB</td>
<td>0.29</td>
<td>0.05</td>
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<tr>
<td>Sex</td>
<td>0.44</td>
<td>0.23</td>
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<tr>
<td>For Daily Stress slope,</td>
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<tr>
<td>Predictor (Daily Stress,</td>
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<td>0.02</td>
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<td>as indicated)</td>
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Table 10. Effect of 2-way interaction between daily stress and health coping belief in predicting health behavior (eating, drinking, smoking, and exercise; Study 2).

<table>
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<th>Outcome</th>
<th>Eating</th>
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<th>Drinking</th>
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<th>Smoking</th>
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<th>Exercise (Moderate and Vigorous)</th>
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<td>$SE$</td>
<td>$p$</td>
<td>$b$</td>
<td>$SE$</td>
<td>$p$</td>
<td>$b$</td>
<td>$SE$</td>
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<td>Overall Intercept,</td>
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<tr>
<td>Intercept</td>
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<td>Baseline Behavior</td>
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<td>Health Behavior Belief</td>
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<td>0.28</td>
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<td>For Daily Stress Slope,</td>
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<td>0.03</td>
<td>0.50</td>
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133
Table 11. Effect of 2-way interaction between chronic stress and health coping belief in predicting health behavior (eating, drinking, smoking, and exercise; Study 2).

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<th>Outcome</th>
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<th></th>
<th>Smoking</th>
<th></th>
<th>Exercise (Moderate and Vigorous)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>b</td>
<td>SE</td>
<td>p</td>
<td>b</td>
<td>SE</td>
<td>p</td>
<td>b</td>
<td>SE</td>
</tr>
<tr>
<td>Overall Intercept, Intercept</td>
<td>2.13</td>
<td>0.12</td>
<td>&lt;.001</td>
<td>0.37</td>
<td>0.06</td>
<td>&lt;.001</td>
<td>0.06</td>
<td>0.02</td>
</tr>
<tr>
<td>Health Behavior Belief</td>
<td>-0.03</td>
<td>0.19</td>
<td>0.91</td>
<td>-0.27</td>
<td>0.00</td>
<td>0.01</td>
<td>0.00</td>
<td>0.01</td>
</tr>
<tr>
<td>Chronic Stress</td>
<td>0.02</td>
<td>0.19</td>
<td>0.91</td>
<td>-0.13</td>
<td>0.06</td>
<td>0.03</td>
<td>0.00</td>
<td>0.01</td>
</tr>
<tr>
<td>Chronic Stress x HB</td>
<td>0.00</td>
<td>0.00</td>
<td>0.99</td>
<td>0.01</td>
<td>0.00</td>
<td>0.01</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>
Table 12. Effect of the three-way interaction between daily stress, chronic stress, and health-coping belief in predicting health behavior (exercise, drinking, smoking, and exercise; Study 2).

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Eating</th>
<th></th>
<th>Drinking</th>
<th></th>
<th>Smoking</th>
<th></th>
<th>Exercise (Moderate and Vigorous)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$b$</td>
<td>$SE$</td>
<td>$p$</td>
<td>$b$</td>
<td>$SE$</td>
<td>$p$</td>
<td>$b$</td>
<td>$SE$</td>
</tr>
<tr>
<td>Overall Intercept,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>2.13</td>
<td>0.03</td>
<td>&lt;.01</td>
<td>0.37</td>
<td>0.00</td>
<td>&lt;.01</td>
<td>0.06</td>
<td>0.02</td>
</tr>
<tr>
<td>Baseline Maladaptive HB</td>
<td>0.94</td>
<td>0.06</td>
<td>&lt;.01</td>
<td>1.01</td>
<td>0.01</td>
<td>&lt;.01</td>
<td>0.05</td>
<td>0.02</td>
</tr>
<tr>
<td>Chronic Stress</td>
<td>-0.06</td>
<td>0.06</td>
<td>0.30</td>
<td>0.00</td>
<td>0.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.01</td>
</tr>
<tr>
<td>Health Belief</td>
<td>-0.02</td>
<td>0.06</td>
<td>0.29</td>
<td>0.01</td>
<td>0.01</td>
<td>0.30</td>
<td>0.00</td>
<td>0.01</td>
</tr>
<tr>
<td>Chronic Stress x Health Belief</td>
<td>0.00</td>
<td>0.00</td>
<td>0.29</td>
<td>-0.00</td>
<td>0.00</td>
<td>0.29</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>For Daily Stress Slope,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.00</td>
<td>0.03</td>
<td>0.88</td>
<td>-0.02</td>
<td>0.03</td>
<td>0.40</td>
<td>-0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Chronic Stress x Health Belief</td>
<td>0.00</td>
<td>0.00</td>
<td>0.30</td>
<td>0.0005</td>
<td>0.00</td>
<td>0.03</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

135
Table 13. Prediction of next-day negative affect by maladaptive health behaviors and daily stress alone, together, and in interaction (Study 2).

<table>
<thead>
<tr>
<th>OUTCOME: Next Day Negative Affect (controlling for same day negative affect)</th>
<th>Maladaptive HB, Daily Stress, &amp; Interaction</th>
<th>Maladaptive HB &amp; Daily Stress</th>
<th>Daily Stress</th>
<th>Maladaptive HB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Intercept, Intercept</td>
<td>11.44 0.67 &lt;.01</td>
<td>11.42 0.67 &lt;.01</td>
<td>11.44 0.66 &lt;.01</td>
<td>11.85 0.67 &lt;.01</td>
</tr>
<tr>
<td>Maladaptive HB Slope, Intercept</td>
<td>-.12 0.09 0.25</td>
<td>-0.02 0.08 0.84</td>
<td></td>
<td>-0.01 0.08 0.92</td>
</tr>
<tr>
<td>Negative Affect Slope, Intercept</td>
<td>0.29 0.04 &lt;.01</td>
<td>0.29 0.04 &lt;.01</td>
<td>0.29 0.04 &lt;.01</td>
<td>0.27 0.04 &lt;.01</td>
</tr>
<tr>
<td>Daily Stress Slope, Intercept</td>
<td>-0.35 0.15 0.02</td>
<td>-0.15 0.11 0.15</td>
<td>-0.15 0.10 0.14</td>
<td></td>
</tr>
<tr>
<td>HB x Daily Stress Slope, Intercept</td>
<td>0.04 0.03 .13</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 14. Effects of daily affect on daily maladaptive health behaviors (Study 2).

| Predictor                     | Daily Negative Affect | Changes to Daily Negative Affect | Daily Positive Affect | Changes to Daily Positive Affect | b   | SE  | p    | b   | SE  | p    | b   | SE  | p    | b   | SE  | p    |
|-------------------------------|-----------------------|----------------------------------|-----------------------|----------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Overall Intercept             |                       |                                  |                       |                                  |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Intercept                    | 3.92                  | 0.18                             | <.01                  | 4.33                            | 0.10 | <.01 | <.01 | 4.87 | 0.19 | <.01 | 4.35 | 0.10 | <.01 |
| Baseline Maladaptive HB       | 0.29                  | 0.05                             | <.01                  | 0.30                            | 0.05 | <.01 | <.01 | 0.29 | 0.05 | <.01 | 0.30 | 0.05 | <.01 |
| Predictor (Affect, as indicated) | 0.03                  | 0.01                             | <.01                  | 0.02                            | 0.01 | <.01 | <.01 | -0.02 | 0.01 | <.01 | -0.02 | 0.01 | <.01 |
Table 15. Interaction between daily affect and depression on maladaptive daily health behaviors, controlling for baseline maladaptive health behaviors (Study 2).

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Daily Negative Affect</th>
<th>Changes to Daily Negative Affect</th>
<th>Daily Positive Affect</th>
<th>Changes to Daily Positive Affect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>b</td>
<td>SE</td>
<td>p</td>
<td>b</td>
</tr>
<tr>
<td>Overall Intercept, Intercept</td>
<td>3.97</td>
<td>0.18</td>
<td>&lt;.01</td>
<td>4.33</td>
</tr>
<tr>
<td>Baseline Maladaptive HB</td>
<td>0.27</td>
<td>0.06</td>
<td>&lt;.01</td>
<td>0.28</td>
</tr>
<tr>
<td>Depressive Symptoms</td>
<td>-0.02</td>
<td>0.02</td>
<td>0.45</td>
<td>0.01</td>
</tr>
<tr>
<td>For Affect Slope, Intercept</td>
<td>0.02</td>
<td>0.01</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>Depressive Symptoms</td>
<td>0.00</td>
<td>0.00</td>
<td>0.08</td>
<td>0.00</td>
</tr>
</tbody>
</table>
Table 16. Daily positive and negative affect as mediators of the relationship between depressive symptoms and daily maladaptive health behaviors (Study 2).

<table>
<thead>
<tr>
<th></th>
<th>Negative Affect</th>
<th></th>
<th>Positive Affect</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$b$</td>
<td>$SE$</td>
<td>$p$</td>
<td>$Sobel's Z$</td>
</tr>
<tr>
<td>For Overall Intercept,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>3.13</td>
<td>0.29</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td>Average Affect</td>
<td>0.03</td>
<td>0.03</td>
<td>0.29</td>
<td>-0.03</td>
</tr>
<tr>
<td>BDI</td>
<td>0.01</td>
<td>0.01</td>
<td>0.45</td>
<td>0.01</td>
</tr>
<tr>
<td>Baseline HB</td>
<td>0.27</td>
<td>0.06</td>
<td>&lt;.001</td>
<td>0.28</td>
</tr>
<tr>
<td>For Affect Slope,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.02</td>
<td>0.01</td>
<td>0.02</td>
<td>-0.02</td>
</tr>
</tbody>
</table>

$Z = 2.15, SE = .003, p = .03$
Figures

Figure 1. Schematic of the structural equation model testing the indirect effect of chronic and acute stress at age 20 on depressive symptoms at age 22-25 via sleep, smoking, and exercise. Standardized path coefficients are presented (Study 1). Depressive symptoms at age 20 are included as a covariate in all paths of the model. Gender and maternal depression status are included as covariates in all paths in which they were found to be significant.

* p< .05, **p<.01, ***p<.001
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141


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161


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