WORRY, RESPIRATORY SINUS ARRHYTHMIA, AND HEALTH BEHAVIORS

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ABSTRACT

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Research has generally shown that worry leads to a decrease in respiratory sinus arrhythmia (RSA) and cardiac vagal activity. Low vagal activity has been associated with a variety of physical ailments, including cardiovascular disease. However, research has also revealed inconsistencies in the relationship between worry and RSA, and the assessment of possible moderating relationships is lacking. The present study investigated the relationships among trait and induced worry on RSA, as well as a number of health behavior moderators, in a sample of undergraduate students. One hundred-fifteen participants completed a pretest measure of worry along with a number of protective health behavior measures. While having their heart rate measured (RSA), participants engaged in a 10-minute baseline condition, a 5-minute worry condition, a 5-minute control condition, and a 10-minute recovery condition. Consistent with predictions, high trait worriers who reported higher levels of physical activity displayed significantly higher levels of RSA, relative to high trait worriers who also reported lower levels of physical activity. Moreover, the same effect was not found for low trait worriers. Possible cardiovascular health implications, as well as implications for effects of physical activity on worry from an afferent perspective, are discussed.
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CHAPTER I. INTRODUCTION

Worry is a phenomenon that appears to be ubiquitously experienced by humans every day. This negative, primarily cognitive, experience (e.g., Stöber & Muijs, 2001) is comprised of a number of defining elements. Specifically, worry is thought to consist of covert problem solving, repetitive appraisal of a perceived threat, and cognitive avoidance of more distressing content, such as threatening images (Borkovec, 1994; Borkovec, Alcaine, & Behar, 2004; Mathews, 1990; and Tallis & Eysenck, 1994). While acknowledging that all of the above aspects are involved in worry, Borkovec argued that the primary function of worry is avoidance of more intense and emotional content (Borkovec et al., 2004). To date, worry, and its relationship to other variables, such as physiology, has primarily been studied in the context of anxiety and clinical populations. Research, therefore, requires careful analysis of worry as a distinct construct that frequently occurs among persons drawn from the general population.

It is thought that worry is linked to various psychological disorders, such as obsessive-compulsive disorder, social phobia, and generalized anxiety disorder. More recent research has also established links between worry and a number of physiological disorders (e.g., Brosschot, Gerin, & Thayer, 2006; Brosschot & Thayer, 2004; Hofmann et al., 2005). For example, studies have found that worry is associated with greater reports of pain, decreased immune function, and cardiovascular disease (CVD).

While it is important and interesting that the links between worry and negative health outcomes (e.g., CVD) have been established, it is equally important to understand the mechanisms involved in these cognitive-physiological relationships. One mechanism is neurobiological in nature and involves the vagus nerve. The vagus nerve establishes a pathway between the brain and heart. The vagus acts to inhibit the heart’s natural pacemaker, the sino-
atrial node, and it is therefore involved in the regulation of heart rate, as well as beat-to-beat variability (e.g., Porges, 2007). Due to the regulating influence the vagus has on the heart, this beat-to-beat variability has been used as an index of vagal activity and overall flexibility of the autonomic nervous system. Specifically, several researchers have shown that a measure of heart rate variability (HRV) called respiratory sinus arrhythmia (RSA) has been shown to be a valid index of vagal activity (e.g., Porges, 2007; Thayer & Lane, 2007).

Another mechanism that seems to be important in the worry and CVD relationship is cardiovascular recovery. That is, the amount of time it takes, and the degree to which, the cardiovascular system can recover from a stressor has been established as a robust predictor of a number of negative CV health outcomes, including CVD (e.g., Brosschot et al., 2006; Schuler & O’Brien, 1997).

In line with the neurobiological and CV recovery mechanism theories, the results of a number of laboratory studies suggest that the phasic effects of worry may lead to an increased risk of developing CVD through low levels of HRV and RSA (i.e., reduced vagal activity) (e.g., Hofmann et al., 2005; Lyonfields, Borkovec, & Thayer, 1995; Thayer, Friedman, & Borkovec, 1996). Specifically, there is theory and empirical research to suggest a bidirectional relationship between pre-frontal structures associated with worry and subcortical structures where the vagus nerve originates (e.g., Thayer & Lane, 2009). It is this pathway, and the vagal connection to the heart, that helps explain how worry may lead to phasic reductions in vagal activity and possible long-term negative CV health outcomes through prolonged activation. Moreover, there are also some prospective data to suggest that chronic worry can have long-term negative health consequences, such as increased risk for CVD (e.g., Kubzansky et al., 1997).
Finally, there are a number of factors that may influence the relationship between worry and cardiac vagal control and, ultimately, CVD. Specifically, worry has been linked to an increase in certain protective health behaviors, such as physical activity (e.g., Mosher et al., 2008), health screenings (e.g., Hay, McCaul, & Magnan, 2006), and healthier eating habits (e.g., Mosher et al., 2008). These behaviors have also been linked to an increase in cardiac vagal control (RSA) and a decreased risk for developing CVD (e.g., Calderon, Smallwood, & Tipton, 2008; Carter, Banister, & Blaber, 2003; Valensi, Pariès, Lormeau, Attia, & Attali, 2005). There is currently a gap in the literature exploring the possible complex interactions between health behaviors and the worry-RSA relationship.

In the following literature review, the construct of worry will be examined along with a review of the definitions and ways that it is measured. Next, discussion of how worry may be associated with adverse health outcomes will be presented (e.g., Stöber & Muijs, 2001; Brosschot et al., 2006). Included in this section is an exploration of how worry may be linked to health behaviors (e.g., Hay et al., 2006; Mullens, McCaul, Erickson, & Sandgren, 2004). Following this, the neurobiological mechanisms, namely vagus nerve activity and its link to CVD will be discussed. Included in this review will be an exploration of how health behaviors influence RSA and CVD. Next, a review of neurobiological mechanisms linking worry to the vagus nerve, RSA, and CVD risk will be provided. Finally, the objectives and hypotheses for the present investigation will be presented.

Worry

Worry is a common experience that may occur in normal everyday life and within psychopathology (e.g., Borkovec, 1994; Borkovec et al., 2004). Moreover, although some data exist to suggest that the tendency to worry may decline with age and the content about which we
Worry may change, it is something that is present throughout our lives. For example, younger people tend to worry more about work, finances, and interpersonal issues, whereas older people tend to worry more about health issues (e.g., Lindesay et al., 2006; Mathews, 1990).

In everyday language, worry and anxiety appear to be used interchangeably (e.g., “I’m feeling anxious about taking our test;” “I’m worried about taking our test”). However, some researchers argue that anxiety is comprised of worry and emotionality (e.g., fear and more somatic symptoms). Indeed, there is research to suggest that worry and anxiety are closely related (e.g., Meyer, Miller, Metzger, & Borkovec, 1990). However, there is also evidence suggesting that anxiety and worry may be separate constructs. For example, Davey, Hampton, Farrell, and Davidson (1992) found that when using partial correlations to control for the overlap between worry and anxiety, different coping styles emerged. Specifically, anxiety was associated with less adaptive ways of coping, while worry was associated with more adaptive coping characteristics, such as problem solving and information seeking. In a study of appraisals associated with situations that involved worry and anxiety, Stöber & Muijs (2001) found that anxiety involved appraisals of “sudden and immediate” threats, whereas worry experiences involved appraisals of a more temporally distal threat. Overall, while there is overlap between worry and anxiety, closer examination suggests that there are qualitative (e.g., more cognitive versus somatic) and quantitative (e.g., temporally immediate versus distal perceived threat) differences that allow separate exploration of these two constructs.

Although there are various ways to describe worry, several common characteristics emerge. Borkovec, Robinson, Pruzinksky, and DePree (1983) initially defined worry as an attempt to cognitively problem-solve a situation that involves feelings, such as fear, and an uncertain outcome. Mathews (1990) referred to worry as a “persistent awareness of possible
future danger, which is repeatedly rehearsed without being resolved” (p. 456). Szabó and Lovibond (2002) found that worrisome thoughts were more likely to be categorized as problem-solving attempts than as ruminative, palliative, or self-blaming tendencies.

Borkovec, et al. (2004) further suggested that worry is a cognitive avoidance response to a perceived threat. That is, if we encounter a threat (real or imagined) that we may be unable to avoid, we turn to covert or cognitive avoidance strategies. Specifically, when a threat is detected, fearful images occur, but an attentional shift to worrisome thinking (“verbal” thinking) avoids or reduces the anxious arousal associated with the fearful imagery. For example, if someone who is afraid of large bodies of water is on a boat, images of the boat capsizing or people drowning may come to mind. Based on the “avoidance” theory of worry (Borkovec et al., 2004), the person’s attention might shift to worrisome thinking (e.g., “verbally” problem-solving by scanning for life jackets, rehearsing what one might do if there is danger, etc.) which, in turn, is negatively reinforced by the reduction in anxious arousal once the fear imagery is disrupted.

Tallis and Eysenck (1994) proposed that worry can be divided into three stages: threat appraisal, worry activation, and coping. Threat appraisal involves assessing several factors: personal loss, imminence, likelihood, and estimated self-efficacy (a person’s own beliefs about their capabilities). Worry activation involves awareness of the thoughts and images about the threat, shifts in attention, and physiological changes. The coping stage suggests that the perceived threat and worry are maintained if the threat problem is not solved. This theory suggests that worry is an intermediate step between threat appraisals and coping. The threat is perceived as present, but coping possibilities do not yet exist, at least as perceived by the
individual. This presumably would account for the perseverative nature of worry-based problem-solving.

Worry and Health

Worry and Physical Health. In addition to worry being associated with various behavior disorders (e.g., generalized anxiety disorder and panic disorder), it is also related to a variety of physical health problems. For example, worry has been associated with neck and low back pain, cold and flu symptoms, and stomach pains (Brosschot & Van Der Doef, 2006). Worry also appears to affect the immune system as marked by a reduction in natural killer cells and an increase in cortisol levels (for a review, see Brosschot et al., 2006).

However, the most robust and most frequently studied link found between worry and physical health problems involves cardiovascular health (e.g., Brosschot et al., 2006). While there are few studies that directly link worry to disease, there is evidence to suggest that worry is related to cardiovascular disease (CVD, e.g., Kubzansky et al., 1997). This is an important relationship to explore, as CVD remains the most common cause of death in the United States (Rosamond et al., 2007). This link and associated mechanisms will be expanded on below, as well as in the discussion of the link between vagus nerve activity and physical health.

Worry and Health Behavior. Another mechanism through which worry may affect physical health is through the establishment and maintenance of protective health behaviors. Specifically, worry is often related to an increase in protective health behaviors, including exercise, healthier diets, and health screenings. While worry has not been explored in relation to health behavior theories (e.g., McCaul & Goetz, 2007), there are empirical data to demonstrate a relationship between worry and health behavior exists.
Leventhal and colleagues’ (2003) Common-Sense Model of Health and Illness Self-Regulation proposes that a perceived threat to health leads to a need to cope with the emotion (fear) associated with the health threat, as well as the health threat itself. Worry fits well within this model in that worry is present due to a perceived threat and involves problem-solving strategies to cope with the threat. For example, a family history of CVD may lead one to worry about developing CVD, and engage in protective behaviors, such as exercise and healthy diet, to decrease the negative “feelings” (worry) associated with the health threat as well as decreasing the reality of the threat itself (CVD).

Empirical data support the theoretical argument above. The majority of studies that examine the worry and health behavior relationship are within the context of cancer, and studies in relation to worry leading to health behaviors specific to a CVD are lacking. However, in a study among cancer survivors, Mosher et al. (2008) found that worry about potential heart disease was associated with a higher likelihood of engaging in protective health behaviors. Specifically, Mosher and colleagues surveyed 678 recently diagnosed breast and prostate cancer survivors to examine the relationships between worry about a future diagnosis of heart disease or cancer, as well as hypothetical and actual adherence to exercise and dietary guidelines.

Results revealed that cancer survivors reported greater worry about a future diagnosis of heart disease or cancer under the hypothetical scenario of nonadherence to guidelines for exercise and a healthy diet. This pattern was more pronounced (greater worry) for heart disease versus cancer, across all health behaviors. Moreover, worry about future heart disease was associated with a greater likelihood to exercise and eat more fruits and vegetables. These data suggest that worry (about heart disease) was associated with a greater likelihood of engaging in protective health behaviors that reduce CVD risk.
There are also data to suggest that worry can lead to actual positive health behavior change. Mullens, McCaul, Erickson, and Sandgren (2004) conducted semi-structured interviews in person or over the phone with 81 colorectal cancer survivors. Survivors were asked about a number of factors associated with their cancer. Specifically, worry (cancer/medical related), anxiety, intrusive thoughts, risk perceptions, and past changes and intended changes in health behavior were assessed.

Results showed that intrusive thoughts were associated with past changes in health behavior, which included exercise, diet, weight loss, smoking, and complimentary therapies (e.g., taking vitamins). All of the predictors, including worry ($r = .25$), were associated with intentions to make changes in all health behavior domains. Moreover, the most frequent reason given for making changes in health behavior was to improve “general health,” followed by “to prevent recurrence,” indicating that their worry translates to intentions of changing health behaviors to improve overall health.

In addition to worry motivating health behaviors such as exercise and healthy diet, worry has been linked to health behaviors (e.g., health screenings) that may be seen as having a more “indirect” effect on physical health. Hay, McCaul, and Magnan (2006) conducted a meta-analysis of 12 prospective studies to examine the effect worry has on the likelihood of breast cancer screening. Specifically, screening behaviors were assessed 1 month to 1 year following the assessment of worry. The sample of women within the studies was diverse (general public and women at high risk for breast cancer). Worry was specific to cancer worry and screening behavior included a breast self-examination and mammogram.

Results of the meta-analysis suggested that worry played an important role in facilitating screening behavior. An effect size of $r = .18$ was revealed, indicating that worry was associated
Worry and Respiratory Sinus Arrhythmia

with a greater likelihood to engage in screening behavior. Using an effect size weighted for sample size that included worry and an intrusive thoughts measure \((r = .12)\), it was shown that 56% of the women who worried obtained a mammogram compared to 44% of those who do not worry. These results provided support for the idea that worry can motivate screening behavior (e.g., doctor visits for a mammogram; stress tests) in addition to health behaviors that have more of a direct effect on physical health (e.g., exercise and healthy diet).

Overall, the studies described above lend support to the notion that worry can motivate protective health behaviors. Data linking worry to screening behavior related to cardiovascular health could not be found. Moreover, the above studies assessed worry within a specific health domain (e.g., cancer or heart disease) and a measure of trait worry is generally lacking. While it is possible that individuals who experience a specific health worry may not be a “general” worrier, it is conceivable to suggest that individuals who have a high tendency to be worriers (i.e., high-trait worriers) will be more likely to experience greater worry across several life domains, including physical health, relative to low-trait worriers. One study was found to include a checklist of exercise behavior along with a measure of trait worry. Consistent with the above rationale, trait worry, as measured by the PSWQ, was positively correlated with routine exercise (Davis, Montgomery, & Wilson, 2002).

**Mechanisms Linking Worry to CVD**

**Respiratory Sinus Arrhythmia and Vagal Activity.** The links between cardiovascular functioning and psychological states, such as worry, are of interest to psychophysicologists and neuroscientists. One cardiovascular variable that is of great recent interest is respiratory sinus arrhythmia (RSA). RSA is a measure of the variability in heart rate (HR) that is influenced by respiration (Berntson, Cacioppo, & Quigley, 1993). Specifically, HR increases with inhalation
and decreases with exhalation; therefore, RSA is characterized by an interaction between HR and respiratory activity (Grossman & Taylor, 2007).

RSA is being increasingly used as a key index of vagal nerve control on heart activity. Given recent findings connecting both worry and CVD to vagal control (e.g., Thayer et al., 1996; Thayer & Lane, 2007) it is important to understand this mechanism. The vagus nerve pathway associated with cardiac function emerges from the nucleus ambiguus in the medulla oblongata. The nerve travels down the neck in the carotid sheath, which also encloses the carotid artery and jugular vein. The nerve then travels to the cardiac plexus, which supplies nerve fibers to the heart, and also connects to the sino-atrial node, which is the “pacemaker” of the heart (Porges, 2007; Saladin, 1998).

The vagus nerve is responsible for parasympathetic control over the heart and significantly contributes to the beat-to-beat variation in HR (Grossman & Taylor, 2007; Porges, 1992, 2007). Porges (2007) described the vagus nerve as a sort of “brake” for the sino-atrial node, such that when vagal activation is high, the average HR is decreased while beat-to-beat variation (i.e., RSA) is increased. Alternatively when vagal activation is low, the average HR increases and while the beat-to-beat variation (i.e., RSA) decreases. Given this direct relationship between RSA and vagal activation, RSA can be used as a valid, noninvasive measure of parasympathetic activity (Porges, 2007).

Vagal Activity and CVD. The study of RSA and vagal activity is important in that RSA has been linked to disorders such as diabetes, obesity, and cardiovascular disease (Masi, Hawkley, Rickett, & Cacioppo, 2007). Thayer and Lane (2007) provided an extensive review on the link between vagal function and CVD. There are a number of mechanisms through which vagal activity (RSA) and CVD are related (e.g., hypertension, diabetes, and cholesterol).
However, the most consistent link between vagal function and CVD relates to inflammation (Haensel, Mills, Nelesen, Ziegler, & Dimsdale, 2008; Masi et al., 2007; Thayer & Lane, 2007). Specifically, acetylcholine, the primary neurotransmitter of the parasympathetic nervous system, mitigates the production of pro-inflammatory cytokines (e.g., interleukin-6 and tumor necrosis factor). As such, high vagal activity acts as a buffer against systemic inflammation. However, when vagal activity is low, the subsequent increase in sympathetic activity facilitates the production of pro-inflammatory cytokines (for a review, see Thayer & Lane, 2007). Systemic inflammation, including inflammation of the myocardium, then leads to an increased likelihood of plaque build-up in the arteries (atherosclerosis – e.g., Libby, 2002).

Atherosclerosis involves a process whereby white blood cells begin to attach themselves to the endothelium, which lines interior walls of the arteries. Eventually, these inflammatory cells infiltrate into the subendothelial area where they collect and narrow the artery walls, increasing the susceptibility of plaque build-up (e.g., Tóth, 2009). Atherosclerosis can then develop into more serious CVD events, such as myocardial infarction and stroke (e.g., Robinson, Fox, Bullano, & Grandy, 2009).

In addition to the more direct link between inflammation and heart disease, parasympathetic activity and RSA has been associated with other conditions considered to be risk factors for CVD, such as diabetes and abnormal cholesterol (e.g., Thayer & Lane, 2007). Moreover, Masi and colleagues (2007) found that after statistically controlling for age, body mass index, and diabetes, RSA was a significant predictor of hypertension. This link is especially important, as hypertension has also been shown to be a predictor of more severe forms of CVD, such as coronary heart disease. These findings also suggest that RSA may be used as an important biomarker of CVD.
Health Behaviors, Vagal Activity, and CVD

There are a number of protective health behaviors that are related to higher RSA and a reduction in risk factors for CVD. Three domains of protective health behaviors will be discussed below. While there may be other dimensions of protective health behaviors that contribute to higher vagal activity and reduced risk for CVD, there is theoretical and empirical evidence linking worry to these three domains. As such, for the purposes of the current study, this review will focus on physical activity, diet, and “responsible” health behaviors (e.g., health screenings and obtaining health education).

Physical Activity and RSA. One important health behavior that seems to have a fairly strong relationship to RSA and CVD is exercise. Specifically, there are a number of studies suggesting that physical activity contributes to lower heart rate, higher RSA, and a reduction in risk for CVD (e.g., Billman, 2009; Carter, Banister, & Blaber, 2003; Rossy & Thayer, 1998). The common mechanism related to these benefits seems to be an increase in vagal activity and, therefore, parasympathetic activation (e.g., for a review, see Carter et al., 2003).

Rossy and Thayer (1998) studied differences in HRV in individuals who were categorized as “high fit” or “low fit” based on their self-reported physical activity, age, body composition, and gender. The authors had all participants engage in three tasks that meant to manipulate cardiac vagal activity. Specifically, participants placed a bag of ice and water on their foreheads to elicit a dive reflex, which increases vagal activity. They also had individuals engage in a reaction time task to elicit a sympathetic response. Finally, they combined these two tasks for the final condition. After controlling for other factors that have been shown to affect HRV, such as BMI, it was found that high frequency HRV (RSA) was significantly higher in
“fit” individuals, relative to the low fit group. These findings suggest that physical activity may lead to greater parasympathetic activity, as evidenced by higher levels of RSA.

While Rossy and Thayer (1998) used a self-report measure of physical activity, Leicht, Allen, and Hoey (2003) had individuals engage in exercise and measured changes in RSA. Specifically, the authors recruited healthy, untrained young adults to participate in an 8-week intensive cycling training program to determine the effects of exercise on vagal activity. Results revealed that participants demonstrated significantly greater resting RSA following the exercise program.

In addition to the reviewed findings by Rossy and Thayer (1998) and Leicht et al. (2003), a number of other studies that have demonstrated an increase in RSA associated with exercise (e.g., Amano, Kanda, Ue, & Moritani, 2001; Goldsmith, Bloomfeld, & Rosenwinkel, 2000). These results suggest that physical activity can lead to greater parasympathetic activity, as evidenced by higher levels of RSA. High vagal activity is associated with a decreased risk for CVD through the mechanisms described above (e.g., attenuation of inflammation and decreased risk for hypertension).

Nutrition and RSA. While the literature linking nutrition and vagal activity and RSA is not as extensive as with physical activity, some data suggest a relationship is present. For example, Valensi et al. (2005) measured HRV as well as dietary intake from a 3-day recall of food intake in 105 overweight individuals. Out of those 105 participants, 39 were diagnosed with cardiac parasympathetic dysfunction (PSD), which is characterized by impairment of parasympathetic control of the heart, as well as an abnormal cardiovascular response to an increase in sympathetic activity. HRV was significantly lower in participants with PSD, relative
to those without PSD. Moreover, a higher intake of simple carbohydrates (e.g., glucose and fructose) was associated with lower HRV.

In a more comprehensive study involving dietary intake and RSA, Park et al. (2009) were the first to examine the direct relationship between dietary intake and RSA. Park et al. (2009) measured food intake and high frequency HRV (i.e., RSA) in 586 older males. A food frequency questionnaire (FFQ) was used to measure dietary intake. In addition, the authors assessed intake of antioxidant nutrients (e.g., vitamin C) and n-3 fatty acids from fish. Participants’ resting RSA was measured for seven minutes with the subject seated.

Park and colleagues found that after controlling for other possible confounds (e.g., physical activity and vitamin supplements), green leafy vegetable intake was associated with higher RSA. Noncitrus fruit intake and total fruit and vegetable intake were marginally associated with higher RSA. N-3 fatty acids (found in tuna and other dark fish) were not found to be associated with higher RSA. The authors indicated that the mechanism through which vegetables would be associated with higher RSA is likely due to cardio-protective features of the vitamins and antioxidants in vegetables. Indeed, they examined the possible cardio-protective nutrient of vitamin C, which are found in leafy vegetables. However, vitamin C was related to higher RSA only in the third quartile of leafy vegetable intake, but not the fourth quartile. It may be that other antioxidants or other cardio-protective nutrients that were not measured are directly responsible for higher RSA.

N-3 fatty acids (e.g., omega-3 fatty acids) are often associated with greater cardiovascular health (e.g., Kris-Etherton, Harris, & Appel, and the Nutrition Committee, 2002). While Park et al. (2009) did not find a significant relationship between n-3 fatty acids and RSA, a number of other studies have shown a relationship exists (e.g., Christensen et al., 1996; Mozaffarian, Stein,
Prineas, & Siscovick, 2008). In a cross-sectional study, Mozaffarian et al. (2008) examined the effect fish consumption over the prior year had on RSA in older adults. Specifically, 4465 participants completed a food frequency questionnaire to specify food intake for the past year. The authors focused on fish high in n-3 fatty acids, as revealed by preliminary analyses in the study. As such, tuna and other broiled or baked fish was included in analyses with RSA but fried fish was not. After controlling for demographic variables, clinical risk factors, and other dietary characteristics, results revealed fish intake was associated with greater RSA. The authors suggest that this finding is due to the high level of n-3 fatty acids found in these fish, which is associated with better cardiovascular health (e.g., Kris-Etherton et al., 2002).

In summary, there is some evidence that exists examining the relationship between diet and RSA that suggests our food intake can affect vagal activity, as indexed by RSA, and ultimately, our cardiovascular health. In addition, it is suggested that vagal activity is an important mechanism through which diet affects cardiovascular health (e.g., Mozaffarian et al., 2008).

The review of the relationships between physical activity, diet, and RSA lead to another important variable to which RSA and cardiovascular health are related; namely, body composition. It is known that diet and physical activity affect body composition. Specifically, an unhealthy diet and sedentary lifestyle is often associated with a higher body mass index (BMI). Moreover, higher BMI is associated with lower vagal activity. Karason, Mølgaard, Wikstrand, and Sjöström (1999) examined the effect of weight loss on RSA. Specifically, they compared two groups of obese patients (BMI = 31-52) to lean individuals (BMI = 17-27). One of the groups of obese patients received either a weight-reducing gastroplasty and the other group just received dietary recommendations, which the authors referred to as a control group.
All three groups were assessed with a 24-hour ambulatory HRV recording at baseline, and the two weight-loss groups were assessed again one year later.

Results revealed significant baseline differences between the obese and non-obese participants. Indeed, obese individuals displayed lower high frequency HRV (RSA) compared to non-obese individuals. At the one-year follow-up, the group who underwent the weight-reducing surgery had greater reductions in BMI compared to the “control” dietary recommendations group. Moreover, the surgery group displayed higher levels of RSA relative baseline and compared to the obese “control” group. Likewise, Rabbia et al. (2003) and Riva et al. (2001) found similar findings when comparing obese adolescents to lean controls. Together, these findings support a relationship between BMI, which is influenced by diet and physical activity, and vagal activity.

**Health Responsible Behaviors, RSA, and CVD.** Another dimension through which health behavior can influence RSA and CVD is health responsible behaviors. Health behaviors in this domain can include routine physical exams, seeking medical information, and obtaining additional screenings and medical tests when necessary (e.g., Walker, Sechrist, & Pender, 1995). While these behaviors may not directly influence RSA or cardiovascular health, these health behaviors can lead to more direct influences such as undergoing lifestyle changes (e.g., exercise and diet), which can lead to higher RSA (e.g., Leicht et al., 2003) and reduced risk for CVD (e.g., Lauritzen, Jensen, Thomsen, Christensen, & Engberg, 2008). Moreover, as discussed above, worry has been shown to be associated with engaging in these types of behaviors.

Receiving health screenings and education from physicians promotes engaging in protective health behaviors that lead to higher RSA and reduced risk for CVD. Lauritzen et al. (2008) examined the influence health tests and health consultations in a primary care setting had
on participants’ subsequent health-related behavior over a five-year period. Participants (n = 1507) were randomly assigned to a control group, which only answered health-related questions; a group that answered questions, received a broad health test with written advice, followed by a 10-15 minute consultation with advice on how to reduce their risk for developing CVD (INC); or a group that received the INC intervention, plus a planned 45-minute consultation (I45C).

Results revealed 69% of the participants in the I45C condition and 90% of all participants in the intervention conditions with elevated cardiovascular risk scores (CVRS), made a number of lifestyle changes. The three most frequently listed lifestyle changes related to losing weight, eating healthier, and increasing physical activity. In addition to being associated with better cardiovascular health, all three of these reported changes are related to higher RSA (e.g., Karason et al., 1999; Park et al., 2009; Rossy & Thayer, 1998). At the five-year follow-up, CVRS, BMI, and serum cholesterol levels were significantly lower in both intervention groups compared to the control group. As such, the results indicate that receiving a health screening for cardiovascular disease and receiving information on how to reduce risk factors leads to protective health behaviors. Moreover, these implemented behavior changes were shown to reduce objective risk factors for CVD (e.g., BMI and cholesterol levels).

Lauritzen et al.’s (2008) findings are supported by a number of other studies that have examined the influence screenings and health education have on CVD risk factors (e.g., Bruckert et al., 2008; Calderon et al., 2008). For example, as part of a CVD risk reduction program in the workplace, Calderon, et al. (2008) provided phone counseling for 366 individuals who were considered to be at high risk for developing CVD (i.e., two or more elevated lipid values). The phone counseling included education about participants’ lab work, as well as education on how
they could reduce their risk, which included making dietary changes and increasing physical activity.

At a two-month follow-up, there were significant decreases from baseline in systolic and diastolic blood pressure, LDL cholesterol, and dietary fat intake. Moreover, compared to baseline, there was a significant increase in physical activity. In addition, results stayed quite consistent at five months when comparing to baseline, in that cholesterol, triglycerides, and dietary fat intake were significantly lower. A limitation to this study is the lack of a control group. However, the baseline comparisons to two follow-up time points suggest the intervention and implemented health behavior changes were helpful in reducing participants’ risk for CVD.

Overall, responsible health behaviors have been shown to lead to reduced risk for developing CVD. Although it is not the behavior itself of obtaining a health screening or receiving education on reducing risk factors that increase vagal activity and reduce risk factors for CVD, it is important to explore and understand these initial health protective behaviors. Indeed, these initial health behaviors are likely to lead to “action-oriented” protective health behaviors that directly lead to an increase in parasympathetic activity (RSA) and a reduced risk of developing CVD.

*Neuroanatomy Linking Worry and the Vagus Nerve*

In understanding the link between worry and RSA, it is important to understand the neuroanatomy and biological mechanisms involved. There is empirical support to suggest that worry is associated with a number of structures, including the anterior cingulate cortex (ACC), several areas in the prefrontal cortex: dorsolateral, dorsomedial, and ventrolateral (DLPFC,
DMPFC, and VLPFC), the parietal cortex, and the insula (e.g., Paulus & Stein, 2006; Schienle, Schäfer, Pignanelli, & Vaitl, 2009).

The insula and parietal cortex are structures that have been suggested to be involved in imagery formation and mental visualization (e.g., Damasio, Grabowski, & Bechara, 2000; Knauff, Kassubek, Mulak, & Greenlee, 2000; Schienle et al., 2009). In addition, the three PFC regions mentioned are implicated in the regulation of negative states by implementing strategies such as reappraisal (e.g., Goldin, McRae, Ramel, & Gross, 2008; McRae et al., 2010; Schienle et al., 2009). Finally, the ACC is suggested to be responsible for the maintenance of information in working memory, and cognitive and emotional processing (e.g., Lenartowicz & McIntosh, 2005; Mohanty et al., 2007).

As discussed earlier, the worry process involves engaging in verbal thinking to avoid thinking about more aversive imagery (e.g., Borkovec et al., 2004). Indeed, decreased activity in regions associated with imagery has been associated with a tendency to worry. For example, Schienle et al. (2009) found that high-trait worry was negatively associated with activity primarily in the right areas of the PFC, ACC, insula, and parietal cortex. Specifically, trait-worry was assessed via the Penn State Worry Questionnaire in a non-clinical sample of 19 women. Participants were presented with 20 aversive pictures and 20 positive pictures and were asked to rate the valance of the pictures (i.e., positive/negative). They were then asked to close their eyes and imagine the previously viewed picture for six seconds. Following the imagery phase, participants rated the vividness of the pictures. Brain images were recorded throughout.

Results revealed negative correlations between high-trait worry and several regions of interest, including the ACC, PFC (DLPFC, DMPFC, VLPFC), insula, and parietal cortex. Specifically, relative to individuals low in trait-worry, individuals who were high in trait-worry
displayed less activity in the mentioned areas during negative imagery. This decrease in activity in these structures primarily occurred in the right hemisphere. This is consistent with the avoidance theory of worry (e.g., Borkovec et al., 2004) in that structures associated with imagery (e.g., insula and parietal cortex) were not as active in high-trait worriers. In addition, decreased activity in the PFC regions associated with cognitive strategies of re-appraisal in high-trait worriers is consistent with the notion that individuals high in trait worry may have a difficult time reaching a “satisfactory” solution, with respect to the problem-solving aspect of worry (e.g., Tallis & Eysenck, 1994). In addition to the fMRI findings, there was a marginally significant finding with respect to high trait-worry being associated with less self-reported vividness of negative imagery.

The above findings provide insight into the neuroanatomy involved in the worry process. In terms of the relationship between worry and RSA, the aforementioned “worry structures” have been directly linked to structures involved in vagal activity (e.g., Thayer & Lane, 2009). It is suggested that these structures play an inhibitory role on cardiovascular activity by way of the vagus (e.g., Ter Horst, 1999). For example, decreases in activity of the left ACC, right DLPFC, and right parietal cortex are associated with a decrease in RSA (e.g., Lane et al., 2009). This process is possible through pathways between the mentioned cortical structures and subcortical structures linked to the vagus nerve, including the nucleus ambiguus (NA) where the mylenated vagus nerve originates. Specifically, there are reciprocal connections between the VMPFC, amygdala, ACC, medulla, and the nucleus ambiguus. It is suggested that the PFC (cortical) structures have an inhibitory effect on the amygdala (subcortical) through GABA, which is the primary inhibitory neurotransmitter in the central nervous system (for a review, see Thayer, 2006). Therefore, when worry takes place, the aforementioned cortical activity is reduced,
thereby decreasing the inhibitory control on the amygdala, which is responsible for facilitating an autonomic response that involves perceived threat and uncertainty. The disinhibition of the amygdala then leads to an inhibition of NA vagal activity and, therefore, parasympathetic influence on the heart (i.e., decrease in RSA - e.g., Thayer, 2009; Thayer & Lane, 2009).

It is noted above that there are reciprocal connections between cortical structures (e.g., PFC and ACC) and subcortical structures (e.g., amygdala and nucleus ambiguus). As such, it should be highlighted that the communication between these structures is bidirectional and that subcortical structures can influence cortical structures associated with cognitive processes such as worry (e.g., Critchley, 2005; Porges, 2007; Thayer, 2006). Moreover, there is evidence to suggest that afferent signals in the cardiac vagal pathway travel to the nucleus of the solitary tract (NTS), which is responsible for transmitting a variety of afferent visceral signals to other areas, including the amygdala (e.g., Porges, 2007). As noted above, the amygdala is bi-directionally connected to prefrontal structures associated with worry. Therefore, while there is no known empirical evidence to demonstrate the afferent influence of the vagus on worry, per se, it is conceivable that physiological changes in RSA could influence prefrontal structures involved in the worry process.

**Worry and RSA**

Theoretical and empirical evidence suggests that trait worry and experimentally induced worry play an important role in cardiovascular activity that can lead to CVD, mediated by prolonged cardiovascular activation and decreased cardiac vagal control (as measured by RSA). As such, there are two mechanisms that may be used to describe how worry leads to CVD. The first mechanism is neurobiological with worry leading to low cardiac vagal activity. The neurobiological pathways that link worry to RSA were described above. Empirical evidence for
this connection has been found in a number of lab studies, which will be described below. The second mechanism in the worry and CVD relationship involves the maintenance of worry and, therefore, autonomic reactivity. Research on this mechanism is rare. However, there are a small number of studies looking at the nature of stress and prolonged cardiovascular recovery, and the link between chronic worry and CVD, which will also be discussed below.

There are a handful of laboratory-based studies that provide support for the inverse relationship between worry and RSA. Thayer et al. (1996) studied the effects of worry on heart rate variability (HRV), which is another index of cardiac vagal activity, in clients with generalized anxiety disorder (GAD) and in nonanxious control individuals. The experimenter and participant determined a worry topic to use in the session. HR and respiration were measured during a 5-minute baseline period, at which time participants were asked to focus on their breathing. Following baseline was a relaxation period divided into three 3.5-minute periods, followed by another 5-minute baseline, followed by three 3.5-minute recording periods of the worry task, during which participants were asked to worry about the topic, which they chose.

Compared to both the baseline and relaxation periods, the worry induction period was associated with shorter inter-beat intervals (increased HR) and reduced cardiac vagal activity. That is, the worry induction significantly reduced cardiac vagal activity in the GAD and control groups. Moreover, individuals with GAD displayed lower cardiac vagal activity across all task periods in comparison to the control group. This study demonstrated that not only did individuals who experienced anxiety have low cardiac vagal activity but that the worry process alone could lead to reduced vagal activity.
Hofmann et al. (2005) examined the effects of a worry induction on RSA by telling participants that they would be asked to give an impromptu speech. Specifically, RSA was measured during a baseline phase, a relaxation phase, worry phase, and an anticipation phase. Each phase lasted 30 seconds with the exception for the anticipation phase, which lasted 3 minutes. During the relaxation phase, participants were asked to engage in relaxing imagery; during the worry phase, participants were asked to listen to a number of ruminative self-statements (e.g., “you have to give a presentation in front of a big class. You feel overwhelmed by negative thoughts as you are facing the audience,” etc.); and during the anticipation phase, participants were told that they will be asked to give a 10-minute impromptu speech and that it will be videotaped.

Results revealed that HR was higher during the worry period than during baseline, relaxation, and the second minute of the anticipation phase. Also, RSA was lower during the worry period than baseline, relaxation, and the second and third minutes of the anticipation phase. These data not only supported the notion that worry led to low RSA, and therefore low vagal control, but also that worry had different physiological characteristics compared to anticipatory anxiety. However, given that the authors were comparing 30-second phases and a 3-minute phase, it seems the physiological difference between the worry and anticipation phase should be interpreted with caution.

Lyonfields, Borkovec, and Thayer (1995) examined vagal tone differences between individuals with generalized anxiety disorder (GAD) and nonanxious controls. Specifically, participants underwent a 5-minute relaxation baseline condition; a 4-minute condition of focusing on aversive imagery, which they identified at the beginning of the study; a 4-minute worry condition, during which they were instructed to worry using “thoughts and words” about a
pre-selected topic; and a final 5-minute relaxing recovery condition. Vagal tone was measured during each phase and Mean Successive Difference (MSD) of inter-beat-intervals provided the index of vagal tone.

Results revealed that individuals high in trait worry and met criteria for GAD had a lower level of vagal tone across all conditions, relative to nonanxious controls low in trait worry. Also, a main effect for condition revealed that individuals displayed lower vagal tone during the worry condition, relative to all other conditions, independent of trait worry. The authors indicated that this effect seemed to be due to changes in the nonanxious control group, as vagal tone remained low across tasks for the GAD group. These findings are consistent with other data showing a decrease in vagal activity when worry is present. Moreover, these findings show a significant decline in vagal activity during a worry condition, relative to an aversive imagery condition; a finding inconsistent with other data indicating that states associated with imagery and anxiety result in greater cardiovascular reactivity compared to a worry state (e.g., Borkovec, 1994; Borkovec & Hu, 1990; Mathews, 1990). However, because the authors did not counter-balance the worry and imagery conditions, one cannot rule out order effects.

The above laboratory studies lend support to the notion that (induced) worry leads to lower vagal activity. However, there are a number of limitations in the studies examining this link, including primarily using undergraduate samples; studying worry within the context of anxiety, rather than a lone construct; and inconsistencies in measuring vagal activity, in terms of method and duration. Indeed, there is empirical evidence showing that RSA is a more accurate measure of cardiac vagal activity (e.g., Porges, 2007) and that comparisons between conditions should be the same in duration (e.g., Allen, Chambers, & Towers, 2007).
It is important to note a sort of paradox that may exist in the worry and cardiovascular activity relationship. One could argue that worry should, in fact, decrease HR given that its function is to problem-solve and avoid the more evocative nature of distressing images by turning to a verbal thought process (Borkovec et al., 2004; Szabó and Lovibond, 2002). However, worry would not be present if a perceived threat did not exist, which is associated with an increase in cardiovascular activity. In other words, while it is conceivable that worry may mitigate the initial cardiac response of more evocative, aversive images, the perceived threat remains in the form of worry and; therefore, maintains the cardiovascular reactivity. Moreover, when considering the potential effects worry has on cardiovascular activity that can lead to CVD, it is the duration of the physiological state rather than the intensity that may be a more important factor when considering the worry/CVD relationship (e.g., Brosschot et al., 2006). The importance of the prolonged duration of worry and cardiovascular activity is discussed below.

The dominant theory that describes the link between worry and CVD suggests that a perseverative cognitive activity, like worry, maintains the state of cardiovascular activation and decreased cardiac vagal activation, which can lead to CVD (e.g., Brosschot & Thayer, 2004). In other words, immediate stressors may reduce RSA (e.g., Friedman & Thayer, 1998) but it is the maintenance of the “stress” in the form of worry and therefore cardiovascular activation that impacts cardiovascular health (Brosschot et al., 2006; Brosschot & Thayer, 2004; Thayer & Lane, 2002).

There is minimal research specifically linking chronic worry to CVD. However, there is evidence to suggest that prolonged stress, and delayed cardiovascular recovery, following a stressor may be associated with an elevated risk for negative cardiovascular outcomes. For example, Schuler and O’Brien (1997) performed a meta-analytic review of 69 studies examining
the relationship between hypertension risk and cardiovascular recovery from stress. Meta-analytic findings suggested that low-risk individuals compared with high-risk individuals exhibited longer and/or less complete cardiovascular recovery from laboratory stressors. Further, in the majority of study comparisons, shorter and/or more complete cardiovascular recovery was associated with decreased risk for hypertension development.

Although the research specific to worry, per se, is less prevalent, there is modest empirical evidence to suggest that the perseverative nature of worry prolongs cardiovascular activity. For example, worry has been shown to be linked to a maintained increase in HR and a decrease in cardiac vagal control during sleep, as well as during the day, indicating the effects of worry on cardiovascular activity are sustained even when the conscious problem-solving activity that often defines worry is not taking place (e.g., Brosschot, Van Dijk, & Thayer, 2007; Pieper & Brosschot, 2005).

Kubzansky et al. (1997) provided further insight into this worry and CVD relationship. They conducted a prospective study on the relationship between worry and coronary heart disease (CHD). As part of a large aging study, 1,759 men completed a questionnaire that measured worry in several life domains, similar to the Worry Domains Questionnaire (Tallis, Eysenck, & Mathews, 1992). They did not have CHD at the time of the initial assessment. The men were followed for 20 years and received a physical exam every 3 to 5 years.

A total worry score was associated with later development of CHD [relative risk – RR = 1.40 (95% CI, 1.07-1.83)]. Further, worry about their social life was associated with an increase in risk of myocardial infarction [RR = 2.54 (95% CI, 1.40-4.13)], financial worry was associated with increased risk of CHD and angina [RR = 1.24 (95% CI, 1.04-1.49)], and health worry was associated with sudden cardiac death [RR = 1.28 (95% CI, .92-1.79)]. These findings remained
significant even after controlling for other factors that could contribute to CHD, such as smoking, drinking alcohol, and family history of heart disease.

The studies reviewed above demonstrate that an inverse relationship exists between worry and cardiac vagal activity, which can be captured by inducing worry and measuring RSA (e.g., Hofmann et al., 2005; Thayer et al., 1996). Moreover, prolonged worry has been linked to the development and maintenance of CHD (e.g., Kubzansky et al., 1997). Although previous studies examining worry and RSA have, for the most part, demonstrated similar findings, the relationship between worry and RSA is not always consistent.

In a previous study by Goetz and O’Brien (2009), the effects of trait and induced worry on RSA were examined in a community sample experiencing work stress. Forty-six males and females (84.8%) with an average age of 45 completed the PSWQ and RSA measures were collected during baseline, worry, control, and recovery conditions. The baseline and recovery conditions involved the participants focusing on their breathing. The worry condition involved participants choosing a topic about which they were currently worried and worrying about it as intensely as they can and in the way they normally worry about it. The control condition involved participants choosing a topic about something that makes them feel peaceful. Each condition was five minutes in duration and the worry and control conditions were counterbalanced. Immediately following each condition, participants provided ratings of worry intensity and frequency, and emotional state. In addition, they wrote what it was they were thinking about during the five-minute periods.

Overall, the results from the self-report data from this study suggested that the worry induction was successful in inducing worry. Specifically, participants experienced cognitions associated with worry during the worry condition. Participants also experienced worry more
intensely and more frequently during the worry condition. Moreover, participants who scored high in trait worry, worried more frequently and intensely across conditions. Finally, participants experienced feelings that were more negative, more frequent, and more intense, during the worry induction, relative to the other conditions.

With respect to the RSA data, our prediction that a worry induction would lead to lower RSA, relative to the other conditions, was confirmed. A main effect for condition was found and post hoc analyses confirmed that participants displayed significantly lower RSA (vagal activity) during the worry condition, relative to all other conditions. These results are consistent with previous findings showing that the induction of perseverative cognitive states, such as worry, lead to lower levels of RSA (e.g., Hofmann et al., 2005; Lyonfields et al., 1995). Taken together with the self-report data, these findings showed that phasic worry leads to a decrease in cardiac vagal activity.

The prediction that individuals higher in trait worry would display an overall lower level of RSA was not confirmed. In fact, the data actually showed an opposite effect, such that individuals high in trait worry displayed higher overall levels of RSA. This finding was inconsistent with other research linking perseverative thinking, including worry, to low vagal activity (e.g., Brosschot et al., 2006; Thayer & Lane, 2002; Thayer & Lane, 2009). There was one other study found where a similar effect emerged.

Davis, Montgomery, and Wilson (2002) found that undergraduate students who scored high in trait worry on the PSWQ showed overall higher levels of HRV across baseline and worry conditions. While it is difficult to theorize as to why this finding emerged in the above study, and in Davis et al’s study, there are a number of possible explanations for this unusual finding. Davis and colleagues suggested that it may be that individuals who scored higher in worry
happened to be higher in aerobic fitness, which is associated with greater cardiac vagal activity (e.g., Rossy & Thayer, 1998). Davis et al. were able to recall a number of participants back to complete a “checklist” of exercise behavior and a measure of aerobic fitness (VO$_2$ Maximum test). The recalled worry group reported higher levels of exercise but significant differences between recalled groups for the VO$_2$ Max test did not emerge. Unfortunately, a measure of fitness was not obtained in the Goetz and O’Brien study. Another possible explanation that Davis et al. suggested was age differences in samples between studies that have found trait worry effects for vagal activity and those that have found no effects or opposite findings. Specifically, it was suggested that trait worry differences in vagal activity may not be found until later in life, as Thayer et al. (1996), who found that high trait worry was associated with lower vagal activity, used a sample with a mean age of 35.6. However, it was also noted that Lyonfields et al. (1995) found significant trait worry differences in vagal activity using an undergraduate sample, such that higher trait worry was associated with lower vagal activity. Moreover, the mean age for the sample in the Goetz and O’Brien study was 45, which further diminishes the argument that age would be a significant factor in finding trait worry differences in vagal activity.

As discussed above, the relationship between worry and RSA is not always consistent. Therefore, it is important to examine other variables that may influence the worry-RSA relationship. It is established that worry can lead to a number of protective health behaviors, including health screenings (e.g., Hay et al., 2006), increased physical activity (e.g., Mullens et al., 2004), and a healthier diet (e.g., Mullens et al., 2004). Moreover, health screenings (e.g., Lauritzen et al., 2008), physical activity (e.g., Rossy & Thayer, 1998), healthy eating habits (e.g., Park et al., 2009), and low BMI (e.g., Karason et al., 1999) have been linked to higher RSA and better cardiovascular health. Given the empirical and theoretical evidence for relationships
between worry, protective health behaviors, and RSA, and the inconsistent worry-RSA relationship, further investigation of other possible influential variables in the worry – RSA relationship is warranted. Davis et al. (2002) included a checklist of exercise behavior as a follow-up to their finding. However, they did not report measuring other health behaviors. Moreover, the authors used a measure of HRV (a standard deviation of R-R), which has been shown to include parasympathetic and sympathetic influences (e.g., Allen, Chambers, & Towers, 2007; Berntson, Cacioppo, & Quigley, 1991; Porges, 2007). RSA, as will be measured in the present study, is a more pure measure of cardiac vagal activity, with more robust findings with respect to neurobiological mechanisms linking worry to cardiovascular activity (e.g., Allen et al., 2007; Porges, 2007; Thayer, 2006; Thayer & Lane, 2009). As such, the present study is novel in several respects, which are outlined below.

**Present Study**

The present study was designed to contribute to the current literature in several important aspects. First, the majority of studies that have examined the effects of worry on RSA, have used clinical populations (e.g., Brosschot & Van Der Doef, 2006; Hofmann et al., 2005; Lyonfields et al., 1995); as such, the present study will include a non-clinical sample of young adults. Second, this study will obtain written data of the participants’ thoughts after each condition of the experiment to assess their thought content during a worry induction. While other studies of this kind have assessed worry intensity and duration, actual assessment of content has been absent. This will give us the opportunity to evaluate the contributions of worry content and worry instruction. Third, although most research in relating worry to vagal tone has tended to focus on worry in the context of anxiety (e.g., Borkovec, Ray, & Stöber, 1998), this study focuses centrally on worry as a stand-alone construct. In addition, the present study will use RSA as an
index of vagal activity (e.g., Porges, 2007) and use comparisons between conditions that will be identical in duration (Allen et al., 2007). From what could be gathered in the current literature, this assessment paradigm, within the context of worry as a lone construct, has not been used to study the link between worry and RSA (vagal activity). Finally, the exploration of variables that may influence the worry-RSA relationship have largely been absent from the literature. Specifically, worry has been associated with higher levels of protective health behaviors (e.g., Mosher et al., 2008; Mullens et al., 2004), which in turn, are associated with higher RSA and better cardiovascular health (e.g., Carter et al., 2003; Park et al., 2009; Rossy & Thayer, 1998). As such, the present study will include assessment of protective health behaviors to explore their possible role in the worry-RSA relationship.

To test the aforementioned relationships, RSA among undergraduate students who differ in trait worry will be assessed under different laboratory conditions (baseline, worry induction, control, and recovery). Additionally, variables that may influence the worry-RSA relationship will be collected to examine the extent to which they account for variance in RSA reactivity and recovery.

**Hypotheses**

**Main Effect Predictions.** It is predicted that relative to the baseline, recovery, and control conditions, all participants will display lower RSA during the worry condition. This prediction is derived from findings that worry induction leads to lower RSA, regardless of their tendency to experience chronic (trait) worry or anxiety (e.g., Berntson et al., 1993; Borkovec et al., 1998; Brosschot & Thayer, 2004; Thayer et al., 1996). It is also predicted that high-trait worriers will display lower RSA across all conditions, relative to low-trait worriers. This prediction is based on evidence that individuals high in trait anxiety and worry have been reported to have lower
cardiac vagal tone (e.g., Thayer et al., 1996). It is predicted that individuals who report higher levels of trait worry will also report higher levels of protective health behaviors (e.g., physical activity), relative individuals who report lower trait worry. This prediction is based on evidence that worry has been associated with higher levels of protective health behaviors (e.g., Mosher et al., 2008; Mullens et al., 2004). Finally, it is predicted that individuals who display higher levels of protective health behaviors (e.g., physical activity) will display higher RSA. This prediction is based on evidence that engaging in protective health behaviors is associated with higher RSA (e.g., Carter et al., 2003; Park et al., 2009; Rossy & Thayer, 1998).

**Interaction Predictions.** Because empirical studies examining the relationship between trait worry and RSA have yielded inconsistent findings, it may be that other variables influence the trait worry – RSA relationship. As discussed above, worry has been shown to be associated with protective health behaviors (e.g., physical activity). Also, health behaviors, such as exercise have been shown to be associated with higher levels of RSA (e.g., Mosher et al., 2008; Mullens et al., 2004). What is not known is how health protective behaviors may interact with the trait worry – RSA relationship.

**Physical Activity.** It is predicted that high trait worriers who report higher levels of physical activity will display higher levels of RSA, relative to high trait worries who report lower levels of physical activity and that low trait worriers who report higher levels of physical activity will display higher levels of RSA, relative to low trait worriers who report lower levels of physical activity. These predictions are based on evidence that a higher level of physical activity is associated with higher RSA (e.g., Mosher et al., 2008). It is also predicted that there will be an interaction between trait worry and physical activity. Specifically, it is expected that the association between physical activity and RSA will be larger for high trait worriers, relative to
low trait worriers. This prediction is based on evidence that low-trait worriers display higher levels of baseline HRV (e.g., Lyonfields, et al., 1995; Thayer et al., 1996) and, therefore, less reactivity. As such, it is plausible to suggest that protective health behaviors will have a lesser impact on RSA for low-trait worriers, relative to high-trait worriers.

*Nutrition.* It is predicted that high trait worriers who report healthier eating habits will display higher levels of RSA, relative to high trait worries who report unhealthy eating habits and that low trait worries who report healthier eating habits will display higher levels of RSA, relative to low trait worriers who report unhealthy eating habits. These predictions are based on evidence that a healthy diet is associated with higher RSA (e.g., Mozaffarian et al., 2008; Park et al., 2009; Valensi et al., 2005). It is also predicted that there will be an interaction between trait worry and diet. Specifically, it is expected that the association between diet and RSA will be larger for high trait worriers, relative to low trait worriers. This prediction is based on evidence that low-trait worriers display higher levels of baseline HRV (e.g., Lyonfields, et al., 1995; Thayer et al., 1996) and, therefore, less reactivity. As such, it is plausible to suggest that protective health behaviors will have a lesser impact on RSA for low-trait worriers, relative to high-trait worriers.

*Health Responsible Behaviors.* It is predicted that high trait worriers who report higher levels of health responsible behaviors will display higher levels of RSA, relative to high trait worriers who report lower levels of health responsible behaviors and that low trait worriers who report higher levels of health responsible behaviors will display higher levels of RSA, relative to low trait worriers who report lower levels of health responsible behaviors. These predictions are based on evidence that engaging in health responsible behaviors is related to improved cardiovascular health (e.g., Calderon et al., 2008; Lauritzen et al., 2008) and higher levels of
RSA (Carter et al., 2003). It is also predicted that there will be an interaction between trait worry and health responsible behaviors. Specifically, it is expected that the association between health responsible behaviors and RSA will be larger for high trait worriers, relative to low trait worriers. This prediction is based on evidence that low-trait worriers display higher levels of baseline HRV (e.g., Lyonfields, et al., 1995; Thayer et al., 1996) and, therefore, less reactivity. As such, it is plausible to suggest that protective health behaviors will have a lesser impact on RSA for low-trait worriers, relative to high-trait worriers.

*Body Mass Index (BMI).* It is predicted that high trait worriers who have a lower BMI will display higher levels of RSA, relative to high trait worries who have a higher BMI and that low trait worriers who have a lower BMI will display higher levels of RSA, relative to low trait worriers who have a higher BMI. These predictions are based on evidence that a lower BMI is a predictor of higher levels of RSA (e.g., Karason et al., 1999; Riva et al., 2001). It is also predicted that there will be an interaction between trait worry and BMI. Specifically, it is expected that the association between BMI and RSA will be larger for high trait worriers, relative to low trait worriers. This prediction is based on evidence that low-trait worriers display higher levels of baseline HRV (e.g., Lyonfields, et al., 1995; Thayer et al., 1996) and, therefore, less reactivity. As such, it is plausible to suggest that protective health behaviors will have a lesser impact on RSA for low-trait worriers, relative to high-trait worriers.
CHAPTER II. METHOD

Participants

One-hundred twenty-eight university students were recruited for this study. A preliminary power analysis was conducted using the GPOWER program (e.g., Faul, et al., 2007) and indicated that for the planned analysis requiring the most participants, 116 participants is sufficient to detect a medium effect size (alpha = .05) with a power of .8 (i.e., 80% of the time it is present). A medium effect size is a standard effect size to indicate adequate differences between conditions (Myers & Well, 2003). Physiological data (RSA) could not be collected for seven participants due to equipment failure and RSA data could not be used for six participants due to irregular ECG waveforms that could not be extracted and analyzed by the RSA program. Therefore, this study is based on a final sample of 115 participants.

Individuals were recruited through SONA, an online research sign-up service. Participants were given a choice to be compensated with $15 or extra credit for their participation. Use of human participants was reviewed and approved by the university’s Human Subjects Review Board (HSRB – see Appendix P).

Measures

Demographics Questionnaire. Participants completed a questionnaire to gather information about age, gender, race, marital status, and education (see Appendix E). The questionnaire also asked how many times participants have been to the doctor (except for dentists and eye doctors) in the past year for a specific illness and for general checkups. Participants were also asked about smoking status and behavior, personal and family history of cardiovascular disease and hypertension, as well as what medications they are taking and the
Worry and Respiratory Sinus Arrhythmia

dosage. This questionnaire was adapted from a measure used in previous studies in the Behavioral Medicine Laboratory at BGSU (e.g., Goetz & O’Brien, 2009).

 Penn State Worry Questionnaire. The Penn State Worry Questionnaire (PSWQ, Meyer, Miller, Metzger, & Borkovec, 1990, see Appendix F) is a 16-item instrument that measures the trait of worry in broad, everyday contexts (e.g., “I am always worrying about something”). The measure initially contained 161 items and used a five-point scale (1 = “Not at all typical of me”; 5 = “Very typical of me”). Meyer et al. (1990) administered the initial measure to 337 college students. Preliminary psychometric evaluations of the instrument (i.e., item analyses, factor analyses) were then used to separate general worry items from other items. These analyses resulted in the current 16-item version of the instrument. A recent analysis of the PSWQ has shown that the instrument measures a unitary construct of general worry (Hazlett-Stevens, Ullman, & Craske, 2004). Meyer, et al. (1990) reported high internal consistency (α = .93) and high test-retest reliability (r = .92) with an 8 to 10 week test-retest interval.

Items 1, 3, 8, 10, and 11 are reverse-scored. All items are then summed to create a total PSWQ score. PSWQ scores may range from 16 to 80 with higher scores reflecting greater worry.

 Thought and Affect Sampling. At the conclusion of each condition of the experiment, participants were asked to “briefly describe the thoughts you experienced during the last 5 minutes.” Responses were written rather than verbally recorded. They were also asked to indicate how often and intensely they worried on a ten-point likert-type scale (0 = “Not at all”, 9 = “All the time” and “An extreme amount”, respectively - see Appendix H). Participants’ thoughts that were written down after each condition were coded by two research assistants and analyzed for inter-rater reliability. In all, written statements were coded three different ways:
degree of worry-related content, concreteness versus abstractness, and content category of written worry statements. Specifically, the raters provided a rating (0 = none, 1 = minimal, 2 = moderate, 3 = maximal) of the extent to which the written thoughts obtained after each condition of the experiment contained worry-related content. This method of assessment and coding procedure has been used in a previous study (Goetz & O’Brien, 2009) and was found to have high inter-rater consistency for rating the worry content of participants’ written thoughts ($r = .81, p < .001$).

Raters also provided ratings of the concreteness of each written thought. Stöber and Borkovec (2002) proposed that worry-related thinking is more abstract in nature and, therefore, contributing to reduced imagery during the worry process. This rating scale consists of the five categories: 1 (abstract), 2 (somewhat abstract), 3 (neither-nor), 4 (somewhat concrete), and 5 (concrete). Abstract was defined as “indistinct, cross-situational, equivocal, unclear, aggregated” and concrete was defined as “distinct, situationally specific, unequivocal, clear, singular.”

Finally, written statements for the worry condition were coded based on content. Content categories were taken from the Worry Domains Questionnaire (WDQ). The development of the WDQ was based on Eysenck’s (1984) proposal that different topics of worry are stored into long-term memory in semantically related clusters. The WDQ measures worry specific to five domains: relationships, lack of confidence, aimless future, work incompetence, and financial (Tallis, Eysenck, & Mathews, 1992). Two additional domains were added for the purposes of this study: “health” and “school”, for a total of seven possible categories.
Health Worry. Participants answered two items about how worried they are about their health (see Appendix G). Specifically, they were asked “During the past week, how often have you worried about your health?” and “How worried are you about your health?” with a five-point likert scale (1 = “Never”; 5 = “All of the time”) and (1 = “Not at all”; 5 = “Extremely”), respectively. A number of studies (e.g., McCaul, Mullens, Romanek, Erickson, & Gatheridge, 2007) have constructed very brief measures to assess domain-specific health-related worry, which correlated moderately with the PSWQ (r = .31) and motivation to engage in a health protective behavior (e.g., quitting smoking; r = .29). The two items were summed to create a “health worry” score.

Positive and Negative Affect Schedule. The Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988) was used to assess participants’ affect following each condition of the experiment. The PANAS is a 20-item self-report measure that assesses current positive and negative affect, using a five-point likert-type scale (1 = “Not at all”, 5 = “Extremely” – see Appendix H). The PANAS is comprised of two subscales: the Positive Affect (PA) subscale and Negative Affect (NA) subscale. The PA subscale assesses the extent to which a participant is currently experiencing positive affect and is comprised of ten positive affect descriptors (e.g., enthusiastic, inspired). Likewise, the NA subscale assesses the extent to which a participant is currently experiencing negative affect and is comprised of ten negative affect descriptors (e.g., jittery, afraid).

Crawford and Henry (2004) reported high internal consistency (α=.89 for PA, and α=.85 for NA). Items 1, 3, 5, 9, 10, 12, 14, 16, 17, and 19 are summed to create a PA score. Higher scores on the PA scale are indicative of greater levels of positive affect or emotion. Items 2, 4, 6,
7, 8, 11, 13, 15, 18, and 20 are summed to create an NA score. Higher scores on the NA subscale are indicative of greater levels of negative affect or emotion.

*Health-Promoting Lifestyle Profile II.* The Health-Promoting Lifestyle Profile II (HPLP-II, Walker, Sechrist, & Pender, 1995) is a 52-item instrument that assesses health-promoting behavior on six dimensions: Health Responsibility (e.g., “Question health professionals in order to understand their instructions.”), Physical Activity (e.g., “Follow a planned exercise program.”), Nutrition (e.g., “Eat 2-4 servings of fruit each day.”), Spiritual Growth (e.g., “Believe that my life has a purpose.”), Interpersonal Relations (e.g., “Praise other people easily for their achievements.”), and Stress Management (e.g., “Take some time for relaxation each day.”). The HPLP-II asks about the frequency with which the individual is currently engaging in the listed health-promoting behaviors (1 = Never; 4 = Routinely). Three subscales were selected from the HPLP-II for use in hypotheses for the present study (see Appendix I): Health Responsibility (9 items; scores ranging 9-36), Physical Activity (8 items; scores ranging 8-32), and Nutrition (9 items; scores ranging 9-36). These health behavior domains were chosen based on established previous literature linking these health behaviors both worry (e.g., Mosher et al., 2008; Mullens et al., 2004) and autonomic flexibility (e.g., RSA) and better cardiovascular health (e.g., Carter et al., 2003; Lauritzen et al., 2008; Ornish et al., 1998; Park et al., 2009; Rossy & Thayer, 1998; Valensi et al., 2005). The other three subscales, as well as the total score for the HPLP-II, were used in exploratory analyses.

The HPLP-II subscales have been shown to have acceptable internal consistency in a number of studies (alphas range from .71 - .85, e.g., Flattery et al., 2006; Salyer, Sneed, & Corley, 2001). Walker & Hill-Polreecy (1996) reported high test-retest reliability ($r = .89$) with a
three-week test-retest interval. A mean score is computed for each subscale to facilitate comparison between subscales (Walker et al., 1995). Higher scores are indicative of engaging in more healthy behaviors. A total score is obtained by computing the mean for all 52 responses with scores ranging from 52 to 208.

*Body Mass Index.* Body Mass Index (BMI) is a commonly used method of estimating body fat. BMI is calculated by obtaining an individual’s body weight (in kilograms) and height (in meters). Weight is then divided by height squared to obtain a BMI value. A BMI of 18.5 - 24.9 kg/m$^2$ falls in the “normal” range, a BMI of 25.0 – 29.9 kg/m$^2$ falls in the “overweight” range, and a BMI equal to or greater than 30 kg/m$^2$ falls in the “obesity” range (National Heart, Lung, and Blood Institute, 1998).

*Daily Stress Inventory.* The Daily Stress Inventory (DSI, Brantley, Waggoner, Jones, & Rappaport, 1987) is a 58-item self-report measure in which participants rate whether or not a particular stressor has occurred during the past 24 hours (Appendix J). In addition to rating frequency of stressors, participants are also asked to rate perceived feelings of stress associated with each item on a 7-point likert-type scale (1 = “Occurred but was not stressful”; 7 = “Caused me to panic”). Items on the DSI are comprised of five categories: interpersonal conflict, personal competency, cognitive stressors, environmental hassles, and varied stressors. The average impact score, which was used for the current study, is derived by dividing the impact of stressors by the frequency of stressors. Internal consistency for the impact score is satisfactory with Cronbach’s alpha of .87 for the impact score (Brantley et al., 1997).

*National Cancer Institute Fruit and Vegetable Screener.* The National Cancer Institute Fruit and Vegetable Screener (FVS) is a 19-itme instrument assessing the frequency of typical
consumption of 10 categories of fruits and vegetables over the past month (Thompson et al., 2002; Appendix K). Participants identify how frequently they consumed various fruits and vegetables (“never” to “5 or more times per day”). In addition to frequency of consumption, portion sizes are assessed for 9 of the items: 100% juice, fruit, lettuce salad, French fries/fried potatoes, other white potatoes, cooked dried beans, other vegetables, tomato sauce, and vegetable soups. There is one single item that asks the frequency of consuming “mixtures that included vegetables” that is not included in the total score. Estimates for portion size were used from the 2005 USDA Food Guide Pyramid definitions of fruit and vegetables cup equivalents. Fruit and vegetable intake is obtained by multiplying the average daily frequency of consumption by number of servings for the portion size. Total daily number of servings of fruits and vegetables was obtained by summing across all groups, which is the value used in analyses. Validation studies have shown the FVS and true intake (24-hour recalls) to correlate between .5-.6 (Thompson, Midthune, Subar, Kahle, Schatzkin, and Kipnis, 2004).

*National Cancer Institute Percentage Energy from Fat Screener.* The National Cancer Institute Percentage Energy from Fat screener (Pfat) consists of 16 questions about typical consumption of foods over the past year (Thompson, Midthune, Subar, Kipnis, Kahle, & Schatzkin, 2007; Appendix L). For the purposes of the current study, the timeframe was changed to one month to be consistent with the timeframe assessed by the FVS. Participants identify how often (“never” to “2 or more times per day”) they consumed 15 categories of food (e.g., bacon, beef, cheese, mayonnaise, and margarine) over the past month. A 16th question asks how often they prepared foods with reduced-fat margarine (“didn’t use margarine” to “almost always or always”). There is a single item, which is not included in the final score, that asks
participants if they believe their diet is “low,” “medium,” or “high” in fat. Reported fat intake is reduced by 0-75% for “margarine/butter” intake, based on the 16th question. Estimates of percentage energy from fat are computed from participant’s reported frequency of intake of the 15 food categories, assigned gender-specific portion sizes, and gender-specific regression coefficients. Correlations between the Pfat and true intake (24-hour recalls) are 0.64 and 0.58 for men and women, respectively (Thompson et al., 2007).

**Paffenbarger Physical Activity Questionnaire.** The Paffenbarger Physical Activity Questionnaire (PPAQ) consists of three items to provide an estimate of kilocalories used per week through physical activity (Paffenbarger, Wign, & Hyde, 1995; Appendix M). Items assess number of blocks walked and number of stairs climbed per day, and engagement in other sports/recreational activities. A metabolic equivalent of task (MET) value is assigned to blocks (miles) walked and stairs climbed per day and multiplied by seven to compute kilocalories spent per week (kcal/week). To assess “sports or recreational” activities, responders list an activity, number of times per year and amount of time each episode they engage in the activity. A MET value is then assigned to each activity based on intensity of the activity (5 kcal/min = light intensity, 10 kcal/min = vigorous intensity, 7.5 kcal/min = mixed intensity - e.g., jogging = 7.5 kcal/min). Energy expenditures for all three items are added together for a total estimated energy expenditure value (kcal/week). The PPAQ has demonstrated good validity with activity recorded from the previous 48 hours (Ainsworth, Leon, Richardson, Jacobs, and Paffenbarger, 1993). Correlations ranged from .35 to .79. Test-retest reliability for one month was adequate (r = .72).

**Respiratory Sinus Arrhythmia.** Respiratory sinus arrhythmia (RSA) was measured using
Biopac Systems MP30 hardware and Biopac version 3.7.2 analysis software. To accomplish this, electrocardiograph (EKG) electrodes were attached to the participant with a Limb Lead II configuration. Specifically, the negative electrode was placed on the right wrist, the positive electrode was placed on the left ankle, and the ground electrode was placed on right ankle (see Appendix B). The EKG sampled electrical activity at a rate of 1000Hz and was used to provide an index of heart rate, which is well above the suggested 500Hz sampling rate for obtaining an accurate measure of RSA (Allen et al., 2007; Bernston, Cacioppo, & Quigley, 1991).

Allen et al’s (2007) method for computing RSA from heart rate data was used. Although RSA is comprised of changes in heart rate at the frequency of respiration, a separate measure of respiration is not needed to obtain a measure of RSA (e.g., Allen et al., 2007; Porges, 2007). The interaction between heart rate variability and respiration occurs at a particular frequency in EKG data (.12 - .40 Hz). A number of computer programs have been developed to extract EKG data, which identify the distance in milliseconds between each R-wave (representing one cardiac beat) in the EKG waveform and create an inter-beat-interval (IBI) series. An algorithm is then used to isolate the RSA frequency and RSA values are then computed and log-transformed by the program. The program used in the current study is described below.

Allen et al. (2007) developed software that includes two programs, the QRSTool and CMetX. The QRSTool allows the user to extract an IBI series from EKG data. Specifically, the QRSTool uses an automated EKG beat detection function. For the current study, a threshold function was used, which assigns beats to all maxima in the EKG time series that exceed a set threshold; in this case, the maxima was the R-wave. The program also allows the user to manually correct for artifacts. Specifically, R-waves that are not identified by the program were
corrected by manually inserting a marker at the missed R-wave. Likewise, any “extra” R-waves that the program identifies (e.g., T-waves with large amplitudes) were corrected by removing the marker.

Once all of the R-waves were identified and marked, and artifacts corrected, the CMetX program was used to compute RSA values. CMetX calculates RSA using the extracted IBI series as input. Specifically, the IBI series is not technically a time series due to cardiac chronotropic variability, meaning the inter-beat-intervals are not equally spaced time intervals. Therefore, CMetX is used to convert the IBI series to a time series sampled at 10Hz, then filtered using a 241-point FIR filter with a .12-.40 Hz bypass, the frequency range at which heart rate variability interacts with respiration. The values are then log transformed and used as the estimate of RSA.

While there are a number of methods available to obtain RSA values, there is not one universally agreed upon method, as the different methods result in similar RSA values (e.g., Allen et al., 2007; Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, 1996). For example, Allen et al. (2007) found that RSA results from their program (CmetX) and results obtained from the patented program (MXEdit V2.21) developed by Porges and Bohrer (1990) were similar. RSA was measured in a sample of 96 college students, at rest and during a stressor (paced arithmetic). Correlations of RSA between the two programs were .992 and .995, respectively for each condition.

Procedure

On arrival to the laboratory, informed consent was obtained from all participants (see Appendix A). After consent was obtained, participants were given a brief tour of the lab and a more detailed explanation of the procedures. Participants then completed the self-report
measures on a laptop computer. Following completion of the self-report measures, participants were asked to remove their shoes, and their height and weight were measured in order to calculate a BMI score. Next, participants were asked to remove their socks for placement of the EKG electrodes. The participants were seated in an upright position in a reclining chair and the EKG electrodes were attached. Following this, recorded instructions were played over an intercom (see Appendix C).

The laboratory procedure consisted of four conditions: a 10-minute resting Baseline condition, a 5-minute Worry condition, a 5-minute Control Condition, and a final 10-minute Recovery Condition. Between each condition, participants were asked to write about what they were thinking. They were also asked to rate the items on the PANAS and to indicate how often and intensely they worried during each condition (see Appendix H).

During the resting Baseline condition, participants were asked to close their eyes and to relax and focus on their breathing. During the Worry condition, participants were instructed to pick a topic about which they are currently most worried and asked to worry about this topic as intensely as they can and in the way they normally worry about it. This worry induction method and induction time is widely used and accepted within the literature (e.g., Behar, Vescio, & Borkovec, 2005; McLaughlin, Borkovec, & Sibrava, 2007; Ruscio & Borkovec, 2004). During the Control condition, participants were asked to think about something that makes them feel peaceful. Finally, during the Recovery condition participants were asked to close their eyes, relax, and focus on their breathing, just as in the first resting Baseline condition. See Appendix C for the instructions given to participants. The Worry and Control conditions were counterbalanced across participants to control for carryover effects. At the conclusion of the
Recovery condition, electrodes were removed, participants were given a debriefing form (see Appendix D), and compensated for participating in the study.
CHAPTER III. RESULTS

Data Reduction

RSA scores were averaged across each condition of the experiment. Only the last five minutes of the Baseline condition and the first five minutes of the Recovery condition were used in computing RSA scores, so as to match the five-minute periods of the Worry and Control conditions (e.g., Allen et al., 2007). Effect sizes were interpreted for significant results of one-way repeated measures ANOVAs, according to recommendations outlined by Cohen (1988): effect sizes measured using partial eta-squared ($\eta^2$) are small at .01, medium at .09, and large at .25. Finally, if significant trait worry x health behavior x condition (or average RSA across conditions) interactions emerged, regression analyses were conducted to investigate possible moderating relationships and to obtain coefficients for plotting slopes. Indeed, moderation analyses are appropriate when an inconsistent relationship exists between a predictor and an outcome variable (e.g., Baron & Kenny, 1986; Frazier, Tix, & Barron, 2004), as is the case with the trait worry – RSA relationship, discussed in the review above. Moreover, a significant moderation effect can suggest a possible mediation process; as such, mediation analyses were pursued if moderation effects emerged (Baron & Kenny, 1986).

Preliminary Analyses

Demographic. The mean age of the sample was 19.52 ($SD = 1.93$) years old. Other demographic characteristics are presented in Table 1. Analyses were conducted to examine differences between the order of conditions (i.e., Worry first versus Control first), gender (i.e., male versus female), race, marital status, and education level (i.e., year in college) on trait worry (PWSQ) and RSA. Condition order (i.e., Worry first versus Control first) was not related to
Worry and Respiratory Sinus Arrhythmia

PSWQ, \( t (113) = .81, p = .42 \); or RSA, \( F (2.71, 306.08) = 2.40, p = .07 \) (sphericity violations were accounted for by adjusting effects using Greenhouse-Geisser’s correction). Gender was associated with differences in PSWQ, \( t (113) = 2.99, p < .01 \), such that female participants reported higher trait worry, relative to male participants. The means for PSWQ (with standard deviations in parentheses) were 51.31 (13.39) and 43.80 (12.90) for female and male participants, respectively. Gender was not associated with RSA, \( F (2.72, 306.89) = 1.70, p = .17 \) (sphericity violations were accounted for by adjusting effects using Greenhouse-Geisser’s correction). Age was not associated with PSWQ, \( F (8, 114) = .82, p = .59 \); or RSA, \( F (2.73, 308.00) = .51, p = .66 \) (sphericity violations were accounted for by adjusting effects using Greenhouse-Geisser’s correction). Race was not associated with PSWQ, \( F (5, 114) = .34, p = .89 \); or RSA, \( F (2.72, 307.87) = .30, p = .81 \) (sphericity violations were accounted for by adjusting effects using Greenhouse-Geisser’s correction). Marital status was not associated with PSWQ, \( F (2, 114) = 1.80, p = .17 \); or RSA, \( F (2.72, 306.87) = .91, p = .43 \) (sphericity violations were accounted for by adjusting effects using Greenhouse-Geisser’s correction). Finally, education was associated with differences in PSWQ, \( F (2, 114) = 3.70, p = .03 \), such that participants with 3-4 years of college education reported higher trait worry, relative to participants with 1-2 years of college education. The means for PSWQ (with standard deviations in parentheses) were 54.27 (15.46) and 46.37 (12.55) for participants with 3-4 years of college education and participants with 1-2 years of college education, respectively. However, education was not associated with RSA, \( F (2.72, 306.76) = 1.73, p = .17 \) (sphericity violations were accounted for by adjusting effects using Greenhouse-Geisser’s correction).
Table 1

Demographic Characteristics of the Sample

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Note. N = 115.

Health Demographic. Health-related demographic variables, including smoking status, number of doctor visits, medications, and personal and family history of heart conditions or hypertension, were examined for differences on trait worry and RSA. Smoking status was not associated with PSWQ, $t (113) = .02, p = .98$; and number of cigarettes smoked per day was not associated with PSWQ, $r = -.44, p = .09$. However, smoking status predicted a main effect difference in RSA, $F (1, 113) = 6.90, p = .01, \eta^2 = .06$. The means for RSA (with standard
deviations in parentheses) were 6.31 (.20) for smokers (n = 16) and 6.89 (.08) for non-smokers (n = 99). However, number of cigarettes smoked per day was not associated with RSA, *F*(2.72, 307.74) = .18, *p* = .89.

PSWQ was not associated with medical doctor visits for illness, *r* = .04, *p* = .64, or check-ups, *r* = .03, *p* = .72. Likewise, there were no observed differences in RSA for medical doctor visits for illness, *F*(2.72, 307.64) = .53, *p* = .65; or check-ups, *F*(2.73, 308.46) = .39, *p* = .74 (sphericity violations were accounted for by adjusting effects using Greenhouse-Geisser’s correction).

Whether or not participants had a cardiovascular condition was not associated with PSWQ, *t* (113) = .31, *p* = .76; or RSA, *F*(2.72, 307.56) = .33, *p* = .78 (sphericity violations were accounted for by adjusting effects using Greenhouse-Geisser’s correction). Likewise, whether or not participants’ parents had a cardiovascular condition was not associated with PSWQ, *t* (113) = 1.35, *p* = .18; or RSA, *F*(3, 339) = 2.09, *p* = .10.

Whether or not participants were taking medication was associated with differences in PSWQ, *t* (113) = 2.34, *p* = .02, such that participants taking medication reported higher trait worry than participants who were not taking medication. The means for PSWQ (with standard deviations in parentheses) were 51.94 (11.56) and 45.97 (14.43) for participants taking medications (n = 45) and participants who are not (n = 70), respectively. Follow-up analysis was conducted to determine if this difference could be accounted for by type of medication (i.e., psychotropic medication versus “other” medication). However, being on trials of psychotropic medication versus other medications did not result in a difference for trait worry, *t* (43) = .60, *p* = .55. Whether or not participants were taking medications was not associated with RSA, *F*(2.73,
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There were no participants who reported consuming caffeine within the 3 hours prior to their lab appointment. There were two participants who reported smoking within the 3 hours prior to their appointments. Smoking within 3 hours of the appointment was not associated with PSWQ scores, $t(113) = .02, p = .98$. However, a main effect emerged for RSA, $F(1, 113) = 4.87, p = .03, \eta^2 = .04$, such that the two individuals who smoked within the 3 hours prior to their appointments displayed lower RSA. The means for RSA (with standard deviations in parentheses) were 5.55 (.57) and 6.82 (.08) for participants who smoked within the 3 hours prior to their appointment and participants who did not smoke, respectively. When the analysis was rerun using smokers only, the effect disappeared, $F(1, 14) = 1.77, p = .21$. Additionally, when all analyses involving RSA were rerun without these two participants, no differences in significance emerged. As such, it was decided to keep both participants in all analyses without adjustment.

Open-Ended Data

Manipulation Check. Inter-rater consistency for rating worry content of participants’ thoughts was high, $r = .77, p < .001$. The experimenter reviewed and corrected discrepancies. Following the coding of participants’ written thoughts for each condition, a one-way repeated measures ANOVA was used to evaluate the extent to which the Worry condition induced worry-related thoughts relative to the other conditions of the experiment. A significant main effect for worry ratings of thought content during each condition was revealed, $F(3, 342) = 304.97, p < .001, \eta^2 = .73$ (see Figure 1).
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Post hoc analyses, using a Bonferroni correction for multiple comparisons ($\alpha = .008$), were conducted to further examine the significant main effect of condition for worry content. Means for worry content (with standard deviations in parentheses) for the Baseline, Worry, Control, and Recovery conditions were .55 (.67), 2.36 (.66), .20 (.42), and .52 (.68), respectively. Specifically, a series of paired-samples t-tests revealed significant differences between the following conditions: Baseline and Worry, $t(114) = 20.73$, $p < .001$; Baseline and Control, $t(114) = 4.83$, $p < .001$; Worry and Control, $t(114) = 29.27$, $p < .001$; Worry and Recovery, $t(114) = 21.46$, $p < .001$; and Control and Recovery, $t(114) = 4.20$, $p < .001$. These results indicated that participants’ thoughts were rated to be higher in worry content during the Worry condition, relative to the other three conditions. Also, participants’ thoughts during the Control condition included less worry content, relative to Baseline and Recovery conditions.

![Figure 1](image.png)

**Figure 1.** Ratings of worry for participants’ written thoughts during each condition.

*Concreteness of Statements.* Inter-rater consistency for rating concreteness of participants’ thoughts was significant, $r = .38$, $p < .001$. In other words, there was only 14% of the variance shared for ratings between the two raters. Possible reasons for low agreement are
presented in the discussion section. The experimenter reviewed and corrected discrepancies. A one-way repeated measures ANOVA was used to evaluate the extent to which the Worry condition induced thoughts that were less concrete, relative to the other conditions of the experiment. Sphericity violations were accounted for by using Greenhouse-Geisser’s correction. A significant main effect for concreteness ratings of thought content during each condition did not emerge, $F(2.78, 317.23) = 2.00, p = .12$ (see Figure 2). Means for concreteness (with standard deviations in parentheses) for the Baseline, Worry, Control, and Recovery conditions were 3.43 (.75), 3.33 (1.11), 3.55 (.87), and 3.35 (.91), respectively.

![Figure 2](image)

**Figure 2.** Ratings of concreteness for participants’ written thoughts during each condition.

**Worry Statement Categories.** A Kappa statistic, used for analyzing inter-rater consistency of categorical data, was computed for categorization of worry statements. Inter-rater agreement was high, Kappa = .87, $p < .001$. Worry category data are presented in Table 2.
Table 2

Worry Category Frequencies

<table>
<thead>
<tr>
<th>Category</th>
<th>n</th>
<th>Percent</th>
<th>Example of Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relationships</td>
<td>23</td>
<td>20</td>
<td>Worried about losing a good friend</td>
</tr>
<tr>
<td>School</td>
<td>36</td>
<td>31.3</td>
<td>Paper I have due today. My bad GPA and grad school</td>
</tr>
<tr>
<td>Finances</td>
<td>4</td>
<td>3.5</td>
<td>Money problems</td>
</tr>
<tr>
<td>Aimless Future</td>
<td>5</td>
<td>4.3</td>
<td>I was extremely worried about my future.</td>
</tr>
<tr>
<td>Lack of Confidence</td>
<td>5</td>
<td>4.3</td>
<td>Failing, thoughts of being judged.</td>
</tr>
<tr>
<td>Health</td>
<td>6</td>
<td>5.2</td>
<td>Worried about health issues and eating habits.</td>
</tr>
<tr>
<td>Work</td>
<td>1</td>
<td>.9</td>
<td>Not performing well in my job next year.</td>
</tr>
<tr>
<td>Other*</td>
<td>10</td>
<td>8.7</td>
<td>Worried, stressful, negative</td>
</tr>
<tr>
<td>Relationships &amp; School</td>
<td>8</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Relationships &amp; Finances</td>
<td>3</td>
<td>2.6</td>
<td></td>
</tr>
<tr>
<td>School &amp; Finances</td>
<td>8</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>School &amp; Health</td>
<td>1</td>
<td>.9</td>
<td></td>
</tr>
<tr>
<td>Finances &amp; Work</td>
<td>1</td>
<td>.9</td>
<td></td>
</tr>
<tr>
<td>Relationships, School, &amp; Finances</td>
<td>2</td>
<td>1.7</td>
<td></td>
</tr>
<tr>
<td>Relationships, Finances, &amp; Aimless Future</td>
<td>1</td>
<td>.9</td>
<td></td>
</tr>
<tr>
<td>School, Health, &amp; Aimless Future</td>
<td>1</td>
<td>.9</td>
<td></td>
</tr>
</tbody>
</table>

Note. The “Other*” category was created for statements that did not include specific content that
could be categorized.

_Affect_

**Positive and Negative Affect Schedule (PANAS).** A one-way repeated measures ANOVA, using condition as the within-subjects factor, was conducted for each PANAS subscale (i.e., Negative Affect – NA and Positive Affect – PA) to evaluate the extent to which participants experienced negative and positive affect during each condition. Sphericity violations were accounted for by using Greenhouse-Geisser’s correction. A main effect for condition emerged for NA, $F(2.19, 249.44) = 186.57, p < .001, \eta^2 = .62$ (see Figure 3). Post hoc analyses, using a Bonferroni correction for multiple comparisons ($\alpha = .008$), were conducted to further examine the significant main effect of condition for NA. Means for NA (with standard deviations in parentheses) for the Baseline, Worry, Control, and Recovery conditions were 15.14 (5.19), 26.83 (8.97), 12.85 (4.65), and 14.42 (5.70), respectively. Specifically, a series of paired-samples t-tests revealed significant differences between the following conditions: Baseline and Worry, $t(114) = 15.22, p < .001$; Baseline and Control, $t(114) = 5.53, p < .001$; Worry and Control, $t(114) = 18.37, p < .001$; and Worry and Recovery, $t(114) = 15.09, p < .001$. These results indicated that participants reported greater negative affect during the Worry condition, relative to all other conditions. Participants also experienced more negative affect during the Baseline condition, relative to the Control condition.
A main effect for condition also emerged for PA, $F(2.65, 302.40) = 24.16, p < .001, \eta^2 = .18$ (see Figure 4). Post hoc analyses, using a Bonferroni correction for multiple comparisons ($\alpha = .008$), were conducted to further examine the significant main effect of condition for PA.

Means for PA (with standard deviations in parentheses) for the Baseline, Worry, Control, and Recovery conditions were 18.10 (6.68), 18.14 (6.68), 23.08 (9.55), and 17.91 (8.55), respectively. Specifically, a series of paired-samples t-tests revealed significant differences between the following conditions: Baseline and Control, $t (114) = 6.62, p < .001$; Worry and Control, $t (114) = 5.82, p < .001$; and Control and Recovery, $t (114) = 6.39, p < .001$. These results indicated that participants reported greater positive affect during the Control condition, relative to all other conditions.
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Figure 4. PANAS Positive affect during each condition.

Worry Frequency and Intensity

Worry Frequency. A one-way repeated measures ANOVA, using condition as the within-subjects factor, was conducted to evaluate the extent to which the induction of worry elicited changes in worry frequency during each condition. A main effect for condition emerged, $F(3, 342) = 265.98, p < .001, \eta^2 = .70$ (see Figure 5).

Post hoc analyses, using a Bonferroni correction for multiple comparisons ($\alpha = .008$), were conducted to further examine the significant main effect of condition for frequency of worry. Means for worry frequency (with standard deviations in parentheses) for the Baseline, Worry, Control, and Recovery conditions were 2.71 (2.18), 6.63 (1.87), 1.55 (1.86), and 2.30 (2.21), respectively. Specifically, a series of paired-samples t-tests revealed significant differences between the following conditions: Baseline and Worry, $t(114) = 18.33, p < .001$; Baseline and Control, $t(114) = 6.23, p < .001$; Worry and Control, $t(114) = 26.87, p < .001$; Worry and Recovery, $t(114) = 22.69, p < .001$; and Control and Recovery, $t(114) = 3.94, p < .001$. These results indicated that participants worried more frequently during the Worry
condition, relative to all other conditions. Participants also worried more frequently during the Baseline and Recovery conditions, relative to the Control condition.

**Figure 5.** Worry frequency during each condition.

**PSWQ and Worry Frequency.** A 1 (PSWQ) X 4 (condition) one-way repeated measures ANCOVA, using condition as the within-subjects factor and PSWQ as a continuous independent variable (covariate), was conducted to evaluate the extent to which trait worry (PSWQ) interacted with the induction of worry and changes in worry frequency. A significant main effect for trait worry (PSWQ) emerged, \( F (1, 113) = 46.28, p < .001, \eta^2 = .29 \), such that individuals who scored higher on the PSWQ reported worrying more frequently across all conditions. For ease of presentation, a median split was performed on PSWQ (\( Mdn = 49.44 \)). The means for worry frequency (with standard deviation in parentheses) were 2.73 (.19) and 3.87 (.20) for low PSWQ and high PSWQ, respectively (see Figure 6). The interaction between PSWQ and frequency of worry across conditions was not significant, \( F (3, 339) = 1.82, p = .14 \).
Worry Intensity. As with worry frequency, a one-way repeated measures ANOVA was conducted on worry intensity to evaluate the extent to which the induction of worry elicits changes in worry intensity during each condition. Sphericity violations were accounted for by using Greenhouse-Geisser’s correction. A main effect for condition emerged, $F(2.79, 317.85) = 242.57, p < .001, \eta^2 = .68$ (see Figure 7).

Post hoc analyses, using a Bonferroni correction for multiple comparisons ($\alpha = .008$), were conducted to further examine the significant main effect of condition for frequency of worry. Means for worry intensity (with standard deviations in parentheses) for the Baseline, Worry, Control, and Recovery conditions were 1.95 (1.77), 5.84 (1.98), 1.23 (1.79), and 1.83 (1.91), respectively. Specifically, a series of paired-samples t-tests revealed significant differences between the following conditions: Baseline and Worry, $t(114) = 18.61, p < .001$; Baseline and Control, $t(114) = 4.54, p < .001$; Worry and Control, $t(114) = 22.21, p < .001$; Worry and Recovery, $t(114) = 19.48, p < .001$; and Control and Recovery, $t(114) = 3.33, p = .001$. These results indicated that participants worried more intensely during the Worry
condition, relative to all other conditions. Participants also worried more intensely during the Baseline and Recovery conditions, relative to the Control condition.

![Figure 7. Worry intensity during each condition.](image)

**PSWQ and Worry Intensity.** A 1 (PSWQ) X 4 (condition) one-way repeated measures ANCOVA was conducted to evaluate the extent to which trait worry (PSWQ) interacted with the induction of worry and changes in worry intensity. A significant main effect for trait worry (PSWQ) emerged, $F(1, 113) = 65.26$, $p < .001$, $\eta^2 = .37$, such that individuals who scored higher on the PSWQ reported worrying more intensely across all conditions (see Figure 8). For ease of presentation, a median split was performed on PSWQ ($Mdn = 49.44$). The means for worry intensity (with standard deviation in parentheses) were 2.13 (.16) and 3.30 (.17) for low PSWQ and high PSWQ, respectively. The interaction between PSWQ and frequency of worry across conditions was not significant, $F(3, 339) = .72$, $p = .54$. 


 Means and standard deviations for the proposed health behavior variables are presented in Table 3. Also, correlations between trait worry and prediction-related health behaviors are presented in Table 4. Inconsistent with predictions, trait worry was negatively correlated with both measures of physical activity and was not significantly associated with the other protective health behaviors. Health responsibility was positively associated with the HPLP-II measures of physical activity and nutrition. The HPLP-II measure of physical activity was positively associated with the PPAQ measure of physical activity, HPLP-II nutrition, and the fruit and vegetable screener, and negatively associated with fat intake. The PPAQ physical activity measure was positively correlated with the fruit and vegetable screener and HPLP-II nutrition. Finally, HPLP-II nutrition was positively associated with the fruit and vegetable screener and negatively associated with fat intake.
Table 3

 Means and Standard Deviations for Health Variables

<table>
<thead>
<tr>
<th>Health Behavior Measure</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPLP-II Nutrition&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.89</td>
<td>1.38</td>
</tr>
<tr>
<td>HPLP-II Physical Activity&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.29</td>
<td>.69</td>
</tr>
<tr>
<td>HPLP-II Health Responsibility&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.87</td>
<td>.50</td>
</tr>
<tr>
<td>Fruit &amp; Vegetable Screener (FVS)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.89</td>
<td>1.38</td>
</tr>
<tr>
<td>Fat Intake Screener (pFat)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>32.42</td>
<td>4.70</td>
</tr>
<tr>
<td>Paffenbarger Physical Activity Questionnaire (PPAQ)&lt;sup&gt;d&lt;/sup&gt;</td>
<td>3005.03</td>
<td>2696.40</td>
</tr>
<tr>
<td>Body Mass Index (BMI)&lt;sup&gt;e&lt;/sup&gt;</td>
<td>26.23</td>
<td>5.68</td>
</tr>
</tbody>
</table>

Note. a = frequency of engaging in the listed health-promoting behavior, b = estimated daily servings of fruits and vegetables, c = estimated percentage of calories from fat, d = estimated weekly kilocalorie expenditure from physical activity, e = estimated BMI (kg/m<sup>2</sup>).

Table 4

 Intercorrelations Between Trait Worry and Health Behaviors

<table>
<thead>
<tr>
<th>Measure</th>
<th>PSWQ</th>
<th>HPLP-HR</th>
<th>HPLP-PA</th>
<th>PPAQ</th>
<th>HPLP - N</th>
<th>FVS</th>
<th>Pfat</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. PSWQ</td>
<td>-</td>
<td>.17</td>
<td>-.19*</td>
<td>-.39**</td>
<td>-.11</td>
<td>-.01</td>
<td>.08</td>
</tr>
<tr>
<td>2. HPLP - HR</td>
<td>-</td>
<td>.30**</td>
<td>-.12</td>
<td>.20*</td>
<td>.15</td>
<td>-.05</td>
<td></td>
</tr>
<tr>
<td>3. HPLP - PA</td>
<td>-</td>
<td>.53**</td>
<td>.50**</td>
<td>.31**</td>
<td>-.26**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. PPAQ</td>
<td>-</td>
<td></td>
<td>.23*</td>
<td>.28**</td>
<td>.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. HPLP - N</td>
<td>-</td>
<td></td>
<td>.42**</td>
<td>-.33**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. FVS</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td>-.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Pfat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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Note. * p ≤ .05, ** p ≤ .01. PSWQ = Penn State Worry Questionnaire, HPLP – HR = Health-Promoting Lifestyle Profile-II – Health Responsibility subscale, HPLP – PA = Health-Promoting Lifestyle Profile-II – Physical Activity subscale, PPAQ = Paffenbarger Physical Activity Questionnaire, HPLP – N = Health-Promoting Lifestyle Profile-II – Nutrition subscale, FVS = Fruit and Vegetable Screener, Pfat = Percentage Energy from Fast screener.

Worry and RSA

RSA and Worry Induction. A one-way repeated measures ANOVA was conducted to evaluate the extent to which the induction of worry elicited changes in RSA. Sphericity violations were accounted for by using Greenhouse-Geisser’s correction. As predicted, a significant main effect for condition emerged, $F(2.73, 310.77) = 27.39, p < .001, \eta^2 = .19$ (see Figure 9).

Post hoc analyses, using a Bonferroni correction for multiple comparisons ($\alpha = .008$), were conducted to further examine the significant main effect of condition on RSA. Mean RSA levels (with standard deviations in parentheses) for Baseline, Worry, Control, and Recovery were 6.78 (.87), 6.54 (.98), 6.81 (.87), and 6.99 (.83), respectively. A series of paired-samples t-tests revealed significant differences between the following conditions: Baseline and Worry, $t(114) = 6.22, p < .001$; Worry and Control, $t(114) = 5.39, p < .001$; Worry and Recovery, $t(114) = 7.52, p < .001$; and Control and Recovery, $t(114) = 4.01, p < .001$. These post hoc analyses revealed that RSA was significantly lower during the worry condition, relative to all other conditions. RSA was also significantly lower during the control condition, relative to the Recovery condition.
A 1 (PSWQ) X 4 (Condition) repeated measures ANCOVA was conducted to evaluate the extent to which the PSWQ interacted with worry and changes in RSA. Sphericity violations were accounted for by using Greenhouse-Geisser’s correction. A significant interaction did not emerge, $F(2.72, 307.63) = .48, p = .68$. Nor did a main effect for trait worry (PSWQ) emerge, $F(1, 113) = .90, p = .35$. As previously stated, there was a significant gender difference in trait worry. An exploratory 1 (PSWQ) x 2 (Gender) x 4 (Condition) repeated measures ANCOVA was conducted to evaluate the extent to which gender differences in trait worry influenced changes in RSA. Including gender did not result in significant interactions or main effects (all $ps > .05$).

Trait Worry, Health Behavior, BMI, and RSA.

As initially proposed, all analyses presented below were first run with median splits for trait worry, daily stress, and health behaviors. However, there were no significant effects with median split analyses (see table in Appendix N). Because dichotomizing continuous variables (e.g., median splits) has a number of adverse consequences, including loss of information about...
individual differences, and loss of effect size and power (e.g., MacCallum, Ahang, Preacher, & Rucker, 2002), analyses were re-run with trait worry, daily stress, and health behaviors used as continuous variables. Specifically, trait worry and stress or health behaviors were standardized (z-scored) to reduce multicollinearity (Aiken & West, 1991; Cohen, Cohen, West, & Aiken, 2003) and entered as covariates. An interaction term was created for each analysis (e.g., trait worry x physical activity) to examine possible interactions on changes in RSA. If significant interactions were observed, regression analyses were performed to obtain regression coefficients and plot slopes. These analyses are presented in the “Follow-up Regression Analyses” section.

Physical Activity. There were two different measures of physical activity. The first measure was a subscale of the HPLP-II. A 1 (trait worry) X 1 (HPLP-II physical activity) X 4 (Condition) repeated measures ANCOVA was conducted to evaluate the extent to which physical activity interacted with trait worry and changes in RSA. Sphericity violations were accounted for using Greenhouse-Geisser’s correction. Consistent with results presented earlier, a main effect for condition on RSA emerged. There was no main effect observed for PSWQ, $F(1, 111) = .21, p = .65$. However, a main effect for HPLP physical activity was detected, $F(1, 111) = 4.63, p = .03, \eta^2 = .04$, such that participants who reported more physical activity displayed higher levels of RSA across all conditions (see Figure 10). The three-way interaction between PSWQ, HPLP physical activity, and condition was not significant, $F(2.73, 302.77) = .61, p = .59$. Likewise, significant two-way interactions did not emerge for PSWQ and condition, $F(2.73, 302.77) = .43, p = .71$; HPLP physical activity and condition, $F(2.73, 302.77) = .91, p = .43$; or PSWQ and HPLP, $F(1, 111) = .74, p = .39$. 
Figure 10. Main effect for HPLP - Physical Activity on RSA.

The second physical activity measure used was the Paffenbarger Physical Activity Questionnaire (PPAQ). A 1 (trait worry) X 1 (PPAQ) X 4 (Condition) repeated measures ANOVA was conducted to evaluate the extent to which physical activity interacted with trait worry and changes in RSA. Sphericity violations were accounted for using Greenhouse-Geisser’s correction. Consistent with results presented earlier, a main effect for condition on RSA emerged. Similarly, the PSWQ main effect was not significant, $F(1, 111) = .13, p = .72$. Finally, the main effect for PPAQ was not significant, $F(1, 111) = 2.27, p = .14$. The three-way interaction between PSWQ, PPAQ, and condition was not significant, $F(2.72, 301.69) = .31, p = .80$. Likewise, significant two-way interactions did not emerge for PSWQ and condition, $F(2.72, 301.69) = .58, p = .63$ or PPAQ and condition, $F(2.72, 301.69) = .56, p = .64$. However, a two-way interaction between PSWQ and PPAQ was significant, $F(1, 111) = 5.50, p = .02, \eta^2 = .05$.

Follow-up regression analyses are presented below.

Nutrition. There were three separate measures of nutrition. Specifically, nutrition was assessed using the nutrition subscale of the HPLP-II, the fruits and vegetables screener (NCI...
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FvFFQ), and the fat intake screener (NCI Pfat). A 1 (trait worry) X 1 (HPLP-II nutrition) X 4 (Condition) repeated measures ANOVA was conducted to evaluate the extent to which nutrition interacted with trait worry and changes in RSA. Sphericity violations were accounted for using Greenhouse-Geisser’s correction. Consistent with results presented earlier, a main effect for condition on RSA emerged. Similarly, the PSWQ main effect was not significant, $F(1, 111) = 1.47, p = .23$. Finally, the main effect for HPLP nutrition was not significant, $F(1, 111) = 2.87, p = .09$. The three-way interaction between PSWQ, HPLP nutrition, and condition was not significant, $F(2.73, 302.82) = 1.98, p = .12$. Likewise, two-way interactions were not significant for PSWQ and condition, $F(2.73, 302.81) = .87, p = .45$; HPLP nutrition and condition, $F(2.73, 302.81) = 2.06, p = .11$; or PSWQ and HPLP nutrition, $F(1, 111) = 2.87, p = .09$.

The second nutrition measure analyzed was the fruits and vegetables screener (FVS). A 1 (trait worry) X 1 (FVS) X 4 (Condition) repeated measures ANOVA was conducted to evaluate the extent to which fruit and vegetable intake interacted with trait worry and changes in RSA. Sphericity violations were accounted for using Greenhouse-Geisser’s correction. Consistent with results presented earlier, a main effect for condition on RSA emerged. Similarly, the PSWQ main effect was not significant, $F(1, 111) = 1.38, p = .24$. Finally, the main effect for FVS was not significant, $F(1, 111) = .46, p = .50$. The three-way interaction between PSWQ, fruit and vegetable intake, and condition was not significant, $F(2.72, 301.47) = .63, p = .58$. Two-way interactions were not significant for PSWQ and condition, $F(2.72, 301.47) = .52, p = .65$, FVS and condition, $F(2.72, 301.47) = 1.19, p = .31$, or PSWQ and FVS, $F(1, 111) = 2.23, p = .14$.

The final nutrition measure analyzed was fat intake (estimated percentage calories from fat - Pfat). A 1 (trait worry) X 1 (Pfat) X 4 (Condition) repeated measures ANOVA was
conducted to evaluate the extent to which fat intake interacted with trait worry and changes in RSA. Sphericity violations were accounted for using Greenhouse-Geisser’s correction.

Consistent with results presented earlier, a main effect for condition on RSA emerged. Similarly, the PSWQ main effect was not significant, $F(1, 111) = .87, p = .35$. Finally, the main effect for Pfat was not significant, $F(1, 111) = .03, p = .86$. The three-way interaction between PSWQ, fat intake, and condition was not significant, $F(2.72, 301.34) = .46, p = .69$. Likewise, two-way interactions were not significant for PSWQ and condition, $F(2.72, 301.34) = .54, p = .64$; Pfat and condition, $F(2.72, 301.34) = .45, p = .72$; or PSWQ and Pfat, $F(1, 111) = .03, p = .86$.

**Health Responsibility.** Health responsibility was measured with a subscale of the HPLP-II. A 1 (trait worry) X 1 (HPLP-II health responsibility) X 4 (Condition) repeated measures ANOVA was conducted to evaluate the extent to which health responsible behaviors interacted with trait worry and changes in RSA. Sphericity violations were accounted for using Greenhouse-Geisser’s correction. Consistent with results presented earlier, a main effect for condition on RSA emerged. Similarly, the PSWQ main effect was not significant, $F(1, 111) = .82, p = .37$. Finally, the main effect for HPLP health responsibility was not significant, $F(1, 111) = .02, p = .90$. The three-way interaction between PSWQ, HPLP health responsibility, and condition was not significant, $F(2.73, 303.28) = .31, p = .80$. Likewise, the two-way interactions were not significant for PSWQ and condition, $F(2.73, 303.28) = .34, p = .78$; HPLP health responsibility and condition, $F(2.73, 303.28) = .23, p = .23$; or PSWQ and HPLP health responsibility, $F(1, 111) = .01, p = .92$.

**Body Mass Index (BMI).** A 1 (trait worry) X 1 (BMI) X 4 (Condition) repeated measures ANOVA was conducted to evaluate the extent to which BMI interacts with trait worry and
changes in RSA. Sphericity violations were accounted for using Greenhouse-Geisser’s correction. Consistent with results presented earlier, a main effect for condition on RSA emerged. Similarly, the PSWQ main effect was not significant, $F(1, 111) = 1.29, p = .26$. Finally, the main effect for BMI was not significant, $F(1, 111) = .34, p = .56$. The three-way interaction between PSWQ, BMI, and condition was not significant, $F(2.73, 302.99) = .25, p = .85$. Likewise, two-way interactions were not significant for PSWQ and condition, $F(2.73, 302.99) = .67, p = .56$; BMI and condition, $F(2.73, 302.99) = 1.41, p = .24$; or PSWQ and BMI, $F(1, 111) = 1.87, p = .17$.

**Exploratory Analyses**

*Stress (Daily Stress Inventory –DSI).* A 1 (trait worry) X 1 (DSI) X 4 (Condition) repeated measures ANOVA was conducted to evaluate the extent to which daily stress interacts with trait worry and changes in RSA. Sphericity violations were accounted for using Greenhouse-Geisser’s correction. Consistent with results presented earlier, a main effect for condition on RSA emerged. Similarly, the PSWQ main effect was not significant, $F(1, 111) = .51, p = .48$. Finally, the main effect for the DSI was not significant, $F(1, 111) = .00, p = .97$. The three-way interaction between PSWQ, DSI, and condition was not significant, $F(2.74, 303.97) = .183, p = .15$. Likewise, two-way interactions were not significant for PSWQ and condition, $F(2.74, 303.97) = .19, p = .89$; DSI and condition, $F(2.74, 303.97) = .36, p = .77$; or PSWQ and DSI, $F(1, 111) = .00, p = .99$.

*HPLP-II.* Exploratory analyses were performed with the three remaining subscales of the HPLP-II: stress management, spiritual growth, and interpersonal relationships, as well as the total score for the HPLP-II measure. 1 (trait worry) X 1 (HPLP-II subscales and total score) X 4
(Condition) repeated measures ANOVAs were conducted to evaluate the extent to which each subscale and the total health promotion activity score interact with trait worry and changes in RSA. Sphericity violations were accounted for using Greenhouse-Geisser’s correction for all measures. There were no significant interactions or main effects that emerged. Statistics are presented in Appendix O.

Follow-up Regression Analyses

*Physical Activity.* Regression analyses were conducted to further examine the interaction between trait worry, physical activity, and average RSA. Specifically, a multiple regression analysis was performed to confirm that physical activity was moderating the relationship between worry and RSA. PSWQ and PPAQ were entered in step 1 and the PSWQ x PPAQ interaction term was entered in step 2. Consistent with the ANCOVA results presented earlier, a significant interaction between PSWQ and PPAQ was observed, $B = .20$, $t (111) = 2.35$, $p = .02$. The PSWQ x PPAQ interaction term accounted 5% of the variance in RSA across conditions over and above the variance explained by PSWQ and PPAQ alone. Figure 11 illustrates the interaction. The group with the highest level of RSA was the high trait worriers who reported higher physical activity ($Y = 7.2$), compared to the high trait worriers who reported lower physical activity ($Y = 6.5$). Low trait worriers who reported higher ($Y = 6.86$) and lower ($Y = 6.96$) physical activity displayed similar levels of RSA. In examining the slopes, it is apparent that levels of RSA for high trait worriers change as a function of physical activity, such that high trait worriers who reported more physical activity displayed higher levels of RSA compared to high trait worriers who reported lower physical activity.

To test the interaction prediction that physical activity would have a greater influence on
the worry – RSA relationship for high trait worriers, compared to low trait worriers, analyses were conducted to determine the difference in RSA for high trait worriers and low trait worriers who reported higher or lower levels of physical activity. Consistent with the prediction, a significant result emerged for the high trait worry slope, $t(111) = 2.13, p = .04$; but not for the low trait worry slope, $t(111) = .60, p = .55$. These results confirm that physical activity has a stronger association with RSA for high trait worriers, relative to low trait worriers. Specifically, the trait worry – RSA relationship changed as a function (i.e., moderated by) of physical activity.

Figure 11. Regression analysis of PSWQ x Physical Activity (PPAQ) on RSA.

Moderation relationships can suggest a possible mediating process (Baron & Kenny, 1986). The first two steps of the mediation analysis were not significant; as such, a full mediation analysis was not performed (Baron & Kenny, 1986). Specifically, trait worry (PSWQ) did not significantly predict changes in average RSA across conditions, $B = -.01, t(113) = .95, p = .35$. Also, PSWQ did not explain a significant proportion of variance in RSA, $R^2 = .01$. Moreover, physical activity (PPAQ) did not significantly predict changes in average RSA across conditions, $B = .00, t(113) = .55, p = .58$. Also, PPAQ did not explain a significant
proportion of variance in RSA, \( R^2 = .00 \).

**Summary of Significant Results**

**Demographic and Health Demographic.** In terms of demographic and medical demographic variables, gender differences in trait worry emerged, such that female participants reported higher trait worry, relative to male participants. Exploratory analyses that included gender, trait worry (PSWQ), and RSA, did not result in any significant findings. Year in college was also associated with differences in trait worry, such that participants with 3-4 years of college education reported higher trait worry, relative to participants with 1-2 years of college education.

In terms of health demographic variables, smoking status was associated with differences in RSA, such that smokers (\( n = 16 \)) displayed lower levels of RSA, relative to non-smokers (\( n = 99 \)). Also, whether or not participants were taking medication was associated with differences in trait worry, such that participants taking medication reported higher trait worry than participants who were not taking medication.

**Open-Ended Data.** A significant main effect for worry ratings of thought content during each condition was revealed. Specifically, participants’ thoughts were rated as higher in worry content during the Worry condition, relative to the other three conditions. Also, participants’ thoughts during the Control condition included less worry content, relative to Baseline and Recovery conditions.

Inter-rater consistency for rating concreteness of participants’ thoughts was significant but there was only 14% shared variance in ratings. A one-way repeated measures ANOVA was used to evaluate the extent to which the Worry condition induced thoughts that were less
concrete, relative to the other conditions of the experiment. A significant main effect for concreteness ratings of thought content during each condition did not emerge. Possible explanations for the low level of agreement in ratings of concreteness are discussed below.

**PANAS (Negative Affect), Worry Frequency, and Worry Intensity.** A main effect for condition emerged for NA. Participants reported greater negative affect during the Worry condition, relative to all other conditions. Participants also experienced more negative affect during the Baseline condition, relative to the Control condition.

A main effect of worry frequency for condition emerged. Specifically, participants worried more frequently during the Worry condition, relative to all other conditions. Participants also worried more frequently during the Baseline and Recovery conditions, relative to the Control condition. Also, a significant main effect for trait worry (PSWQ) emerged, such that individuals who scored higher on the PSWQ reported worrying more frequently across all conditions.

A main effect of worry intensity for condition emerged. Specifically, participants worried more intensely during the Worry condition, relative to all other conditions. Participants also worried more intensely during the Baseline and Recovery conditions, relative to the Control condition. Also, a significant main effect for trait worry (PSWQ) emerged, such that individuals who scored higher on the PSWQ reported worrying more intensely across all conditions.

**RSA and Physical Activity.** As predicted, a significant main effect of RSA for condition emerged. Specifically, RSA was significantly lower during the Worry condition, relative to all other conditions. RSA was also significantly lower during the Control condition, relative to the Recovery condition.
An interaction between trait worry, PPAQ, and condition did not emerge. However, a two-way interaction between PSWQ and PPAQ was significant. Consistent with predictions, higher levels of physical activity had a greater association with RSA for high trait worriers, compared to low trait worriers. Finally, also consistent with predictions, a main effect for HPLP physical activity emerged, such that participants who reported engaging in more physical activity displayed higher levels of RSA across all conditions, relative to participants who reported lower levels of physical activity.
CHAPTER IV. DISCUSSION

The purpose of this study was to examine the effects of trait and induced worry on RSA (cardiac vagal activity) and possible moderating physical health-related mechanisms. Results confirmed the hypothesis that a worry induction would lead to lower levels of RSA, and therefore, lower vagal activity, relative to all other conditions. This finding is consistent with previous findings regarding the influence of induced worry on RSA (e.g., Borkovec et al., 1998; Hofmann et al., 2005).

In terms of the hypotheses involving health behaviors, there was a significant interaction between trait worry and physical activity. The results supported the hypothesis that high trait worriers who engaged in higher levels of physical activity would display higher levels of RSA, relative to all other groups. High trait worriers who reported higher levels of physical activity displayed similar levels of RSA of low trait worriers who reported low and high levels of physical activity. The association that physical activity had with RSA was significant for high trait worriers but not low trait worriers. That is, physical activity moderated the relationship between trait worry and RSA.

Open-Ended Data

Manipulation Check. One of the unique measures of this study that is lacking in the current literature linking worry to RSA in a lab setting is the inclusion of an open-ended manipulation check. While other studies have assessed worry content using multiple-choice responses (e.g., Ruscio & Borkovec, 2004), specific data as to whether negative thought content was worry-related is generally absent without open-ended data. Goetz & O’Brien (2009) used this same manipulation check and obtained similar results. Specifically, in the present study, participants wrote their thoughts after each condition. These data were coded for the level of
worry content. Indeed, participants’ thoughts included more worry content during the Worry condition relative to all other conditions. Furthermore, participants’ thoughts during the Control, “peaceful” condition included less worry content relative to Baseline and Recovery.

**Concreteness of Statements.** Although the internal consistency correlation was significant for ratings of concreteness for written statements, actual level of agreement was quite low. Rating criteria were based on Stöber and Borkovec’s (2002) method, which involved having participants choose two worry topics, provide written descriptions of the worry topics, and then provide three potential negative consequences for each of the two problems. Therefore, Stöber and Borkovec had more qualitative data available to assess for each participant. The written statements for the present study (in all conditions) varied in length from a few words to a couple of brief sentences. It is likely that it was more difficult to provide quantitative ratings to brief (i.e., a few words) written responses.

**Worry Statement Categories.** The majority (58.3%) of participants experienced worries related to school or relationships, or both. This is consistent with other studies that assess worry domains (Borkovec, Robinson, Pruzinsky, & DePree, 1983; Lindesay et al., 2006). For example, Lindesay et al. (2006) found that individuals ages 16-24, compared to older individuals, worried most about relationships/family and work (which included being a student). Borkovec et al. (1983) also performed a worry content rating analysis with college students and found the two most frequently worried about topics were relationships and academics.

**Self-report Measures**

**PANAS.** Participants reported experiencing more negative affect during the Worry condition compared to all other conditions. This finding is consistent with other research assessing negative emotion during worry inductions (e.g., Goetz & O’Brien, 2009). Participants
also experienced more negative affect during the Baseline compared to the Control condition. This may have been due to participants’ initial uncertainty and anxiety about what the remaining tasks would involve. Consistent with the finding that participants reported thought content with less worry during the Control condition, participants also reported experiencing more positive affect during the Control condition compared to all other conditions. This finding suggests that the Control condition was successful in inducing a “relaxed” state, relative to the other conditions.

**Trait Worry Measure.** The PSWQ mean for this study was similar to other studies using non-clinical samples (e.g., Kelly, 2004; Meyer et al., 1990). Higher trait worry means for females has been found in several other studies (e.g., Kelly, 2004; Robichaud, Dugas, & Conway, 2003). There is some evidence to suggest that it is more difficult for females to “turn off” the worry process (Borkovec et al., 1983). This idea is consistent with findings from Robichaud et al. (2003). The authors predicted that female worriers may be different on two cognitive factors that may influence the severity of worry: thought suppression and negative problem orientation. Robichaud et al. reviewed literature that suggested attempts to suppress thought actually maintains perseveration on the thought and results in reemergence of the thought immediately following attempts to suppress it (e.g., Lavy & van den Hout, 1990; Wegner & Zanakos, 1994). Females also tend to have a more negative problem orientation compared to males (D’Zurilla, Maydeu-Olivares, & Kant, 1998). The authors suggested that women may be less confident that a solution exists to the perceived threat. Indeed, Robichaud et al. (2003) found that women reported higher trait worry, more thought suppression, and higher negative problem orientation (i.e., less confidence in potential solutions to the threat). As such,
the authors suggested that gender differences for other cognitive variables, such as thought suppression and problem-solving appraisal, may account for gender differences in trait worry.

There were also differences in trait worry depending on year in college. Specifically, participants in their third or fourth year of college reported a greater tendency to worry, compared to participants in their first or second years of college. Similar data could not be found in other studies assessing trait worry. One explanation may be that participants who are in their third and fourth years of college also have more responsibilities (e.g., jobs, choosing a major, more difficult classes), and, therefore, may experience more worry, than participants in their first or second year of college.

Finally, participants who were taking medication reported a greater tendency to worry, compared to participants who were not taking medication. It is conceivable that this difference may be accounted for by type of medication. Specifically, it is reasonable to suggest that individuals on trials of psychotropic medication may report higher trait worry; however, this was not the case. Another possible explanation for this difference is related to Leventhal et al.’s (2003) Common-Sense Model of Health and Illness Self-Regulation. As reviewed earlier, a perceived threat to health leads to a need to cope with the negative state (e.g., worry) associated with the health threat, as well as the health threat itself. As such, it may be that when high trait worriers perceive a health threat, they may be more likely to seek medication as a solution to mitigate worry and the threat itself.

*Worry Frequency and Intensity.* Overall, participants reported worrying more frequently and more intensely during the Worry condition, relative to all other conditions. Moreover, participants reported worrying less frequently and less intensely during the Control condition relative to Baseline and Recovery. These findings are consistent with previous research
measuring frequency of worrisome thoughts between worry and imagery conditions (Lyonfields et al., 1995). Results also showed that individuals who scored higher in trait worry (PSWQ) worried more frequently and more intensely across all conditions. The findings of worry frequency and intensity are consistent with those found by Goetz and O’Brien (2009).

Overall, the results from the self-report data from this study suggest that the worry manipulation was successful in inducing worry. Specifically, participants experienced cognitions associated with worry during the Worry condition. Participants also experienced worry more intensely and more frequently during the worry condition. Moreover, participants who scored high in trait worry, worried more frequently and intensely across conditions. Finally, participants experienced affect that was more negative during the worry induction, relative to the other conditions.

**Correlations Between Trait Worry and Proposed Health Behaviors**

Inconsistent with predictions, trait worry was negatively related to physical activity but no other health behavior measures. As such, discussion will focus on the relationship between trait worry and physical activity. Contrary to research reviewed in the introduction (e.g., Mosher et al., 2008), the present study found a negative relationship between trait worry and both measures of physical activity. A possible explanation may be related to avoidance. Specifically, the worry process involves covert avoidance of more emotionally-laden stimuli (Borkovec et al., 2004). It is possible that some high trait worriers may translate this cognitive avoidance to overt, behavioral avoidance. For example, it may be that some individuals high in trait worry are more avoidant of other activities, due to the preoccupation with worry content. That is, resources (time and energy) may be prioritized to “dealing” with the worry, rather than other life activities. While worry is not necessarily associated with avoidance of specific stimuli (e.g., large crowds),
as is the case for phobias, the GAD literature suggests that it is associated with general behavioral avoidance (e.g., Butler, Cullington, Hibbert, Klimes, & Gelder, 1987). Another possible interpretation is that individuals who engage in higher levels of physical activity are engaging in less worry. Indeed, exercise has been associated with a decrease in anxiety sensitivity (Broman-Fulks & Storey, 2008; Ströhle, 2009). As discussed in more detail below, there is evidence to suggest that there may be changes in cortical structures involved in worry, with an increase vagal activity via afferent visceral signals from the heart (e.g., Critchley, 2005; Porges, 2007).

*Respiratory Sinus Arrhythmia (RSA)*

**RSA and Smoking.** Preliminary analyses revealed a significant difference in RSA between smokers and non-smokers, such that smokers displayed lower levels of RSA. This finding is consistent with several studies examining the short-term (e.g., Nabors-Oberg et al., 2002) and chronic effects (e.g., Hayano et al., 1990) on RSA. The results from the present study further support the assertion that chronic smoking behavior and associated lower RSA may lead to cardiovascular problems (e.g., Nabors-Oberg et al., 2002).

**RSA and Worry.** As stated above, our prediction that a worry induction would lead to lower RSA, relative to the other conditions, was confirmed. A main effect for condition was found and post hoc analyses confirmed that participants displayed significantly lower RSA (vagal activity) during the Worry condition, relative to all other conditions. These results are consistent with previous findings showing that the induction of perseverative cognitive states, such as worry, lead to lower levels of RSA (e.g., Hofmann et al., 2005; Lyonfields et al., 1995). Taken together with the self-report data above, these findings show that phasic worry leads to a decrease in cardiac vagal activity.
The prediction that individuals higher in trait worry would display an overall lower level of RSA was not confirmed. This finding is inconsistent with other research linking perseverative thinking, including worry, to low vagal activity (e.g., Brosschot et al., 2006; Thayer & Lane, 2002; Thayer & Lane, 2009). Also, an interaction for RSA between trait worry and the worry induction was not found. Overall, the main effect for condition for RSA adds a more objective confirmation that worry was taking place. That is, the predicted physiological response of a reduction in RSA was associated with worrisome thinking.

Respiratory Sinus Arrhythmia, Worry, and Health Behavior

Health Responsibility. Contrary to predictions, health responsible behaviors did not interact with the trait worry - RSA relationship. Moreover, there were no main effects that emerged. The measure assessed behaviors such as “Question health professionals in order to understand their instructions.” It may be that a measure of health responsible behaviors is too “indirect” of an index of overt health behaviors, such as exercise. That is, while individuals may clarify instructions from a health professional, clarification may not lead to implementing the instructions.

Nutrition. Contrary to predictions, three separate measures of nutrition (i.e., general nutrition – HPLP-II, fruit and vegetable intake, and fat intake) did not interact with the trait worry – RSA relationship. Moreover, there were no main effects that emerged. The literature linking nutrition and RSA is quite limited at this time. Although there were several nutrition measures used in the present study, it may be that they were not specific enough to types of foods to result in significant results. For example, Park et al. (2009) found that participants who consumed more green leafy vegetables (not vegetables in general) displayed higher RSA. The authors did not find any differences in RSA for fruit intake.
Body Mass Index (BMI). Contrary to predictions, BMI did not interact with the trait worry – RSA relationship. Moreover, no main effects that emerged. BMI has been associated with differences in RSA (e.g., Karason et al., 1999). However, studies that have found BMI effects on RSA used a dichotomized BMI variable to test differences in RSA (e.g., Karason et al., 1999; Rabbia et al., 2003; Riva et al., 2001). As discussed in the results section above, dichotomizing continuous variables can result in inaccurate findings (e.g, MacCallum et al., 2002). Additionally, it has been argued that BMI alone may not be a valid measure of cardiovascular health (e.g., Blair & Brodney, 1999; Fogelhom, 2010). For example, Fogelholm (2010) conducted an extensive review of 36 studies and examined the relative health risks of poor cardio-respiratory fitness or physical inactivity in normal-weight people compared to obesity in individuals with good cardio-respiratory fitness or high physical activity. Results of the review revealed that individuals with higher BMI and high fitness were at lower risk for cardiovascular mortality, compared to individuals with a “normal” BMI and low fitness.

Physical Activity. Two measures were used to assess physical activity. Consistent with predictions, analyses with the measure that assessed only frequency of certain physical activities (HPLP-II physical activity) revealed that more frequent physical activity was associated with higher levels of RSA, which is consistent with other studies (e.g., Billman, 2009; Carter et al., 2003; Rossy & Thayer, 1998). Analyses involving a measure of a more comprehensive assessment of physical activity based on kilocalorie expenditure (PPAQ) partially supported our prediction that physical activity would interact with the trait worry – RSA relationship.

Specifically, results from the present study demonstrated an interaction between trait worry and physical activity for RSA, such that physical activity moderated the worry - RSA relationship. These findings suggest that engaging in more physical activity is related to an
elevation in RSA for high trait worriers to the extent that they display similar levels of RSA as low trait worriers. In other words, it appears that physical activity may buffer the effects of worry more strongly for persons who engage in this cognitive activity more frequently and intensely.

A possible reason why physical activity is differentially associated with RSA among high trait worriers, relative to low trait worriers, is that high trait worriers who do engage in higher levels of physical activity are engaging in exercise more intensely (i.e., working harder) when they do exercise, are more aerobically fit and, therefore, demonstrating a greater increase in RSA. It is conceivable that greater intensity during exercise would be more negatively reinforcing for high trait worriers, as aerobic exercise has been shown to lead to a decrease in “anxiety sensitivity” symptoms, including cognitive symptoms (e.g., fear of publicly observable anxiety reactions, fear of cardiovascular symptoms, fear of cognitive dyscontrol - Broman-Fulks & Storey, 2008).

As discussed earlier, Goetz & O’Brien (2009) found that high trait worriers displayed higher RSA across baseline, worry, control, and recovery conditions. That finding led to the present study and the exploration of health behaviors that may shed light on the inconsistent relationship between trait worry and RSA (e.g., Davis et al, 2002; Goetz & O’Brien, 2009). Recognizing that there were different populations that were sampled for Goetz & O’Brien (2009) and the present study, it is conceivable that results from the present study lend insight into the unexpected finding in Goetz & O’Brien (2009). Specifically, it may be that the high trait worriers were engaging in more physical activity, and therefore displayed higher levels of RSA.

**Limitations**
As discussed above, there were a number of interesting findings that emerged from this study with respect to the induction of worry, the interaction with physical activity, and the influence worry has on cardiac vagal activity. However, a number of limitations will be discussed. First, the research sample consisted of undergraduate students, which limits the generalizability to adults in the general community. Second, a measure of aerobic fitness would have been beneficial to rule out fitness differences between trait worry groups, as greater fitness is correlated with higher vagal activity (Goldsmith et al., 1997). Moreover, there are apparent differences in cardiovascular health outcomes when examining aerobic fitness versus physical activity (e.g., Fogelholm, 2010). Finally, a measure of imagery versus thought content would have been an additional useful validity check regarding the cognitive activity occurring during each condition. As indicated in the introduction, worry is associated with verbal cognitive activity rather than imagery (e.g., Borkovec et al., 2004).

Implications and Conclusions

Cardiovascular Implications. The worry induction – RSA findings of the present study are in line with other empirical research showing that state worry leads to a reduction in RSA (e.g., Hofmann et al., 2005; Lyonfields et al., 1995; Thayer et al., 1996). Specifically, we found a strong effect for a worry induction on RSA, which has implications for cardiovascular health. The most consistent mechanism by which vagal activity is associated with CVD is inflammation (Haensel et al., 2008; Masi et al, 2007; Thayer & Lane, 2007). As previously reviewed, the worry process is associated with a decrease in activity in cortical (PFC) structures, thereby disinhibiting amygdala, and therefore, inhibiting vagal activity and acetylcholine production (e.g., Thayer, 2009; Thayer & Lane, 2009). The lack of acetylcholine leads to production of pro-
inflammatory cytokines and subsequent inflammation of the myocardium and atherosclerosis (e.g., Libby, 2002; Thayer & Lane, 2007).

Although most of the research that has examined the relationship between trait worry and RSA has found an inverse relationship (e.g., Lyonfields et al., 1995; Thayer et al., 1996), it is clear that this is not always the case (e.g., Davis et al., 2002; Goetz & O’Brien, 2009) and other variables may influence this relationship, as was the case for the present study. Therefore, perhaps the more interesting, and novel finding, was the association physical activity had with the trait worry – RSA relationship. Specifically, consistent with predictions, there was a significant difference in RSA between high trait worriers who reported lower physical activity, compared to high trait worriers who reported higher physical activity. A significant difference did not emerge for low trait worriers. As such, these findings support the idea that physical activity moderated the trait worry – RSA relationship. Also consistent with predictions, in a separate measure of physical activity, more physical activity was associated with higher levels of RSA. Together, these findings support the notion that physical activity is protective to cardiovascular health, and may be especially beneficial for high trait worriers.

Worry Implications: Consideration of the Afferent Pathway. In addition to the health-protective benefits physical activity has on RSA, especially for high trait worriers; theoretically, there are also potential cognitive benefits. Indeed, a plethora of research exists that has demonstrated the mood enhancing and anxiolytic effects of physical activity, especially aerobic exercise (for a review, see Ströhle, 2009). However, these studies have primarily focused on depression and less on anxiety; and while a number of neurobiological mechanisms have been examined (e.g., increased norepinephrine, increased β-endorphins – for a review, see Ströhle, 2009), discussion of RSA and vagal activity could not be found.
As previously reviewed, there are reciprocal connections between cortical structures involved in worry (e.g., PFC and ACC) and subcortical structures involved in vagal activity (amygdala and nucleus ambiguus). Therefore, these subcortical structures can influence cognitive processes, including worry (e.g., Critchley, 2005; Porges, 2007). There is evidence that afferent signals in the cardiac vagal pathway travel to the nucleus of the solitary tract (NTS), which transmits visceral signals to the amygdala, which, in turn, can transmit signals to the aforementioned structures associated with worry. As such, in addition to the other mentioned biological mechanisms involved in exercise mitigating anxiety symptoms, it is possible that physical activity may change cognitive patterns associated with anxiety (i.e., worry) via changes in vagal activity.

Conclusions. The present study examined the influence of a number of health variables the trait worry – RSA relationship. The results suggest that physical activity is an important variable when examining differences in RSA at different levels of trait worry. Specifically, the potential effect of physical activity for RSA was more apparent for high trait worriers. As discussed above, these moderating effects have physical, as well as mental, health implications. Overall, it is apparent that trait worry, alone, may not be a good predictor of differences in RSA, and that including other health-related factors is essential to fully understand the relationship between trait worry and RSA, as well as cardiovascular health.

In addition to replicating the above findings in a community sample, a future direction that may warrant further exploration is examining the afferent vagal pathway as a mechanism between physical activity (exercise) and change in worry. Including an exercise manipulation among high trait worriers, obtaining ambulatory measures of RSA, and assessing changes in
worry frequency, intensity, and duration, may provide additional, important data in terms of an additional mechanism, as well as potential dose-specific interventions for high trait worriers.
REFERENCES


Worry and Respiratory Sinus Arrhythmia


Worry and Respiratory Sinus Arrhythmia


Worry and Respiratory Sinus Arrhythmia


APPENDIX A

“Cognition, Heart Rate Variability, and Health” Informed Consent Form

This research study is designed to increase knowledge of how different thoughts and health factors affect the functioning of the heart and cardiovascular health. The researcher responsible for this project is Paul Goetz, M.S. and will be supervised by William H. O’Brien, Ph.D., who is a clinical psychologist and faculty member in the Psychology Department at Bowling Green State University. Other graduate students in the clinical psychology training program at BGSU will assist with the study as well. All assistants will be supervised by Paul Goetz and Dr. O’Brien.

As a participant in this treatment study, you will be asked to (a) complete several questionnaires that measure anxiety, physical symptoms, and a number of health behaviors including physical activity, and eating habits, which will take approximately thirty minutes to complete. Your height and weight will also be recorded as a measure of body composition, and (b) think about stress related and non-stress related thoughts while having your heart rate measured. The entire procedure will take about one hour. The entire experiment will take place in the psychophysiology lab at Bowling Green State University.

The primary benefit of this study is that it will advance understanding of how different thoughts (stress related and non-stress related) and other health factors (such as eating habits and physical activity) affect heart rate and cardiovascular health. Additionally, you will be given the choice of being compensated with extra credit or $15 for your participation.

There are no known risks associated with participation in this study.

All information collected in this study is confidential. However, there are certain situations when confidentiality may need to be broken. Such situations include threats to harm someone else or yourself, circumstances involving child or elder abuse, or legal circumstances where a group member uses psychological information in a defense or prosecution of a crime.

In order to protect your confidentiality, all information collected in this study will contain a unique identification number and any information linking your name to this identification number will only be accessible by the primary investigators of this study. All identifying information will be destroyed after the completion of this study. During the study, all records will be strictly safeguarded and kept in a locked office accessible only to the investigators of this study.

Should the results of the study be published in scientific journals, your anonymity will be assured. By participating in this study, you agree to permit Bowling Green State University to compile and publish data at conclusion of the study.

Participation in this study is voluntary and you are free to withdraw from the study at any time without explanation or penalty. Additionally, you have the right to refuse to take part in any activity in which you feel uncomfortable.
If any questions or concerns arise during the course of this study, you may contact William H. O'Brien, Ph.D. at 419-372-2974 (wobrien@bgsu.edu), Paul Goetz, M.S. at 701-367-9846 (pgoetz@bgsu.edu), or the Chair of the Human Subjects Review Board at Bowling Green State University at 419-372-7716 (hsrb@bgsu.edu).

By signing this form you are indicating that you have read this document, had all of your questions answered, and agree to participate in this study.

Participant Signature


Date


Researcher Signature


Date
APPENDIX B

Experimenter Instructions

Before the participant comes in, make sure that all of the equipment is turned on (the computer, the camera and monitor, both amplifiers for the sound equipment, and the BioPac system). Check the participant number sheet to see which program to run (the worry first condition or the control first condition)

Sit the participant down at the computer in the lab.

Thanks for coming in. My name is _______ and I’m a student in psychology. I’ll start off by giving you an informed consent form to read and sign, and then from there I’ll describe a little bit about what we’ll be doing today. So first I’ll give you the consent form and please read it carefully (Give them the informed consent form.) If you’re comfortable with everything, go ahead and sign it, and if you have any questions, please let me know.

After they have finished reading the consent form and signed it, place our copy in the folder on the desk and make sure to give them their copy.

We will be asking you to do a couple of different things today. First I will have you complete some questionnaires on the computer, which should take about 30 minutes. After that, I will be taking a measure of your heart rate while I ask you to think about a couple of different things. Any questions?

Get the questionnaire ready in Perseus and say:

Now I will ask you to complete a few questionnaires on the computer. I will be in the room next door so just come and let me know when you are finished and we will move on to the next task.

Make sure the program is ready to run on the computer and the participant’s number is entered. After they have finished the questionnaire:

Next I will ask for you to take your shoes off and step on the scale so I can record your weight (write down their weight in pounds on the BMI data sheet). Now step over here and I am going to get your height (be sure they are standing up straight with their back and head against the wall and write down their height in feet and inches on the BMI data sheet). Okay, you can put your shoes back on.

Next I will be taking a measure of your heart rate. Because we need to attach a couple of sensors to you ankles, I will need for you to take your socks off.

Now I will have you come over to this chair (have them sit in the chair but don’t have them recline – they should be sitting up-right). I will be connecting two sensors to your ankles and one to your right wrist. Also, I will be placing two strips of paper medical tape over
the top of the sensor on your wrist to hold it in place. This part of the session will take about 30 minutes. Also, just so you know, none of this equipment is harmful to you. Any questions?

Instructions will be given to you through this speaker and I will also be able to hear you through this microphone in case you have any questions. I will also be able to see what is happening through this camera. We will not be taping anything; it’s just so I can see that the sensors are hooked up ok.

You will be receiving instructions through the speaker asking you to think about several different things. Also, at 4 time periods you will be asked to write down what it was you were thinking about. Your name will not be attached to what you write so please be honest. There are lines here for each time you will be asked to write something. Any questions?

Ok, now I will attach the sensors.

**Attach the self-adhesive electrodes to the leads.** Attach the leads according the illustration below. Place the negative electrode on the right wrist (Place two strips of paper top over the top of the White lead and electrode to hold it in place), place the positive electrode on the inside of the left ankle, and place the ground electrode on the inside of the right ankle. Attach the leads according to these conditions:
Now, please sit back in the chair and get as comfortable as you can. I will go into the next room now to start the program. Any questions? Ok, remember to sit comfortably and keep as still as you can.

Go into the computer room and make sure you are getting a strong EKG reading. If so, start the BioPac program. Start the audio recording for Baseline Instructions. After the instructions say “Start Now” following instructions for the Baseline condition, PRESS THE SPACEBAR to insert an event marker. When the instructions come on at the end of the 10-minutes Baseline period, PRESS THE SPACEBAR to insert an event marker.

When the participant says “Finished” (and you see that they have completed the questionnaire, start the audio recording for the next condition (Control or Worry) based on the random assignment. Follow the instructions as indicated above for each condition.

After the program is finished, go into the room and unhook the sensors.

We are all finished here. Here is a letter telling you a little more about this part of the study and about what we hope to learn from what we did today. Do you have any questions?

Would you like extra credit or $15 for compensation?

- Record on the participant sheet if they were given extra credit or paid $15.

Okay, we’re all done here. Thank you very much for participating.

- Make sure to record which condition they were in on the “thought record.”

- Turn off all of the equipment.
The instructions for the four conditions that were delivered through the computer program were as follows:

“We will be asking you to think about a number of different things today. It is very important that you try your best to think about what it is these instructions are asking you to think about. You will be prompted four times throughout this session to answer a few questions about what it was you were thinking and what your mood was like. Please be as honest as possible while writing these thoughts, even if the content has nothing to do with what the instructions asked you to think about.”

*Baseline Condition.* “Now, please close your eyes and for the next few minutes, just focus on your breathing. Start now.” The computer now begins collecting physiological data. After 10 minutes, the program pauses. “Now please pick up the clipboard and answer the questions for the Baseline Period and let the experimenter know when you are finished by saying “finished” into the microphone. You will have three minutes to complete the questions. When you are finished, please get comfortable in the chair again and sit as still as possible.” When the experimenter sees that the participant is comfortable and sitting still, the program is started to begin the next phase.

*Control Condition.* “Now I would like you to think about something that makes you feel peaceful. Pick a topic that makes you feel peaceful. Take some time now to pick this topic. Now, for the next few minutes, I would like you to think about what makes you feel peaceful in the way you normally think about it. Start now.” The computer now begins collecting physiological data. After five minutes, the program pauses. “Now please pick up the clipboard
and answer the questions for the Peaceful Period and let the experimenter know when you are finished by saying “finished” into the microphone. You will have three minutes to complete the questions. When you are finished, please get comfortable in the chair again and sit as still as possible.” When you are finished, please get comfortable in the chair again and sit as still as possible.” When the experimenter sees that the participant is comfortable and sitting still, the program is started to begin the next phase.

Worry Condition. “Now I would like you to think about something that you are currently worried about. Pick a topic about which you are currently most worried. Take some time now to pick this topic. Now, for the next few minutes, I would like you to worry about this topic as intensely as you can and in the way you normally worry about it. Start now.” The computer now begins collecting physiological data. After five minutes, the program pauses. “Now please pick up the clipboard and answer the questions for the Worry Period and let the experimenter know when you are finished by saying “finished” into the microphone. You will have three minutes to complete the questions. When you are finished, please get comfortable in the chair again and sit as still as possible.” When you are finished, please get comfortable in the chair again and sit as still as possible.” When the experimenter sees that the participant is comfortable and sitting still, the program is started to begin the next phase.

Recovery Condition. “Now, I would like you to please close your eyes and for the next several minutes, just focus on your breathing again. Start now.” The computer now begins collecting physiological data. After 10 minutes, the program pauses. “Now please pick up the clipboard and answer the questions for the Recovery Period. You will have three minutes to complete the questions. When you are finished, please speak into the microphone to let the experimenter know that you are finished and we will come in to remove the sensors.”
Dear study participant:

We wanted to tell you a little bit more about this part of the study to give you a better understanding of what we hope to learn.

We asked you to do several things today. We had you complete various questionnaires asked things about your health and worry. Then, we asked you to think about a couple of different things (related to worry and something peaceful) while we measured your heart rate. One thing we are interested in is how stress (worry) and other health factors, such as eating habits, physical activity, and body composition, can affect our physical health. Specifically, we are interested in whether worrying affects our cardiovascular health and the possible long-term implications stress and worry can have on our physical health.

So that’s what we were testing today. We hope that you found the study interesting, and we appreciate your participation very much. If you have further questions, feel free to call Paul Goetz at 701-367-9846.

Sincerely,

William O’Brien, Ph.D.
Professor
APPENDIX E

Participant Number: ________

Demographic Inventory

The following questions ask for you to provide a wide range of information about yourself such as: health history, family background, age, etc. As always, your responses to these questions will be kept completely confidential. We ask that you be as honest as possible throughout the survey.

1. What is your age? ________

2. What is your gender?
   ___ Male
   ___ Female

3. What is your race?
   ___ African American
   ___ Caucasian
   ___ American Indian or Alaska Native
   ___ Native American or other Pacific Islander
   ___ Asian
   ___ Hispanic or Latino/a
   ___ Bi-Racial
   ___ Other __________________

4. What is your marital status:
   ___ Single
   ___ Married
   ___ Divorced
   ___ Co-habitating with a Partner
   ___ Separated
   ___ Widowed

4. What is the highest grade or year you finished and got credit for in regular school or college?
   ___ One or two years of college
   ___ Three to four years of college
   ___ College graduate
   ___ Post-Graduate Education

5. Do you smoke cigarettes?
   ___ Yes
   ___ No

If so, how many cigarettes do you smoke per day (there are usually 20 cigarettes in a pack)?
   ______

5. How many times during the past year have you visited a doctor because of illness? (do not include dentists or eye doctors)
6. How many times during the past year have you visited a doctor for a general checkup? That is, not because of a specific illness or condition? (do not include dentists or eye doctors)

Number of checkups ____________

7. Do you have any heart conditions or high blood pressure?

____ Yes
____ No

If so, what condition(s) do you have?
________________________
________________________

8. Do either of your parents have a heart condition or high blood pressure?

____ Yes
____ No

If so, what condition(s) do they have?
________________________
________________________

9. Are you currently taking any medication?

____ Yes
____ No

If so, what are you taking?

Medication 1: ________________________  Dose: ____________
Medication 2: ________________________  Dose: ____________
Medication 3: ________________________  Dose: ____________
Medication 4: ________________________  Dose: ____________
Worry and Respiratory Sinus Arrhythmia

APPENDIX F

PSWQ

Below are some statements about worrying. Please circle one number (1-5) next to each statement that describes how typical that statement is for you.

<table>
<thead>
<tr>
<th></th>
<th>Not at all typical of me</th>
<th>Very typical of me</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>If I do not have enough time to do something, I do not worry about it</td>
<td>1</td>
</tr>
<tr>
<td>2.</td>
<td>My worries overwhelm me.</td>
<td>1</td>
</tr>
<tr>
<td>3.</td>
<td>I do not tend to worry about things</td>
<td>1</td>
</tr>
<tr>
<td>4.</td>
<td>Many situations make me worry</td>
<td>1</td>
</tr>
<tr>
<td>5.</td>
<td>I know I should not worry about things, but I just can’t help it.</td>
<td>1</td>
</tr>
<tr>
<td>6.</td>
<td>When I am under pressure I worry a lot.</td>
<td>1</td>
</tr>
<tr>
<td>7.</td>
<td>I am always worrying about something.</td>
<td>1</td>
</tr>
<tr>
<td>8.</td>
<td>I find it easy to diminish worrisome thoughts.</td>
<td>1</td>
</tr>
<tr>
<td>9.</td>
<td>As soon as I finish one task, I start to worry about everything else I have to do.</td>
<td>1</td>
</tr>
<tr>
<td>10.</td>
<td>I never worry about anything.</td>
<td>1</td>
</tr>
<tr>
<td>11.</td>
<td>When there is nothing more I can do about a concern, I do not worry about it any more.</td>
<td>1</td>
</tr>
<tr>
<td>12.</td>
<td>I have been a worrier all my life.</td>
<td>1</td>
</tr>
<tr>
<td>13.</td>
<td>I notice that I have been worrying about things.</td>
<td>1</td>
</tr>
<tr>
<td>14.</td>
<td>Once I start to worry, I cannot stop.</td>
<td>1</td>
</tr>
<tr>
<td>15.</td>
<td>I worry all of the time.</td>
<td>1</td>
</tr>
<tr>
<td>16.</td>
<td>I worry about projects until they are done.</td>
<td>1</td>
</tr>
</tbody>
</table>
Health Perceptions

Below are two questions asking you about your feelings about your current and future physical health. Please read the questions carefully and select only one response.

1) During the past week, how often have you worried about your health?

1) Never 2) 3) 4) 5) All of the time

2) How worried are you about your health?

1) Not at all worried 2) 3) 4) 5) Extremely worried
Thought and Affect Questionnaire

Baseline Period

Participant # ______

1. Briefly describe the thoughts you experienced during the last 10 minutes.

________________________________________________________________________
________________________________________________________________________

2. The words listed below describe different feelings and emotions. Read each item and then, in the space next to that word, indicate the extent to which you felt that way during the past 10 minutes.

1 = very slightly or not at all
2 = a little
3 = moderately
4 = quite a bit
5 = extremely

____ interested
____ hostile
____ enthusiastic
____ nervous
____ determined
____ attentive
____ jittery
____ active
____ afraid

____ excited
____ proud
____ irritable
____ alert

____ upset
____ irritable
____ attentive
____ jittery
____ active
____ afraid

____ strong
____ inspired
____ ashamed

____ guilty

3. During the last 10 minutes, how often did you find yourself experiencing worry?

0         1         2         3         4         5         6         7         8         9
Not at all               All the time

4. During the last 10 minutes, how intensely did you worry?

0         1         2         3         4         5         6         7         8         9
Not at all               An extreme amount

STOP HERE, place the clipboard back onto the table and say “finished”
Worry Period

1. Briefly describe the thoughts you experienced during the last 5 minutes.

____________________________________________________________________

____________________________________________________________________

2. The words listed below describe different feelings and emotions. Read each item and then, in the space next to that word, indicate the extent to which you felt that way during the past 5 minutes.

1 = very slightly or not at all
2 = a little
3 = moderately
4 = quite a bit
5 = extremely

_____ interested
_____ hostile
_____ nervous

_____ distressed
_____ enthusiastic
_____ determined

_____ excited
_____ proud
_____ attentive

_____ upset
_____ irritable
_____ jittery

_____ strong
_____ alert
_____ active

_____ guilty
_____ ashamed
_____ afraid

_____ scared
_____ inspired

3. During the last 5 minutes, how often did you find yourself experiencing worry?

0 1 2 3 4 5 6 7 8 9
Not at all All the time

4. During the last 5 minutes, how intensely did you worry?

0 1 2 3 4 5 6 7 8 9
Not at all An extreme amount

STOP HERE, place the clipboard back onto the table and say “finished”
Peaceful Period

1. Briefly describe the thoughts you experienced during the last 5 minutes.

____________________________________________________________
____________________________________________________________

2. The words listed below describe different feelings and emotions. Read each item and then, in the space next to that word, indicate the extent to which you felt that way during the past 5 minutes.

1 = very slightly or not at all
2 = a little
3 = moderately
4 = quite a bit
5 = extremely

_____ interested
_____ hostile
_____ enthusiastic
_____ determined

_____ distressed
_____ proud
_____ attentive

_____ excited
_____ irritable
_____ jittery

_____ upset
_____ alert
_____ active

_____ strong
_____ ashamed
_____ jittery

_____ guilty
_____ inspired
_____ afraid

3. During the last 5 minutes, how often did you find yourself experiencing worry?

0 1 2 3 4 5 6 7 8 9

Not at all All the time

4. During the last 5 minutes, how intensely did you worry?

0 1 2 3 4 5 6 7 8 9

Not at all An extreme amount

STOP HERE, place the clipboard back onto the table and say “finished”
Worry and Respiratory Sinus Arrhythmia

Recovery Period

1. Briefly describe the thoughts you experienced during the last 10 minutes.

________________________________________________________________________

________________________________________________________________________

2. The words listed below describe different feelings and emotions. Read each item and then, in the space next to that word, indicate the extent to which you felt that way during the past 5 minutes.

1 = very slightly or not at all
2 = a little
3 = moderately
4 = quite a bit
5 = extremely

_____ interested
_____ hostile
_____ nervous

_____ excited
_____ enthusiastic
_____ determined

_____ distressed
_____ proud
_____ attentive

_____ nervous
_____ determined

_____ upset
_____ irritable
_____ jittery

_____ strong
_____ alert
_____ active

_____ strong
_____ alert

_____ guilty
_____ ashamed
_____ jittery

_____ guilty
_____ ashamed

_____ excited
_____ proud

_____ excited
_____ proud

_____ smart
_____ inspired

_____ strong
_____ active

3. During the last 10 minutes, how often did you find yourself experiencing worry?

0 1 2 3 4 5 6 7 8 9
Not at all All the time

4. During the last 10 minutes, how intensely did you worry?

0 1 2 3 4 5 6 7 8 9
Not at all An extreme amount

STOP HERE, place the clipboard back onto the table and say “finished”
APPENDIX I

HPLP-II

DIRECTIONS: This questionnaire contains statements about your present way of life or personal habits. Please respond to each item as accurately as possible, and try not to skip any item. Indicate the frequency with which you engage in each behavior by circling:

- **N** for never,
- **S** for sometimes,
- **O** for often,
- **R** for routinely

<p>| | | | |</p>
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<tr>
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<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Never</td>
<td>Sometimes</td>
<td>Often</td>
</tr>
</tbody>
</table>

1. Discuss my problems and concerns with people close to me.       N S O R
2. Choose a diet low in fat, saturated fat, and cholesterol.        N S O R
3. Report any unusual signs or symptoms to a physician or other health professional. N S O R
4. Follow a planned exercise program.                               N S O R
5. Get enough sleep.                                                N S O R
6. Feel I am growing and changing in positive ways.                 N S O R
7. Praise other people easily for their achievements.              N S O R
8. Limit use of sugars and food containing sugar (sweets).         N S O R
9. Read or watch TV programs about improving health.               N S O R
10. Exercise vigorously for 20 or more minutes at least three times a week (such as brisk walking, bicycling, aerobic dancing, using a stair climber). N S O R
11. Take some time for relaxation each day.                         N S O R
12. Believe that my life has purpose.                               N S O R
13. Maintain meaningful and fulfilling relationships with others.  N S O R
14. Eat 6-11 servings of bread, cereal, rice and pasta each day.    N S O R
15. Question health professionals in order to understand their instructions. N S O R
16. Take part in light to moderate physical activity (such as sustained walking 30-40 minutes 5 or more times a week). N S O R
17. Accept those things in my life which I cannot change.           N S O R
18. Look forward to the future.                                     N S O R
19. Spend time with close friends.                                  N S O R
<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>20.</td>
<td>Eat 2-4 servings of fruit each day.</td>
<td>N</td>
<td>S</td>
</tr>
<tr>
<td>22.</td>
<td>Take part in leisure-time (recreational) physical activities (such as swimming, dancing, bicycling).</td>
<td>N</td>
<td>S</td>
</tr>
<tr>
<td>23.</td>
<td>Concentrate on pleasant thoughts at bedtime.</td>
<td>N</td>
<td>S</td>
</tr>
<tr>
<td>24.</td>
<td>Feel content and at peace with myself.</td>
<td>N</td>
<td>S</td>
</tr>
<tr>
<td>25.</td>
<td>Find it easy to show concern, love and warmth to others.</td>
<td>N</td>
<td>S</td>
</tr>
<tr>
<td>26.</td>
<td>Eat 3-5 servings of vegetables each day.</td>
<td>N</td>
<td>S</td>
</tr>
<tr>
<td>27.</td>
<td>Discuss my health concerns with health professionals.</td>
<td>N</td>
<td>S</td>
</tr>
<tr>
<td>28.</td>
<td>Do stretching exercises at least 3 times per week.</td>
<td>N</td>
<td>S</td>
</tr>
<tr>
<td>29.</td>
<td>Use specific methods to control my stress.</td>
<td>N</td>
<td>S</td>
</tr>
<tr>
<td>31.</td>
<td>Touch and am touched by people I care about.</td>
<td>N</td>
<td>S</td>
</tr>
<tr>
<td>32.</td>
<td>Eat 2-3 servings of milk, yogurt or cheese each day.</td>
<td>N</td>
<td>S</td>
</tr>
<tr>
<td>33.</td>
<td>Inspect my body at least monthly for physical changes/danger signs.</td>
<td>N</td>
<td>S</td>
</tr>
<tr>
<td>34.</td>
<td>Get exercise during usual daily activities (such as walking during lunch, using stairs instead of elevators, parking car away from destination and walking).</td>
<td>N</td>
<td>S</td>
</tr>
<tr>
<td>35.</td>
<td>Balance time between work and play.</td>
<td>N</td>
<td>S</td>
</tr>
<tr>
<td>36.</td>
<td>Find each day interesting and challenging.</td>
<td>N</td>
<td>S</td>
</tr>
<tr>
<td>37.</td>
<td>Find ways to meet my needs for intimacy.</td>
<td>N</td>
<td>S</td>
</tr>
<tr>
<td>38.</td>
<td>Eat only 2-3 servings from the meat, poultry, fish, dried beans, eggs, and nuts group each day.</td>
<td>N</td>
<td>S</td>
</tr>
<tr>
<td>39.</td>
<td>Ask for information from health professionals about how to take good care of myself.</td>
<td>N</td>
<td>S</td>
</tr>
<tr>
<td>40.</td>
<td>Check my pulse rate when exercising.</td>
<td>N</td>
<td>S</td>
</tr>
<tr>
<td>41.</td>
<td>Practice relaxation or meditation for 15-20 minutes daily.</td>
<td>N</td>
<td>S</td>
</tr>
</tbody>
</table>
42. Am aware of what is important to me in life. N S O R
43. Get support from a network of caring people. N S O R
44. Read labels to identify nutrients, fats, and sodium content in packaged food. N S O R
45. Attend educational programs on personal health care. N S O R
46. Reach my target heart rate when exercising. N S O R
47. Pace myself to prevent tiredness. N S O R
48. Feel connected with some force greater than myself. N S O R
49. Settle conflicts with others through discussion and compromise. N S O R
50. Eat breakfast. N S O R
51. Seek guidance or counseling when necessary. N S O R
52. Expose myself to new experiences and challenges. N S O R

© S.N. Walker, K. Sechrist, N. Pender, 1995. Reproduction without the author's express written consent is not permitted. Permission to use this scale may be obtained from: Susan Noble Walker, College of Nursing, University of Nebraska Medical Center, Omaha, NE 68198-5330.
Below are listed a variety of events that may be viewed as stressful or unpleasant. Read each item carefully and decide whether or not that event occurred within the past 24 hours. If the event did occur, circle the “Y” response. Then, circle the number from 1 to 7 that best corresponds with the amount of stress the event caused you (see numbers below). Please answer as honestly as you can so that we may obtain accurate information.

1-occurred but was not stressful  
2-caused very little stress  
3-caused a little stress  
4-caused some stress  
5-caused much stress  
6-caused very much stress  
7-caused me to panic

<table>
<thead>
<tr>
<th>Did the Event Occur?</th>
<th>Level of Stress</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Occurred but not stressful</td>
</tr>
<tr>
<td>1. Performed poorly on a task</td>
<td>Y N</td>
</tr>
<tr>
<td>2. Performed poorly due to others</td>
<td>Y N</td>
</tr>
<tr>
<td>3. Thought about unfinished work</td>
<td>Y N</td>
</tr>
<tr>
<td>4. Hurried to meet deadline</td>
<td>Y N</td>
</tr>
<tr>
<td>5. Interrupted during task/activity</td>
<td>Y N</td>
</tr>
<tr>
<td>6. Someone spoiled your completed task</td>
<td>Y N</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>-----------------------------------------------------------------</td>
</tr>
<tr>
<td>7.</td>
<td>Did something you are unskilled at</td>
</tr>
<tr>
<td>8.</td>
<td>Unable to complete a task</td>
</tr>
<tr>
<td>9.</td>
<td>Was unorganized</td>
</tr>
<tr>
<td>10.</td>
<td>Criticized or verbally attacked</td>
</tr>
<tr>
<td>11.</td>
<td>Ignored by others</td>
</tr>
<tr>
<td>12.</td>
<td>Spoke or performed in public.</td>
</tr>
<tr>
<td>13.</td>
<td>Dealt with rude waiter/waitress/salesperson</td>
</tr>
<tr>
<td>14.</td>
<td>Interrupted while talking</td>
</tr>
<tr>
<td>15.</td>
<td>Was forced to socialize</td>
</tr>
<tr>
<td>16.</td>
<td>Someone broke a promise/appointment</td>
</tr>
<tr>
<td>17.</td>
<td>Competed with someone</td>
</tr>
<tr>
<td>18.</td>
<td>Was stared at</td>
</tr>
<tr>
<td>19.</td>
<td>Did not hear from somebody you expected to hear from</td>
</tr>
<tr>
<td>20.</td>
<td>Experienced unwanted physical contact (crowded, pushed)</td>
</tr>
<tr>
<td>21.</td>
<td>Was misunderstood</td>
</tr>
<tr>
<td>22.</td>
<td>Was embarrassed</td>
</tr>
<tr>
<td>23.</td>
<td>Had your sleep disturbed</td>
</tr>
<tr>
<td>24.</td>
<td>Forgot something</td>
</tr>
<tr>
<td>25.</td>
<td>Feared illness/pregnancy</td>
</tr>
<tr>
<td>26.</td>
<td>Experienced illness/physical discomfort</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>27. Someone borrowed something without your permission</td>
<td>Y</td>
</tr>
<tr>
<td>28. Your property was damaged</td>
<td>Y</td>
</tr>
<tr>
<td>29. Had minor accident (broke something, tore clothing)</td>
<td>Y</td>
</tr>
<tr>
<td>30. Thought about the future</td>
<td>Y</td>
</tr>
<tr>
<td>31. Ran out of food/personal article</td>
<td>Y</td>
</tr>
<tr>
<td>32. Argued with significant other</td>
<td>Y</td>
</tr>
<tr>
<td>33. Argued with another person</td>
<td>Y</td>
</tr>
<tr>
<td>34. Waited longer than you wanted</td>
<td>Y</td>
</tr>
<tr>
<td>35. Interrupted while thinking/relaxing</td>
<td>Y</td>
</tr>
<tr>
<td>36. Someone “cut” ahead of you in line</td>
<td>Y</td>
</tr>
<tr>
<td>37. Performed poorly at a sport or game</td>
<td>Y</td>
</tr>
<tr>
<td>38. Did something that you did not want to do</td>
<td>Y</td>
</tr>
<tr>
<td>39. Unable to complete all plans for today</td>
<td>Y</td>
</tr>
<tr>
<td>40. Had car trouble</td>
<td>Y</td>
</tr>
<tr>
<td>41. Had difficulty in traffic</td>
<td>Y</td>
</tr>
<tr>
<td>42. Money problems</td>
<td>Y</td>
</tr>
<tr>
<td>43. Store lacked a desired item</td>
<td>Y</td>
</tr>
<tr>
<td>44. Misplaced something</td>
<td>Y</td>
</tr>
<tr>
<td>45. Bad weather</td>
<td>Y</td>
</tr>
<tr>
<td>46. Unexpected expenses (fines, traffic ticket, etc.)</td>
<td>Y</td>
</tr>
<tr>
<td>Question</td>
<td>Y</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>---</td>
</tr>
<tr>
<td>47. Had confrontation with an authority figure</td>
<td></td>
</tr>
<tr>
<td>48. Heard some bad news</td>
<td>Y</td>
</tr>
<tr>
<td>49. Concerned over personal appearance</td>
<td>Y</td>
</tr>
<tr>
<td>50. Exposed to feared situation or object</td>
<td>Y</td>
</tr>
<tr>
<td>51. Exposed to upsetting TV show, movie, book</td>
<td>Y</td>
</tr>
<tr>
<td>52. “Pet peeve” violated (somebody failed to knock, etc.)</td>
<td>Y</td>
</tr>
<tr>
<td>53. Failed to understand something</td>
<td>Y</td>
</tr>
<tr>
<td>54. Worried about another’s problems</td>
<td>Y</td>
</tr>
<tr>
<td>55. Experienced narrow escape from danger</td>
<td>Y</td>
</tr>
<tr>
<td>56. Stopped unwanted personal habit (overeating, smoking, nail biting)</td>
<td>Y</td>
</tr>
<tr>
<td>57. Had problem with kid(s)</td>
<td>Y</td>
</tr>
<tr>
<td>58. Was late to work/appointment</td>
<td>Y</td>
</tr>
<tr>
<td>Any stressor that we missed? List below.</td>
<td></td>
</tr>
<tr>
<td>59. ___________________________</td>
<td>Y</td>
</tr>
<tr>
<td>60. ___________________________</td>
<td>Y</td>
</tr>
</tbody>
</table>
Instructions:
Think about what you ate in the PAST MONTH.
Please think about all the fruits and vegetables that you ate last month. Include those that were:
- raw and cooked,
- eaten as snacks and at meals,
- eaten at home and away from home (restaurants, friends, take-out), and
- eaten alone and mixed with other foods,

1. Over the last month, how many times per month, week or day did you drink 100% juice such as orange, apple, grape or grapefruit juice? Do NOT count fruit drinks like Kool-Aid, lemonade, Hi-C, cranberry juice drink, Tang, and Twister. Include juice you drank at mealtimes and between meals. Please circle one response.

<table>
<thead>
<tr>
<th>Never or more</th>
<th>1-3 times</th>
<th>1-2 times</th>
<th>3-4 times</th>
<th>5-6 times</th>
<th>1 time</th>
<th>2 times</th>
<th>3 times</th>
<th>4 times</th>
<th>5 times</th>
</tr>
</thead>
<tbody>
<tr>
<td>In last per question month</td>
<td>per</td>
<td>per</td>
<td>per</td>
<td>per</td>
<td>per</td>
<td>per</td>
<td>per</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1a. Each time you drank 100% juice, how much did you usually drink? Please circle one response.

<table>
<thead>
<tr>
<th>Less than ¼ cup</th>
<th>¼ to 1 ¼ cups</th>
<th>1 ¼ to 2 cups</th>
<th>More than 2 cups</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Less than 6oz.)</td>
<td>(6 – 10 ounces)</td>
<td>(10-16 ounces)</td>
<td>(more than 16 ounces)</td>
</tr>
</tbody>
</table>

2. Over the last month, how many times per month, week or day did you eat fruit? Count any kind of fruit – fresh, canned and frozen. Do NOT count juices. Include fruit you ate at all mealtimes and for snacks. Please circle one response.

<table>
<thead>
<tr>
<th>Never or more</th>
<th>1-3 times</th>
<th>1-2 times</th>
<th>3-4 times</th>
<th>5-6 times</th>
<th>1 time</th>
<th>2 times</th>
<th>3 times</th>
<th>4 times</th>
<th>5 times</th>
</tr>
</thead>
<tbody>
<tr>
<td>In last per question month</td>
<td>per</td>
<td>per</td>
<td>per</td>
<td>per</td>
<td>per</td>
<td>per</td>
<td>per</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2a. Each time you ate fruit, how much did you usually eat? Please circle one response.

<table>
<thead>
<tr>
<th>Less than 1 medium fruit</th>
<th>1 medium fruit</th>
<th>2 medium fruits</th>
<th>More than 2 medium fruits</th>
</tr>
</thead>
<tbody>
<tr>
<td>(OR less than ½ cup)</td>
<td>(OR about ½ cup)</td>
<td>(OR about 1 cup)</td>
<td>(OR more than 1 cup)</td>
</tr>
</tbody>
</table>

3. Over the last month, how often did you eat lettuce salad (with or without other vegetables)?

<table>
<thead>
<tr>
<th>Never or more</th>
<th>1-3 times</th>
<th>1-2 times</th>
<th>3-4 times</th>
<th>5-6 times</th>
<th>1 time</th>
<th>2 times</th>
<th>3 times</th>
<th>4 times</th>
<th>5 times</th>
</tr>
</thead>
<tbody>
<tr>
<td>In last per question month</td>
<td>per</td>
<td>per</td>
<td>per</td>
<td>per</td>
<td>per</td>
<td>per</td>
<td>per</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3a. Each time you ate lettuce salad, how much did you usually eat? Please circle one response.

About ½ cup
About 1 cup
About 2 cups
More than 2 cups

4. Over the last month, how often did you eat French fries or fried potatoes? Please circle one response.

Never
1-3 times
1-2 times
3-4 times
5-6 times
1 time
2 times
3 times
4 times
5 or more

4a. Each time you ate French fries or fried potatoes, how much did you usually eat? Please circle one response.

Small order or less
Medium order
Large order
Super Size order or more

5. Over the last month, how often did you eat other white potatoes? Count baked, broiled, and mashed potatoes, potato salad, and white potatoes that were not fried. Please circle one response.

Never
1-3 times
1-2 times
3-4 times
5-6 times
1 time
2 times
3 times
4 times
5 or more

5a. Each time you ate these potatoes, how much did you usually eat?

1 small potato
1 medium potato
1 large potato
2 medium potatoes

or more
(½ cup or less)
(½ to 1 cup)
(1 to 1 ½ cups)
(1 ½ cups or more)

6. Over the last month, how often did you eat cooked dried beans? Count baked beans, bean soup, reﬁred beans, pork and beans and other bean dishes. Please circle one response.

Never
1-3 times
1-2 times
3-4 times
5-6 times
1 time
2 times
3 times
4 times
5 or more

6a. Each time you ate these beans, how much did you usually eat? Please circle one response.
7. Over the **last month**, how often did you eat **other vegetables**?

**DO NOT COUNT:**
- Lettuce Salads
- White Potatoes
- Cooked Dried Beans
- Vegetables in mixtures, such as in sandwiches, omelets, casseroles, Mexican dishes, stews, stir-frys, soups, etc.
- Rice

**COUNT:**
- All other vegetables — raw, cooked, canned, and frozen

7a. Each of these times that you ate **other vegetables**, how much did you usually eat? Please circle one response.

<table>
<thead>
<tr>
<th>Less than ½ cup</th>
<th>½ to 1 cup</th>
<th>1 to 2 cups</th>
<th>More than 2 cups</th>
</tr>
</thead>
</table>

8. Over the **last month**, how often did you eat **tomato sauce**? Include tomato sauce on pasta or macaroni, rice, pizza and other dishes. Please circle one response.

<table>
<thead>
<tr>
<th>Never</th>
<th>1-3 times</th>
<th>1-2 times</th>
<th>3-4 times</th>
<th>5-6 times</th>
<th>1 time</th>
<th>2 times</th>
<th>3 times</th>
<th>4 times</th>
<th>5 times</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Go to question #7)</td>
<td>per</td>
<td>per</td>
<td>per</td>
<td>per</td>
<td>per</td>
<td>per</td>
<td>per</td>
<td>per</td>
<td>per</td>
</tr>
</tbody>
</table>

8a. Each time you ate **tomato sauce**, how much did you usually eat? Please circle one response.

- About ¼ cup
- About ½ cup
- About 1 cup
- More than 1 cup

9. Over the **last month**, how often did you eat **vegetable soups**? Include tomato soup, gazpacho, beef with vegetable soup, minestrone soup, and other soups made with vegetables. Please circle one response.

<table>
<thead>
<tr>
<th>Never or more (Go to question #10)</th>
<th>1-3 times</th>
<th>1-2 times</th>
<th>3-4 times</th>
<th>5-6 times</th>
<th>1 time</th>
<th>2 times</th>
<th>3 times</th>
<th>4 times</th>
<th>5 times</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Go to question #10)</td>
<td>per</td>
<td>per</td>
<td>per</td>
<td>per</td>
<td>per</td>
<td>per</td>
<td>per</td>
<td>per</td>
<td>per</td>
</tr>
</tbody>
</table>

9a. Each time you ate **vegetable soup**, how much did you usually eat?

<table>
<thead>
<tr>
<th>Less than 1 cup</th>
<th>1 to 2 cups</th>
<th>2 to 3 cups</th>
<th>More than 3 cups</th>
</tr>
</thead>
</table>
10. Over the **last month**, how often did you eat **mixtures that included vegetables**? Count such foods as sandwiches, casseroles, stews, stir-fry, omelets, and tacos.

| Times per day | Never or more | 1-3 times per week | 1-2 times per week | 3-4 times per week | 5-6 times per week | 1 time per week | 2 times per week | 3 times per week | 4 times per week | 5 times per week |
|---------------|---------------|--------------------|--------------------|--------------------|--------------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Month         | Never         | 1-3 times          | 1-2 times          | 3-4 times          | 5-6 times          | 1 time         | 2 times        | 3 times        | 4 times        | 5 times        |
Worry and Respiratory Sinus Arrhythmia

APPENDIX L

PFAT

1. Think about your eating habits over the **PAST MONTH**. About how often did you eat or drink each of the following foods? Remember breakfast, lunch, dinners, snacks, and eating out. *Place an “X” in only one box for each food.*

<table>
<thead>
<tr>
<th>TYPE OF FOOD</th>
<th>never</th>
<th>Less than 1 time per month</th>
<th>1-3 times per month</th>
<th>1-2 times per week</th>
<th>3-4 times per week</th>
<th>5-6 times per week</th>
<th>1 time per day</th>
<th>2 or more times per day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold Cereal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skim Milk, on cereal or to drink</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eggs, fried or scrambled in margarine, butter or oil</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sausage or bacon, regular-fat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Margarine or butter on bread, rolls, pancakes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orange juice or grapefruit juice</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruit (not juices)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beef or pork hot dogs, regular-fat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cheese or cheese spread, regular fat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>French fries, home fries, or hash browns</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Margarine or butter on vegetables, including potatoes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mayonnaise, regular-fat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salad dressing, regular-fat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rice</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Margarine, butter, or oil on rice or pasta</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Over the **PAST MONTH**, when you prepared foods with margarine or ate margarine, how often did you use reduced-fat margarine? *Please circle one response.*

<table>
<thead>
<tr>
<th>Don’t use Margarine</th>
<th>Almost of the time</th>
<th>About ¼ of the time</th>
<th>About ½ of the time</th>
<th>About ¾ of the time</th>
<th>Almost always or always</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Overall, when you think about the foods you ate over the **PAST MONTH**, would you say your diet was high, medium, or low in fat? *Please circle one response.*

<table>
<thead>
<tr>
<th>High</th>
<th>Medium</th>
<th>Low</th>
</tr>
</thead>
</table>
Paffenbarger Physical Activity Questionnaire

1. How many city blocks or their equivalent do you normally walk each day? ______ blocks/day
   (Let 12 blocks = 1 mile)

2. What is your usual pace of walking? (Please check one.)
   a. ___ Casual or strolling (less than 2 mph)  b. ___ Average or normal (2 to 3 mph)
   c. ___ Fairly brisk (3 to 4 mph)  d. ___ Brisk or striding (4 mph or faster)

3. How many flights or stairs to you climb up each day? ___ flights/day (Let 1 flight = 10 steps.)

4. List any sports or recreation you have actively participated in during the past year.
   Please remember seasonal sports or events.

<table>
<thead>
<tr>
<th>Sport, Recreation, or Other Physical Activity</th>
<th>Number of Times/year</th>
<th>Hours</th>
<th>Minutes</th>
<th>Years Participation</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Results of Proposed Analyses Using Dichotomous Predictors

<table>
<thead>
<tr>
<th>Measure</th>
<th>$F$</th>
<th>df</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical Activity</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSWQ x HPLP-PA x Condition</td>
<td>1.38</td>
<td>2.73, 303.33</td>
<td>.25</td>
</tr>
<tr>
<td>PSWQ x RSA</td>
<td>.11</td>
<td>1, 111</td>
<td>.74</td>
</tr>
<tr>
<td>HPLP-PA x RSA</td>
<td>3.15</td>
<td>1, 111</td>
<td>.08</td>
</tr>
<tr>
<td>PSWQ x HPLP-PA x RSA</td>
<td>.00</td>
<td>1, 111</td>
<td>.95</td>
</tr>
<tr>
<td>PSWQ x PPAQ x Condition</td>
<td>.26</td>
<td>2.72, 302.4</td>
<td>.84</td>
</tr>
<tr>
<td>PSWQ x RSA</td>
<td>.12</td>
<td>1, 111</td>
<td>.73</td>
</tr>
<tr>
<td>PPAQ x RSA</td>
<td>1.29</td>
<td>1, 111</td>
<td>.26</td>
</tr>
<tr>
<td>PSWQ x PPAQ x RSA</td>
<td>.03</td>
<td>1, 111</td>
<td>.87</td>
</tr>
<tr>
<td><strong>Nutrition</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSWQ x HPLP-II Nutrition (N) x Condition</td>
<td>1.15</td>
<td>2.72, 301.42</td>
<td>.33</td>
</tr>
<tr>
<td>PSWQ x RSA</td>
<td>.27</td>
<td>1, 111</td>
<td>.61</td>
</tr>
<tr>
<td>N x RSA</td>
<td>.02</td>
<td>1, 111</td>
<td>.90</td>
</tr>
<tr>
<td>PSWQ x N x RSA</td>
<td>.03</td>
<td>1, 111</td>
<td>.86</td>
</tr>
<tr>
<td>PSWQ x FVS x Condition</td>
<td>1.76</td>
<td>2.74, 304.15</td>
<td>.16</td>
</tr>
<tr>
<td>PSWQ x RSA</td>
<td>.27</td>
<td>1, 111</td>
<td>.60</td>
</tr>
<tr>
<td>FVS x RSA</td>
<td>.06</td>
<td>1, 111</td>
<td>.81</td>
</tr>
<tr>
<td>PSWQ x FVS x RSA</td>
<td>.10</td>
<td>1, 111</td>
<td>.75</td>
</tr>
<tr>
<td>PSWQ x Pfat x Condition</td>
<td>1.29</td>
<td>2.74, 304.18</td>
<td>.28</td>
</tr>
<tr>
<td>PSWQ x RSA</td>
<td>.26</td>
<td>1, 111</td>
<td>.61</td>
</tr>
<tr>
<td>Pfat x RSA</td>
<td>.57</td>
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<td>BMI</td>
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APPENDIX O

Trait Worry x HPLP-II Subscales and Total Score x Condition or average RSA across conditions

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<th>( P )</th>
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<td>2.73, 302.49</td>
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Note. Sphericity violations were accounted for using Greenhouse-Geisser’s correction for all within-subjects tests.
May 19, 2010

TO: Paul Goetz
   Clinical Psychology

FROM: Hillary Harms, Ph.D.
   HSRB Administrator

RE: HSRB Project No.: H10D283GFB

TITLE: Cognition, Heart Rate Variability, and Health

You have met the conditions for approval for your project involving
human subjects. As of May 18, 2010, your project has been granted final
approval by the Human Subjects Review Board (HSRB). This approval
expires on May 4, 2011. You may proceed with subject recruitment and data
collection.

The final approved version of the consent document(s) is attached.
Consistent with federal OHRP guidance to IRBs, the consent document(s)
bearing the HSRB approval/expiration date stamp is the only valid version
and you must use copies of the date-stamped document(s) in obtaining
consent from research subjects.

You are responsible to conduct the study as approved by the HSRB and to use
only approved forms. If you seek to make any changes in your project
activities or procedures (including increases in the number of participants),
please send a request for modifications immediately to the HSRB via this
office. Please notify me, in writing (fax: 372-6916 or email: hsr@bgsu.edu)
upon completion of your project.

Good luck with your work. Let me know if this office or the HSRB can be of
assistance as your project proceeds.

Comments/Modifications:
Stamped consent document is coming to you via campus mail.

C: Dr. William O’Brien

Research Category: FULL BOARD REVIEW