2008

Situational and dispositional influences on cardiovascular reactivity to daily academic stressors

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Situational and Dispositional Influences on Cardiovascular Reactivity to Daily Academic Stressors

A Thesis
Presented to
The Faculty of
Western Washington University

In Partial Fulfillment
of the Requirements for the Degree
Master of Science

by
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October 2008

ABSTRACT

Stress has many physical effects on the body, including producing elevations in heart rate and blood pressure. This study investigated associations between daily academic stressors and cardiovascular activity. Because individual differences may influence physical reactions to academic stressors, differences in threat/challenge appraisal, test anxiety, and behavioral inhibition were considered as potential moderators of the relationship between academic stressors and cardiovascular activity. Forty-five undergraduate student participants (10 men, 35 women, *M* age = 20.58) wore an ambulatory blood pressure monitor for four consecutive days, and completed a series of individual difference assessments. Acute and anticipatory academic stressors were associated with cardiovascular reactivity for men only. Challenge appraisals (low threat) were associated with elevated cardiovascular responses during times of greater academic stress. Additionally, test anxiety and behavioral inhibition moderated the association between academic stressors and cardiovascular activity. However, these patterns were somewhat varied and inconsistent. This research suggests that men's everyday academic stressors are linked with blood pressure, and such reactivity may predict health complications later in life. Interventions in early college, or earlier in life, may be helpful in promoting good health among students.

ACKNOWLEDGMENTS

Many people contributed to the successful completion of this project. Initial thanks go to my thesis committee for their willingness to always answer questions, and the Psychology department at Western Washington University for providing the funding needed to rent the ambulatory blood pressure monitors used in this study.

I would also like to thank the students who participated in this project, and the faculty of these students who allowed their classes to be disrupted. I would also like to thank my undergraduate research assistants Melissa Turnbull, Megan Murray-Wagner, Lara Schiff, Fiona O'Farrell, and Lindsay Meagher for helping collect and enter the data for this study. Additional thanks to Justin Kaiser for helping with the programming and maintenance of the palm pilots.

My most heart felt thanks goes to my advisor and thesis chair Dr. Barbara Lehman. The daily forms, protocols, and the general method used in this study all stemmed from a larger study conducted by Barbara. Without her assistance (both inside and outside of school hours), patience, sense of humor, and willingness to read draft after draft after draft, this thesis would not have been possible.

Finally, I would like to thank my family. Both my parents and my husband have been part of this study since the beginning. Not only have they listened to me rant, they have helped read drafts and enter data. Their support and understanding was instrumental in completing this project.

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SITUATIONAL AND DISPOSITIONAL INFLUENCES ON CARDIOVASCULAR REACTIVITY TO DAILY ACADEMIC STRESSORS

Because academic tasks during college provide numerous challenges, stress may be an everyday occurrence for many students. It is no surprise that college students report that exams, papers, and studying are a source of considerable stress (Hughes, 2004; 2005; McDonald, 2001). Stress can manifest physically in many ways. One such manifestation is changes in cardiovascular responses (heart rate, systolic blood pressure and diastolic blood pressure) during a stressor (Loft et al., 2007). For example, Conley and Lehman (2007) reported that daily academic stressors such as tests and exams were associated with cardiovascular reactivity (i.e. elevated diastolic blood pressure) among healthy college students.

Another potential manifestation of stress is poor health and sickness among college students during times of stress (Hughes, 2004). Stress has also been found to increase production of the stress hormone cortisol (Huwe, Henning, & Netter, 1998) and cause changes in the immune system (Evans, Bristow, Hucklebridge, Clow, & Pang, 1994). Cardiovascular reactivity among young healthy participants is an important topic of study because reactivity to stressors early in life has been associated with heart disease and the development of hypertension in later adulthood (Matthews, Salomon, Brady, & Allen, 2003; Treiber et al., 2003). While stress has many effects on the body, this paper is primarily focused on the effects of academic stressors on cardiovascular responses. This study also seeks to explore whether individual differences and anxieties associated with academic activities cause academic events to be more closely tied to cardiovascular arousal for some people. Stress appraisal, test anxiety, and behavioral inhibition are all considered as potential moderators of the relationship between academic stressors and cardiovascular activity.

Academic stressors can be defined as self-relevant thoughts or events that impair the accomplishment of a goal and relate to school performance or to overall school success (Conley & Lehman, 2007; Kemeny, 2007). This definition reflects the fact that events only become stressors if they threaten a self-relevant goal (Kemeny). A self-relevant goal in the context of academics can range from graduating from college to passing a specific class or turning in an important assignment. For example, events such as passing an exam or writing a paper can be defined as academic stressors if the student feels that failing the exam or failing to write the paper will interfere with their graduation from college (a self-relevant goal). Two distinct categories of academic stressors can be identified: acute academic stressors and anticipatory academic stressors. As described below acute and anticipatory academic stressors may have different effects on cardiovascular activation.

Acute stressors are typically defined as short-term immediate threats to a goal (Kemeny, 2007). For example, taking a biology test or a psychology test would be classified as an acute academic stressor because the student is directly involved with the stressor; he or she is experiencing the actual stressor. Anticipatory stressors are defined as long term events that have the potential to influence a major goal in the future (Kemeny). Studying for an exam and writing a Master's thesis paper are both examples of anticipatory academic stressors because the stressor has not happened yet; the student is preparing for the stressor to occur. The key distinction between these two academic stressors is whether the goal is being currently threatened (acute) or if the threat is impending (anticipatory). Although academic stressors have been associated with cardiovascular activity, few studies have examined how cardiovascular responses to acute and anticipatory academic stressors are shaped by situational or dispositional differences.

In 2007, Conley and Lehman used ambulatory blood pressure monitoring and daily palm pilot reports over four consecutive days to investigate the association between academic stressors, stress appraisals and cardiovascular responses. They found that during acute academic stressors participant heart rates were significantly elevated beyond each participant's own mean heart rate. This association was not found for systolic or diastolic blood pressure. Event appraisals also moderated cardiovascular activity during an academic stressor. Threat appraisals, which are determinations that one is unable to accomplish the current task, influenced diastolic blood pressure reactivity to acute academic stressors. Diastolic blood pressure was significantly elevated at times when threat appraisals were made during an acute academic stressor.

Academic events have also been found to influence the stress hormone cortisol. Weekes et al. (2006) looked at the association between examination stress and both physiological and psychological functioning. Participants reported feeling higher levels of stress during examination periods than during non-examination periods. Additionally, Weekes et al. found that, for men only, cortisol was higher when taking exams than when not taking exams. This study did not examine the relationship between academic stressors and cardiovascular activity.

The phrase cardiovascular reactivity is used in the present study to refer to the fluxuations in an individual's systolic blood pressure, diastolic blood pressure, and heart rate that occur in association with an event or stressor. Systolic blood pressure (SBP) refers to the amount of pressure exerted against the arterial walls when the heart is contracting. Diastolic blood pressure (DBP) refers to the amount of pressure exerted against the arterial walls between heart beats, while heart rate refers to the number of heart beats per minute (Hugdahl, 1995). Increases in cardiovascular activity provide an indication of activation of the sympathetic nervous system, which helps supply the body with resources to combat an immediate stressor (Sapolsky, 1998).

Allostatic Load

Both physical and mental stressors have been associated with changes in the sympathetic nervous system as indicated by SBP and DBP (Brady & Matthews, 2006; Sapolsky, 1998), and HR (Loft et al., 2007). This is a concern because over time the repeated activation of the body's stress response, such as increased cardiovascular activity, can have a cumulative effect on the body (McEwen, 1998) leading to negative health outcomes. This allostatic load, also known as the physiological cost of repeated stress exposure, can lead to a decrease in the body's ability to respond to a stressor when needed. Specifically, repeated stressors do not give the body an opportunity to rest, thereby making it harder for the body to adjust and activate a response to future stressors.

When the body's stress response is continually activated, it's ability to shut off the stress response also becomes impaired. This inability to shut off the stress response can lead to health problems, such as increased cortisol (Huwe et al., 1998), decreased immune functioning (Evans, et al., 1994), and increased risk for hypertension (Brady & Matthews, 2006). This impaired functioning in the stress response is of particular concern to college students, since during the academic school year students are exposed to academic stressors almost daily. However, while repeated stress has been associated with many negative health outcomes, individual differences may make some people particularly susceptible to negative health outcomes associated with stress.

Individual Differences in Stress Responses

The experience of a particular academic stressor may not be the same for all individuals, and individual responses may vary across situations. Both psychological differences among people and situational characteristics may influence the way academic stressors are experienced.

The three potential moderators of the stress response investigated in this study are stress appraisal, test anxiety, and behavioral inhibition. These factors were chosen because each differentially influences, and is influenced by, academic stressors. First, situational appraisals vary depending on the context of the stressor. As further elaborated in the next section threat appraisals, determinations that a stressor can not be accomplished are likely to occur, are likely to be made during difficult and overwhelming events. In contrast to threat appraisals, which vary by situation, test anxiety and behavioral inhibition are enduring individual characteristics that may influence both stress appraisal and cardiovascular reactivity. Test anxiety was examined because it is specifically relevant to academic situations, and helps us to consider the likelihood of responding with anxiety during academic situations. Third, behavioral inhibition was tested as a potential moderator of reactivity to stressful situations because it is a broad response framework that measures a predisposition to limit or halt behaviors in response to negative stimuli (regardless of the context), and may be associated with greater detection and reactivity to stressors in the environment.

Stress Appraisal

One potential moderator of cardiovascular activation to academic stressors is stress appraisal, specifically the likelihood of making a threat or challenge appraisal. Stress appraisals are individual interpretations of how a stressful event may influence personal wellbeing or goal completion (Folkman & Lazarus, 1985). Because appraisal is based on individual interpretations of stressful events, different people may view the same event in different ways. Appraisals of academic events occur when the individual needs to perform well to accomplish a specific goal (Blascovich & Mendes, 2000), such as passing a class in order to graduate.

In this study, stress appraisal is viewed as a continuum with threat appraisals occurring when the stressor is viewed as something that can *not* be accomplished, and challenge perceptions arising when the stressor is viewed as something that is difficult but *can* be accomplished (Blascovich & Mendes, 2000; Seery, Blascovich, Weisbuch, & Vick, 2004). For example, someone experiencing an academic stressor as a threat might have thoughts similar to "I can't do this," "I didn't study enough," or "I'm going to fail." In contrast, someone experiencing an event as a challenge might have mental cognitions similar to, "I can do this," "I studied," and "I can handle this." Some students may view a particular academic stressor as challenging, while a different student may view it as more threatening (Blascovich & Mendes, 2000; Sarid, Anson, Yaari, & Margalith, 2004).

Differences in stress appraisal can influence cardiovascular responses to academic stressors. Students who view academic stressors as a challenge might be expected to experience less cardiovascular reactivity than students who view academic stressors as a threat (Seery et al., 2004). For example, Conley and Lehman (2007) found that during acute academic stressors, individuals who made threat appraisals had greater cardiovascular activation than individuals who made challenge appraisals. Similarly, Maier, Waldstein, and Synowski (2003) found that diastolic blood pressure reactivity (DBP) was greatest among participants who made threat appraisals. Together, these results support the expectation that threat appraisals will predict increases in cardiovascular reactivity during a stressful event, while challenge appraisals should act to buffer stress reactivity.

However, it should be noted that some research has found greater cardiovascular reactivity during challenge appraisals than during threat appraisals (Blascovich, Mendes, Hunter, & Salomon, 1999). For example, Quigley, Barrett and Weinstein (2002) found elevated heart

rates when participants made challenge appraisals of verbal mental arithmetic tasks. Additionally, Wright, Martin, and Bland (2003) found that cardiovascular responses depend on the difficulty of the task. Specifically, if the task is not viewed as achievable participants exert less effort and will have less pronounced cardiovascular responses. The rationale for this pattern is that those who make a threat appraisal may simply give up, while in a challenge situation resources may be drawn together to meet the challenge. Exactly how challenge and threat appraisals influence cardiovascular activity is still unclear. One purpose of this study is therefore to determine how challenge and threat appraisals influence cardiovascular reactions to acute academic stressors and anticipatory academic stressors.

Test Anxiety

Test anxiety is an individual difference that can influence cardiovascular reactivity to academic stressors. Test anxiety is a negative emotional state that can induce cognitive and physiological changes before and/or after an examination period (King, Ollendick, & Prins, 2000). Compared to individuals with lower levels of test anxiety, those with higher levels of test anxiety have been found to worry more about their academic performance (Beidel & Turner, 1988).

Test anxiety can be divided into two components: worry and emotionality. The worry component refers to concern over failure, as well as concern over the potential consequences of failure. Emotionality refers to negative emotions, such as arousal and unease that may occur during a stressful event (King et al., 2000). Of these two components, worry has been associated with the declines in academic performance including poorer grades on academic assignments and a need for increased time to finish assignments (King et al.).

Holroyd, Westbrook, Wolf, and Badhorn's (1978) study of test anxious and non-anxious women found that anxious women performed worse on exams and reported higher levels of worry during tests than women with lower levels of test anxiety. Both Huwe et al. (1998) and Holroyd et al. (1978) found that participants with high anxiety reported more feelings of discomfort and worry, took longer to complete assignments, and had lower grades than participants with low anxiety. Beidel and Turner (1988) reported that individuals with higher levels of test anxiety reported more worry about their academic performance then individuals with lower levels of test anxiety.

Few studies have investigated the role of test anxiety in shaping the influence of academic stress on physiological responses. Those studies that have looked at this association have typically found that participants with lower test anxiety have less cardiovascular reactivity than participants who have more test anxiety (Holroyd et al., 1978; Huwe at al., 1998). For example, Holroyd et al. (1978) found that low-test anxious women had greater heart rate variability during a laboratory stressor, indicating greater adaptability in stressful situations. Additionally, Huwe et al. (1998) found that participants with high test anxiety had greater cardiovascular reactivity to an oral psychology exam compared to participants with low test anxiety. Beidel (1988) examined the differences in cardiovascular reactivity during a timed vocabulary task and an oral reading session and found that participants in the test anxious group demonstrated increased heart rate compared to participants in the low test anxious condition.

Based on the above findings, it is reasonable to assume that when compared to participants who have lower levels of test anxiety, those with higher levels of test anxiety will demonstrate elevated blood pressure and heart rate reactivity to academic stressors. One goal of this study is to investigate the relationship between test anxiety and both acute and anticipatory

academic stressors. Because individuals with higher levels of test anxiety worry more about their academic performance and need additional time to complete assignments (Beidel & Turner, 1988; Holroyd et al., 1978; Huwe at al., 1998) it is expected that the effect of test anxiety on cardiovascular activation will be most evident during anticipatory academic stressors. This is expected because test anxiety is primarily focused on the anticipated worry associated with an academic stressor, which is best reflected by anticipatory academic stressors.

Behavioral Inhibition

While test anxiety is a concept unique to academic situations, behavioral inhibition is a broad response framework that captures individual sensitivity to stressful situations and to threats of non-reward (Boksem, Tops, Wester, Meijman, & Lorist, 2006). The behavioral inhibition system (BIS) can best be thought of as an attention system. Specifically, it is an attentional system informed by several neurocognitive structures, most notably the anterior cingulate cortex (ACC). The ACC helps to detect potential threats and other negative stimuli in the surrounding environment (Amodio, Master, Yee, & Taylor, 2007). Once a potential threat has been identified, the behavioral inhibition system works to stop ongoing behavior until a response to the stressor has been initiated (Amodio et al., 2007; Gray, 1990). Although the BIS concept has strong neurocognitive roots, a self-report measure that has been linked both with patterns of brain activation and with emotional reactivity has been validated and used in previous research (e.g., Carver & White, 1994; Cavanagh & Allen, 2008). This study uses that self-report measure.

Several studies have looked at the role of BIS in facilitating emotional responses during stressors (Carver & White, 1994; Heponiemi, Keltikangas-Jarvinen, Puttonen, & Ravaja, 2003). For example, Carver and White (experiment 3; 1994) found that higher BIS scores were predictive of nervousness induced by a laboratory stressor. Other studies have shown that

individuals with higher BIS levels react to impending punishment with more negative emotions, such as increased arousal and anxiety (Amodio et al., 2007; Gray, 1990). Similarly, Heponiemi et al. (2003) found that higher BIS predicted greater sensitivity to negative stressors as well as more unpleasant emotions during a laboratory stressor. From these results, Heponiemi et al. concluded that individuals with higher BIS sensitivity are more prone to experience stress and are more likely to experience more negative emotions during a stressor. Furthermore, researchers have shown that emotions, especially negative emotions, influence cortisol reactivity during stressful situations (Mason, 1968).

Because no studies considered behavioral inhibition as a potential moderator of cardiovascular reactions to academic stressors, hypotheses related to BIS are primarily speculative. However, because BIS predicts increased arousal and anxiety in situations with the potential for punishment or negative consequences, it is anticipated that participants higher in BIS responding will have similar cardiovascular responses during academic stressors as individuals with higher levels of test anxiety.

Measuring Cardiovascular Reactivity

To accomplish the goals of this study, ambulatory blood pressure monitoring was used for four consecutive days. Ambulatory blood pressure monitoring is one of many methods used to investigate cardiovascular reactivity to stressors. Other common methods include laboratory stress tasks, such as mental arithmetic and public speaking (Kirschbaum, Pirke, & Hellhammer, 1993). While the findings from laboratory studies are important, many of the laboratory stressors used do not have a direct impact on a student's overall life, and may not impede the accomplishment of a relevant life goal. Many students may therefore lack the motivation to perform well on these tasks. There is also no certainty that the manipulations used in laboratory

studies can be generalized to the real world. Observations of naturally occurring stressors, on the other hand, allow for the measurement of cardiovascular reactivity to a stressor as the participant is experiencing the stressor. Ambulatory blood pressure monitoring allows for a better understanding of the factors that influence blood pressure in a real academic context.

Because assessments are taken as the individual is actually experiencing the stressor, generalizability of the findings to the "real world" are clear and there are fewer motivational concerns. However, ambulatory blood pressure monitoring can be prone to equipment failure, and misuse of the equipment can lead to missing information. These potential problems were addressed through training, proper maintenance, and clear instructions to the participants.

The current study uses ambulatory blood pressure monitoring to gather information on cardiovascular reactivity to academic stressors. By using a variation of the Experience Sampling Method (ESM; Reis & Gable, 2000) approximately once an hour throughout the day participants reported on their academic, emotional, and physical activity at the time of each ambulatory blood pressure measure. In addition, at the end of each day, participants describe their most stressful events for that day. These methods provided complimentary approaches to identifying the effects of the varying academic stressors that occurred throughout the day. Individual differences in BIS and test anxiety were assessed at the end of the study via self-report questionnaires (Carver & White, 1994; Taylor & Deane, 2002).

Hypotheses

Based on previous research, four hypotheses were posed for this study. First, it was predicted that there would be an increase in cardiovascular activity (SBP, DBP, and HR) during academic stressors, especially during acute academic stressors. Because of individual differences in blood pressure and heart rate, this study assessed cardiovascular activity multiple times each

day. Hierarchical Linear Modeling (HLM) was used to compare readings for a particular individual during times when academic stressors were occurring to times when they were not.

The second hypothesis predicted that appraisal would moderate the influence of acute and anticipatory academic stressors on cardiovascular reactivity. Specifically, consistent with previous work by Conley and Lehman (2007) it was predicted that threat appraisals would be associated with elevated cardiovascular reactivity. However, it is recognized that threat appraisals could be associated with decreased cardiovascular activity (Quigley et al., 2002).

Third, in regard to test anxiety, it was predicted that test anxiety would influence the strength of the association between academic stressors and cardiovascular activity. Specifically, it was expected that participants higher in test anxiety would demonstrate increased cardiovascular reactivity to anticipatory academic stressors, compared to participants with lower levels of test anxiety.

The final hypothesis in this study looked at the association between behavioral inhibition and cardiovascular activation during academic stressors. It was predicted that behavioral inhibition would moderate the association between academic stressors and cardiovascular reactivity. Specifically, it was expected that greater behavioral inhibition would be associated with increased cardiovascular activity during an academic stressor.

METHOD

Participants

During the 2007-2008 academic school year, 45 undergraduate student participants (10 men, 35 women, *M* age = 20.58) completed the current study. The sample was comprised mostly of European-American/White participants (77.8%); 6.7% participants were of Asian/Asian-American descent, 2.2% of Native American descent, and 2.2% of African American/Black descent, 8.9% did not specify their ethnicity.

Participants were recruited through the undergraduate Psychology subject pool at Western Washington University. Each participant received a choice of one gift card donated by a community organization and five credit hours to meet undergraduate psychology class requirements. Data from two additional participants who withdrew from the study (one due to personal illness, and one who was dropped for missed appointments and inconsistent completion of protocols) were not included in the analyses.

To be eligible for this study all participants were required to meet several qualifications. Because physical activity elevates blood pressure and heart rate and also decreases comfort and fit of the blood pressure cuff, participants were required to refrain from strenuous physical exercise while wearing the blood pressure cuff. In addition, participants diagnosed with hypertension or taking medications that influenced their blood pressure or heart rate were excluded from this study. These procedures are typical for research on ambulatory blood pressure in healthy populations (Brady & Matthews, 2006).

Procedure

This study was conducted on 5 consecutive week days. On days 1 through 4 participants wore the ambulatory blood pressure monitor from approximately 8am until

11pm. The monitor took a reading once every hour during this time. On the fifth day participants returned their equipment, completed a series of individual difference assessments, and were debriefed.

Initial Session

On the first day participants came into the lab one hour before their first class began, typically between 7am and 10am. At this time participants completed a consent form (Appendix A) detailing their rights and responsibilities and an equipment use agreement form (Appendix B) explaining the participant's responsibility to keep the equipment safe and to report any problems immediately. All participants were given an information sheet (Appendix C) explaining how to ensure an accurate reading, describing trouble shooting pointers, and briefly explaining the within-day questions. During this initial meeting, participant arm circumference was measured and an appropriate sized blood pressure cuff was fitted. Information on family history of hypertension, as well as participant height and weight was also collected at this time (Appendix D). Finally, participants were instructed on the use and basic troubleshooting of the blood pressure monitors and the palm pilots. Participants were given the phone number for the on-call duty phone, and were instructed to call the number at any time of the day if they experienced any problems with their equipment or any discomfort with the blood pressure cuff.

Daily Routines

After the fitting on the first day of participation the blood pressure monitor automatically activated and a reading was taken. If a particular reading was not successful (e.g. due to excessive participant movement), the monitor automatically attempted another reading a few minutes later. If the participant was driving or in a situation where the blood

pressure reading could not be taken, participants were able to manually stop the reading and restart it at a better time. Every time the blood pressure monitor activated participants completed the 2-4 minute within-day questionnaire on a palm pilot. The within-day responses and the blood pressure readings are date and time stamped, so the answers on the within-day questionnaire could be paired with the corresponding blood pressure reading. Blood pressure readings and within day surveys that occurred less than 30 minutes apart were paired together, with an average time difference between measures of three and a half minutes (*SD* = 6.66). On average participants completed 48 blood pressure readings and 42 within-day questionnaires over the course of this study.

At the end of each day, the participant removed the blood pressure cuff and completed an online end of day survey (paper copies were provided for participants without internet access). For the next three mornings, before their first class the participant came back into the lab. At this time the previous day's data were downloaded from the monitor and the palm pilots, and the participant was refitted with the blood pressure cuff. Also at this time, participants were asked to indicate how many hours they slept the previous night, and if they had any problems with the blood pressure monitor or the within-day questionnaire (Appendix E).

Final Day

On the final day in the study participants returned to the lab in the afternoon (between 3pm and 5pm). At this time all equipment was returned and participants completed assessments of test anxiety and behavioral inhabitation, as well as other measures not used in this study. Following the assessments, participants were debriefed by a research assistant. As shown in Appendix F and G the debriefing explained the purpose and the goals of the study.

All participants were given a copy of their own blood pressure measurements. The research assistant explained the basic information on each printout (the total number of readings completed, the average SBP and DBP and their average HR) to the participant. Each participant was instructed to talk to a physician if they were interested in more in-depth information about their blood pressure readings. At the end of the debriefing all participants were given a packet of pamphlets addressing topics such as stress, coping with stress, counseling/wellness services available at the University, metabolic syndrome, and pre-hypertension.

Materials

During this study data were collected from participants in four ways: ambulatory blood pressure monitoring, within-day reports taken at the time of the blood pressure readings, end of day reports, and end of study assessments of individual differences.

Ambulatory Blood Pressure

Readings of blood pressure and heart rate in this study were obtained through use of ambulatory blood pressure monitors from Spacelabs. The monitors used in this study (#90217) were light weight and were designed to be carried in a side pouch or on a belt. The blood pressure cuff was placed by the researcher on the non-dominant arm. A sensor was placed directly over the brachial artery, and readings were taken using the oscillometric method.

Following the recommendations of Marler, Jacobs, Lehoczky, and Shapiro (1988) for identifying readings that are likely to be artifacts, outlying blood pressure (systolic, diastolic, and heart rate) readings were identified and removed from the data set. Systolic blood pressure readings less than 70 mm Hg and greater than 250 mm Hg were removed (n = 0).

Additionally, diastolic blood pressure readings less than 45 mmHg and greater than 150 mm Hg (n = 9) and heart rate readings less than 40bpm and greater than 200bpm (n = 2) were deleted. Finally, SBP/DBP readings less than 1.0625 + 0.00125(DBP) were removed (n = 1) and readings greater than 3.0 were deleted (n = 1). A total of 13 (0.6%) cardiovascular readings were deleted.

Each morning a test reading was taken to ensure that the equipment was working properly before the participant left the lab. Before analyses were conducted all of the test readings were deleted (n = 223). The mean systolic blood pressure for this sample was 120.40 (14.84), diastolic was 75.39 (10.77), and heart rate was 79.55 (14.43).

Within Day Reports

Within day reports in this study were collected through hourly assessments completed on a palm pilot through use of the program iESP (Intel Research). The within day questions were designed to gather information on academic events and on factors known to influence blood pressure (Appendix H). Participants indicated their posture (standing, sitting, lying down) and their activity level at the time of the blood pressure reading (none, limited, light, moderate, heavy, extreme). These measures were adapted from Kamarck et al. (2002).

Academic Events. On the within day measure participants were also asked several questions relating directly to academic stressors. The within-day survey was taken approximately every hour, even if an academic event did not occur. Branching was used on this survey. If no academic events had occurred in the previous ten minutes, the participant skipped all questions related to academics. However, participants who indicated that they had experienced an academic event in the last ten minutes were asked to identify the type of academic experience and how stressful it was for them on a scale from 0 (less) to 100 (more).

These academic events were divided into two categories, acute academic stressors and anticipatory academic stressors. Acute academic stressors (short-term immediate threats) included: taking an exam, taking a quiz, participating in class, and being active in class. Anticipatory academic stressors (long term events that may influence a goal in the future) included: studying for an exam, doing school work, writing a paper, attending lecture, and thinking about school. The total stress rating for acute academic stressors and anticipatory academic stressors was calculated for each reading and used during analyses. See Table 1 for frequencies, means and standard deviations of these academic events. These mean stress ratings were formed by aggregating all responses for a particular individual. A mean and standard deviation was then calculated to summarize the readings for each participant.

Table 1

Frequencies, means, and standard deviations of stress ratings of within-day academic stressors

Academic Event	*M*	*SD*	*N*
Acute Academic Stressors			
Participating in Class	35.51	26.37	102
Active in Class	40.96	29.38	52
Taking Exam	64.07	26.11	56
Taking Quiz	55.09	30.78	11
Total Acute Stressors	48.91	28.16	221
Anticipatory Academic Stressors			
School Work	50.88	26.23	207
Studying for Exam	60.02	24.95	185
Writing a Paper	55.73	28.29	62
Attending Lecture	29.21	24.00	136
Thinking about School	56.29	24.50	259
Total Anticipatory Stressors	50.43	25.59	849

Note. Maximum score = 100, minimum score = 0. Higher means indicate greater stress ratings.

Analyses of the means and standard deviations of the academic stressors from the within-day survey (see Table 1) showed that the mean stress rating for anticipatory academic events was significantly higher than the rating for acute academic events (t (40) = -2.02, p = 0.05). Overall, more readings were taking during anticipatory academic stressors than during acute academic stressors.

Stress Appraisal. Following each blood pressure reading all participants were also asked questions on the within day measure assessing their challenge and threat appraisal. Participants were asked if in the last ten minutes they felt: "successful at what you were doing," "was what you were doing manageable?," "did you have control over the outcome?," "did you have the ability to succeed at what you were doing?," "was the situation fair?," and "was the outcome good?" (reliability = .71). Reliability was tested through HLM by considering each item as an observation at level 1, which was then nested within the specific within day measurement and then nested within each person. These questions were adapted from the Stress Appraisal Measure (SAM; Peacock & Wong, 1990). Consistent with other operational definitions of challenge and threat appraisal (Seery et al., 2004), questions assessing stress appraisal were asked using a single continuous scale with integer values ranging from 0 (less threat, more challenge) to 100 (more threat, less challenge). The mean for all readings in this sample was 29.39, *SD* = 17.50. All participants completed this measure following each reading, regardless of whether they had experienced an academic stressor.

End of Day Reports

Each night participants indicated their most stressful events for the day (up to six events), why the events were stressful, and when they occurred (Appendix I). These events

were coded by two undergraduate research assistants as either stressful academic events, stressful social events, other stressful events, or non-stressors (Kappa .81; Appendix J). Disagreements between the two research assistants were independently rated again and were resolved by the author and her advisor. Academic stressors were defined as events that had the potential to influence an important academic goal; e.g. passing a class. Social stressors were defined as events that had the potential to influence an important social goal; e.g. fight with a significant other. Only the events relating directly to academics were used for analysis in this study.

After the academic stressors were identified, two different research assistants coded these events as either acute academic stressors or as anticipatory academic stressors (Kappa = .81; Appendix K for coding scheme). Acute academic stressors were defined as "short term immediate threats to a goal", and anticipatory academic stressors were defined as "events that have the potential to influence a goal in the future." For example, participants could identify their "psychology 101 test" as their most stressful academic event that day because they "had no time to study!" This event would be identified as an acute academic stressor. The time that these academic stressors occurred was then manually paired with the corresponding ambulatory blood pressure reading, and dummy coding was used to form two new dummy coded measures to identify times when an acute academic stressor (coded as 1) or an anticipatory academic stressor (coded as 1) occurred from times when no academic stressor occurred (coded as 0 for both variables). This was the second method used to assess the influence of academic stressors on cardiovascular activity.

On the end of day survey participants indicated how stressful each event was from 0 (not at all stressful) to 100 (extremely stressful). These stress ratings were also manually

paired with the corresponding blood pressure measurement, forming two new variables. These modified dummy variables had values of 0 at times when no end of day stressor was reported and were assigned the reported stress rating (from 0 to 100) at times linked with a reported stressor. The mean stress rating for all acute academic stressors was 59.87 (*SD* = 25.40) and the mean stress rating for anticipatory academic stressors was 65.41 (*SD* = 22.82). These stress ratings were used as the final method to test the effects of academic stressors on cardiovascular activity. Because there were only three occasions that were coded as both an acute and anticipatory stressor, it was possible to test the differences between the stress ratings given to acute and anticipatory stressors through HLM. To accomplish this, dummy coding (0 = anticipatory academic stressors, 1 = acute academic stressors) was used to determine whether the stress ratings applied to anticipatory stressors differed significantly from those applied to acute stressors. The three readings that were associated with both anticipatory and acute stressors were omitted from this analysis. Results of this random effects analysis suggested that there was no difference in the stress ratings given to acute and anticipatory academic stressors identified on the end of day survey (t (40) = -0.412, p = 0.682).

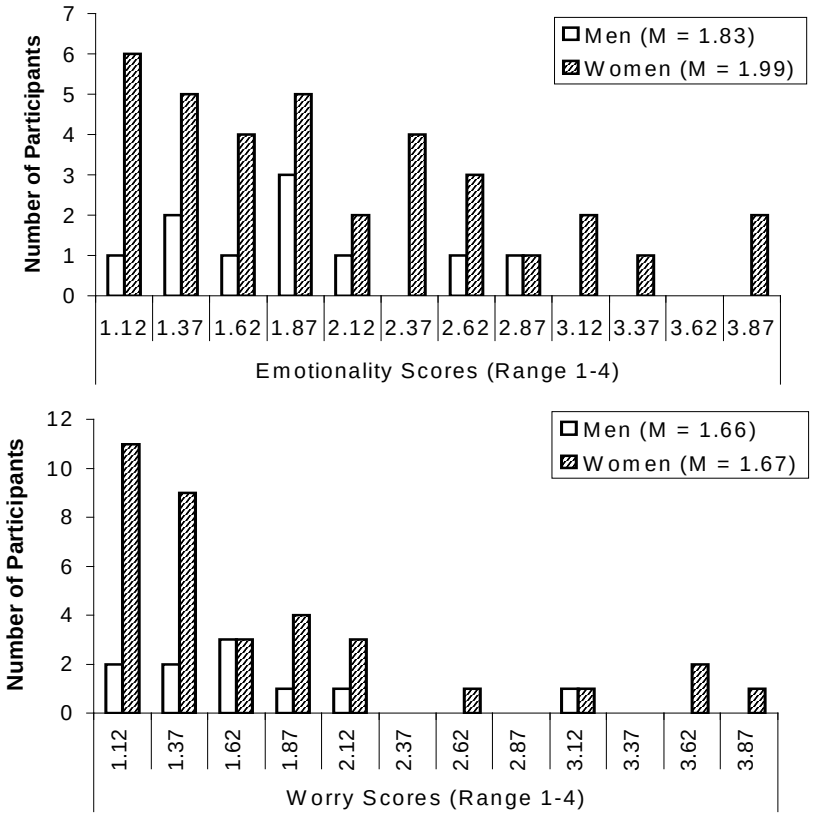
End of Study Measures

Test anxiety. Test anxiety was measured through a 20 item scale (Cronbach's alpha = .92; Taylor & Deane, 2002, Appendix L). This test anxiety scale includes subscales of both worry (8 items) and emotionality (8 items). Sample emotionality items include: "while taking examinations I have an uneasy, upset feeling," and "I feel very jittery when taking an important test". Sample worry items include: "during examinations I get so nervous that I forget facts I really know," and "during test I find myself thinking about the consequences of

failing." Responses were on a 4 point Likert type scale, with 1 being *Almost never* and 4 being *Almost always*; with higher scores indicating participants have a higher level of test anxiety.

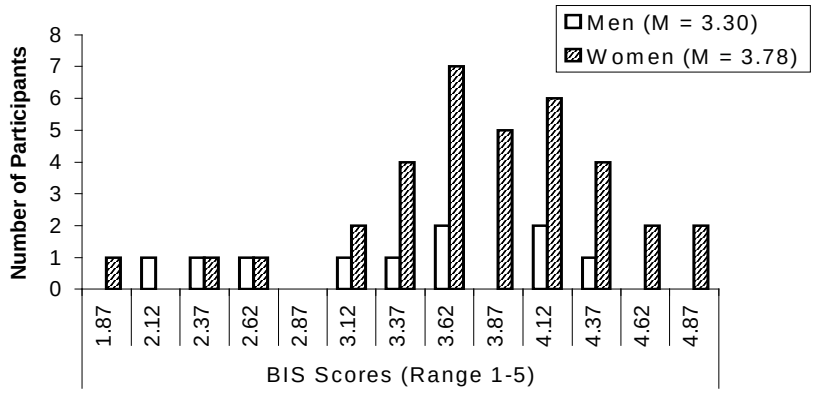
Responses were positively skewed, the mean for worry in this sample was 1.67 (*SD* = 0.72), and the mean for emotionality was 1.95 (*SD* = 0.75). See Figure 1 for distribution for men and women. Because only ten men participated in this study it is difficult to identify outliers among the men. Additionally, with only ten men the likelihood of specific cases influencing the tests of test anxiety, as well as BIS (described below), is increased.

Figure 1. Distribution of test anxiety scores for men and women.



Behavioral Inhibition. Participants also completed Carver and White's (1994, Appendix M) measure of behavioral inhibition. The measure of behavioral inhibition consisted of seven items, Cronbach's alpha = .77. The

Figure 2. Distribution of scores for behavioral inhibition for men and women.



questions included “I worry about making mistakes,” and “If I think something unpleasant is going to happen I usually get pretty ‘worked up.’” All questions were assessed on a 5 point Likert scale, with 1 being *Strongly Disagree* and 5 being *Strongly Agree*, with higher scores indicating participants have higher behavioral inhibition. Responses on this scale were negatively skewed, the mean for this sample was 3.68 (*SD* = 0.71). See Figure 2 for the distribution for men and women.

RESULTS AND PRELIMINARY DISCUSSION

Overview of Analyses

Data analyses in this thesis were conducted through Hierarchical Linear Modeling (HLM). This method was used because there were many blood pressure readings for each participant, and these readings were not independent of each other. HLM analysis allows for the blood pressure readings that occurred during an academic stressor to be compared to that person's typical scores.

A set of 3-level models was used in this study. The level 1 variables in these models were the within-day readings taken throughout the four days of participation. The variables included at level 1 were SBP and DBP and HR, stress appraisal (as measured on the within-day questionnaires), and acute and anticipatory academic stressors. The level 2 variable represents information at the daily level. Although no predictors are included at this level, readings from within days were not independent of each other, and the 3-level models more adequately captured the variability in the data than the 2-level models. Level 3 variables, reflecting individual differences at the participant level included: gender, worry, emotionality, and behavioral inhibition. When constructing the models used in this study, all dichotomous covariates were entered into the model as uncentered variables, and robust standard errors are reported for all analyses. Group mean centering was used at level 1, grand mean centering was used at level 3.

The covariates tested for inclusion in this study were posture (dummy coded as sitting and standing), which varied with each blood pressure reading, sleep, family history of hypertension, and gender. Because sleep and family history of hypertension were not found to have any influence on HR, SBP or DBP, they were not included in the final analyses.

Posture was found to have a significant association with HR, SBP, and DBP, so all subsequent HR, SBP, and DBP analyses included the dummy coded sitting and standing variables as covariates at level 1. Gender was found to have an association with SBP, so all SBP analyses also included gender as a covariate at level 3.

All analyses related to hypothesis 1 (and subsequent hypotheses) were first conducted without considering sex as a level 3 moderator of level 1 effects. Next, the potential differences between men and women were tested by using sex to predict the slope of the academic stressors on the cardiovascular outcomes of SBP, DBP and HR.

Organization of Results

All of the analyses in this study were conducted three times: once using information collected from the within-day survey, once with the end of day participant stress ratings, and finally with the end of day dichotomous variables. Analyses of the end of day dichotomous variables paralleled the end of day participant stress ratings. To avoid redundancy only the analyses of the end of day participant stress ratings are reported here, except where the dichotomous variables and the participant stress ratings differ. There are three such cases, and these cases are described in the appropriate sections, after the end of day participant stress ratings. The end of day participant stress ratings also included findings not found for the end of day dichotomous variables; there are 16 such cases. These additional findings for the participant stress rating likely reflect the greater sensitivity of this continuous measure.

All results are grouped by hypothesis. In each of these sections the results from the within-day analyses are reported first, followed by the end of day participant stress ratings. For ease of presentation each sub section is further divided into results for acute academic stressors and anticipatory academic stressors. All analyses are first reported without

considering sex (as a level 3 moderator). Next, differences between men and women are reported using sex to predict the slope of the academic stressors on the cardiovascular outcomes of SBP, DBP and HR. Finally, a brief discussion of each hypothesis is provided. The exception to this organization is the preliminary analyses section.

Preliminary Analyses

Verifying End of Day Stressors

Because the end of day survey is a retrospective analysis, the academic stressors reported on the end of day survey were compared with the academic stressors reported on the within day survey to verify that the end of day stressors were reported as stressful on the within day survey. Both acute academic stressors ($\beta = 0.29$, t (2071) = 3.59, $p = 0.001$) and anticipatory academic stressors ($\beta = 0.26$, t (2162) = 2.90, $p = 0.004$) reported as stressful on the end of day survey were reported as stressful on the within day.

Understanding Academic Stressors

To better understand the role that academic stressors played in inducing cardiovascular responses, the individual effects of specific academic stressors were investigated. Specifically, the effect of “thinking about school”, “writing a paper”, “taking a test” (or quiz), “working on school work”, and “studying for an exam” on cardiovascular activity were explored. Only writing a paper was found to have an association with SBP (β = -0.05, t (1123) = -3.04, $p = 0.003$). Contrary to expectations, participants had lower SBP, but not DBP or HR, at times when they were writing a paper.

Correlations Between Variables

Table 4 presents correlations among the major variables in this study. Variables collected on the within-day survey were first aggregated to the level of the individual. As can

be seen in Table 2, DBP was positively correlated with both SBP and HR, however SBP and HR were not correlated with each other. Additionally, both components of text anxiety were positively correlated. Finally, BIS was positively correlated with both worry and emotionality, although BIS was more strongly associated with emotionality, as opposed to worry. However, neither BIS, worry or emotionality were correlated with threat appraisal. No other variables were significantly correlated with each other. Although the association is non-significant, it is noteworthy that BIS is negatively associated with SBP, DBP, and HR.

Table 2

Correlations among cardiovascular measures and potential moderating variables, at level of the individual (N = 45)

	SBP	DBP	HR	Threat	Emot	Worry	BIS
SBP[1]	-						
DBP[1]	0.70**	-					
HR[1]	0.24	0.35*	-				
Threat[1]	-0.13	-0.11	-0.06	-			
Emot	-0.05	-0.13	0.12	0.14	-		
Worry	0.06	0.00	0.11	0.06	0.75**	-	
BIS	-0.27	-0.18	-0.15	0.01	0.52**	0.39**	-

Note. [1]A mean of all readings for each individual was computed. Emot = Emotionality, BIS = Behavioral Inhibition. * $p < .05$. ** $p < .01$.

Test of Direct Effects of Stress Appraisal, Test Anxiety, and Behavioral Inhibition

Before analyses were completed, each potential level 3 moderating variable was tested to determine if it contributed a statistically significant amount to the cardiovascular variables. None of the potential moderators (worry, emotionality, behavioral inhibition, stress appraisal) accounted for significant variability in the intercept of any of the outcome

variables (SBP, DBP or HR). In other words, cardiovascular outcomes did not differ as a function of test anxiety, BIS, or stress appraisal. Therefore, in subsequent analyses these variables were used only to test the interactive hypotheses of whether the association between academic stressors and cardiovascular activity varied by each potential moderator. These moderators were therefore used only to predict the slope of academic stressors on cardiovascular outcomes, not the intercept.

Hypothesis 1

Hypothesis 1 investigated the relationship between acute and anticipatory academic stressors and cardiovascular activity. As Table 3 shows, academic stressors from both the within day and the end of day were tested at level 1. It was predicted that that cardiovascular responses (SBP, DBP, and HR) would be elevated during academic stressors. This hypothesis was tested in three different ways. First, the stress ratings for acute academic stressors and anticipatory

Table 3

Example of equations used to test hypothesis 1

Level 1

Cardiovascular Outcome =

$\pi_0 + \pi_1(\text{Academic Stress Rating}) + \pi_2(\text{Covariate}_1) + \ldots$

$\pi_k(\text{Covariate}_k) + e$

Level 2

$\pi_0 = \beta_{00} + r_0$

$\pi_1 = \beta_{10} + r_1^*$

$\pi_2 = \beta_{20} + r_2^*$

$\pi_k = \beta_{k0} + r_k^*$

Level 3

$\beta_{00} = \Upsilon_{000} + u_{00}$

$\beta_{10} = \Upsilon_{100} + u_{10}^*$

$\beta_{20} = \Upsilon_{200} + u_{20}^*$

$\beta_{k0} = \Upsilon_{koo} + u_{k0}^*$

Note. *Models were initially estimated as random effects at both L2 and L3 (as shown), but if a random component was not statistically significant ($p > .10$), effects were estimated as fixed. All analyses for SBP and DBP were estimated as fixed. The covariate standing was estimated as random in tests of HR.

academic stressors as measured by the within-day questionnaire were used to test the relationship between academic stressors and cardiovascular activity. Second, as described on pg. 20, the dichotomous dummy codes created from the open ended responses on the end of day survey were used to identify the time that the participant experienced their most stressful academic events that day from other readings. Third, as described on pg. 20, the stress ratings for the acute academic stressors and the anticipatory academic stressors identified on the end of day survey were used as a measure of acute and anticipatory stress to test this hypothesis. Separate analyses were conducted for SBP, DBP, and HR, as well as for acute and anticipatory academic stressors.

Results for Hypothesis 1

Within-Day Survey

Acute academic stressors. As shown in Table 4, acute academic stressors, as indicated by stress ratings provided by the participant at the time of each blood pressure reading, did not have any direct association with the outcome variables of systolic blood pressure (SBP), diastolic blood pressure (DBP), or heart rate (HR). However, a marginally significant finding suggested that during acute academic stressors participants had lower HR (β = -0.03, t (1529) = -1.89, p = 0.058). There was no difference between men and women in the association between acute academic stressors and cardiovascular activity.

Anticipatory academic stressors. Anticipatory academic stressors did not have a direct association with SBP, DBP, or HR (see Table 4), and the strength did not differ for men and women.

Table 4

Association Between Acute and Anticipatory Academic Stressors and Cardiovascular Outcomes

	HR		SPB		DBP	
	Intercept	Slope	Intercept	Slope	Intercept	Slope
Predictor Measure						
Within Day Variables						
Acute	70.55 (1.56)	-0.03 (0.01)†	117.42 (3.73)	0.00 (0.01)	64.99 (1.10)	0.00 (0.01)
Anticipatory	70.61 (1.57)	-0.01 (0.01)	117.39 (3.70)	-0.01 (0.00)	64.97 (1.10)	-0.00 (0.00)
End of Day						
Acute	70.47 (1.58)	0.00 (0.03)	117.55 (3.70)	-0.01 (0.02)	64.88 (1.13)	-0.02 (0.03)
Anticipatory	70.64 (1.58)	0.00 (0.01)	117.31 (3.73)	-0.00 (0.01)	64.98 (1.11)	-0.00 (0.02)

Note. This table summarizes 12 separate analyses. The numbers in each column are the unstandardized coefficients for each predictor on the cardiovascular outcome, and items in parentheses are the standard errors. † $p < .07$.

End of Day Survey

Acute academic stressors. Across all participants, acute academic stressors, as indicated by stress ratings of academic events provided each night before bed, were not associated with participant cardiovascular outcomes. However, the association between acute academic stressors and both SBP and DBP differed for men and women. Follow-up analyses indicated that more stressful acute academic stressors significantly predicted elevated cardiovascular activity for men, but not for women. Specifically, men showed elevated SBP ($\beta = 0.09$, t (253) = 2.47, $p = 0.015$) and DBP ($\beta = 0.09$, t (253) = 16.98, $p < 0.001$) during more stressful acute academic events, while women showed non significantly lower levels of SBP and DBP during more stressful acute academic events.

Anticipatory academic stressors. Although anticipatory academic stressors coded from stress ratings on the end of day surveys were not correlated with any of the cardiovascular outcomes, the association between anticipatory academic stressors did differ for men and women. Follow-up analyses indicated that men had significantly elevated DBP during more stressful anticipatory academic stressors ($\beta = 0.07$, t (267) = 3.28, $p = 0.002$), while women had lower, although not significantly lower, DBP during more stressful anticipatory academic stressors.

Hypothesis 1 Preliminary Discussion

The first goal of this study was to determine whether acute and anticipatory academic stressors were associated with elevations in cardiovascular activity. Acute stressors were defined as short-term immediate threats to a goal, and anticipatory stressors were defined as long term events that have the potential to influence a major goal in the future (Kemeny, 2007).

Consistent with previous research suggesting that academic stressors are sufficient to induce a physiological stress response (Conley & Lehman, 2007; Hughes, 2004, 2005; Weekes et al., 2006), this study found that acute and anticipatory academic stressors were associated with elevations in cardiovascular activity. However, these elevations in cardiovascular responses were found for men only.

Hypothesis 2

Hypothesis two predicted that stress appraisal would moderate the association between academic stressors and cardiovascular activity. Specifically, it was anticipated that threat appraisals would be associated with elevations in cardiovascular responses during stressful academic events. This hypothesis was tested using stress appraisal of academic stressors, as provided on the within-day questionnaires, as a level one moderator of academic stressors (see Table 5). Similar to hypothesis one, this hypothesis was first tested

Table 5

Example of equations used to test hypothesis 2

Level 1

Cardiovascular Outcome =

$\pi_0 + \pi_1(\text{Academic Stress Rating}) + \pi_2(\text{Stress Appraisal}) + \pi_3(\text{AcademicStressRatingxStressAppraisal}) + \pi_4(\text{Covariate}_1) + \ldots\pi_k(\text{Covariate}_k) + e$

Level 2

$\pi_0 = \beta_{00} + r_0$

$\pi_1 = \beta_{10} + r_1*$

$\pi_2 = \beta_{20} + r_2*$

$\pi_3 = \beta_{30} + r_3*$

$\pi_4 = \beta_{40} + r_4*$

$\pi_k = \beta_{k0} + r_k*$

Level 3

$\beta_{00} = \Upsilon_{000} + u_{00}$

$\beta_{10} = \Upsilon_{100} + u_{10}*$

$\beta_{20} = \Upsilon_{200} + u_{20}*$

$\beta_{30} = \Upsilon_{300} + u_{30}*$

$\beta_{40} = \Upsilon_{400} + u_{40}*$

$\beta_{k0} = \Upsilon_{koo} + u_{k0}*$

Note. *Models were initially estimated as random effects at both L2 and L3 (as shown), but if a random component was not statistically significant ($p > .10$), effects were estimated as fixed. All analyses for SBP and DBP were estimated as fixed. The covariate standing was estimated as random in tests of HR.

without testing for differences between men and women, and then again including the differences between men and women.

When testing the effects of stress appraisal, centered interaction terms were used to avoid multicollinearity. Interaction terms were computed in SPSS, using group mean centered parent terms, and imported into HLM. To compute these level 1 interaction terms, products were formed for stress appraisal and each measure of academic stress. The level 1 moderator of stress appraisal, the interaction terms, and the academic stressor variable were then entered at level 1 as group mean centered.

In addition to testing the moderating role of stress appraisal on academic stressors and cardiovascular responses, academic stressors were also used to predict stress appraisal. This step was taken for academic stressors identified on the within-day questionnaires as well as for academic stressors coded from the end of day surveys.

Results for Hypothesis 2

Academic Stressors Predicting Stress Appraisal

Prior to testing the moderating role of stress appraisal, acute academic stressors and anticipatory academic stressors were tested to see if they predicted stress appraisal. Overall, acute academic stressors measured either throughout the day or at night did not predict stress appraisal. However, anticipatory academic stressors did predict threat appraisal. Specifically, during more stressful anticipatory academic stressors participants made more threat appraisals. This was found to be true for information obtained on both the within-day survey and the end of day survey ($\beta = 0.02$, t (1738) = 2.175, $p = 0.03$ and $\beta = 2.98$, t (1701) = 2.34, $p = 0.019$, respectively).

Of primary interest to this thesis however was whether academic stressors would be more closely linked with cardiovascular reactivity when these stressors were appraised as threatening. The second hypothesis in this study tests this association.

Within-Day Survey

Acute academic stressors. Stress appraisal did not moderate the association between acute academic stressors (as measured by stress ratings provided each hour) and SBP, DBP, or HR. However, the effect of stress appraisal on cardiovascular reactivity did differ between men and women. Specifically, follow-up analyses indicated that when men made challenge appraisals (low threat), as opposed to threat appraisals, during more stressful acute academic events they showed significant elevations in HR (β = -0.003, t (263) = -2.638, p = 0.009). In contrast, women showed lower, although not significantly lower, HR during more stressful acute academic events, regardless of their stress appraisal.

Anticipatory academic stressors. Stress appraisals did not influence SBP, DBP, or HR reactivity to anticipatory academic stressors. Even when differences between men and women were considered, stress appraisal did not have a moderating influence on cardiovascular responses to anticipatory academic stressors.

End of Day Survey

Acute academic stressors. Stress appraisals did not influence cardiovascular activity during acute academic stressors (as indicated by information collected each night). However, the influence of acute academic stressors and stress appraisal on cardiovascular activity differed for men and women. Follow-up analyses indicated that when men made challenge, as opposed to threat, appraisals during more stressful acute academic stressors they had significantly elevated HR (β = -0.006, t (243) = -3.496, p = 0.001). In contrast, when women

made challenge appraisals during more stressful acute academic stressors they had non-significantly lower HR.

Anticipatory academic stressors. Stress appraisals influenced the strength of the relationship between anticipatory academic stressors and SBP, but not DBP or HR. Specifically, challenge appraisals were associated with elevated SBP during more stressful anticipatory academic stressors (β = -0.14, t (1437) = -2.279, p = 0.023), while threat appraisals were associated with lower SBP during anticipatory academic stressors.

The moderating role of stress appraisal also varied for men and women. Follow-up analyses revealed that men had significantly elevated SBP when making challenge appraisals during more stressful anticipatory academic stressors (β = -0.007, t (257) = -2.942, p = 0.004). In contrast, SBP for women was higher, although not significantly higher, when making challenge appraisals, and SBP was non-significantly lower when making threat appraisals during more stressful anticipatory academic stressors.

Analyses of dichotomous indicators of anticipatory academic stressors, as coded from the end of day survey, suggested a parallel gender difference in the pattern for HR. Specifically, men had significantly elevated HR when making challenge appraisals during anticipatory academic stressors (β = -0.55, t (257) = -2.051, p = 0.041). In contrast, HR for women was non significantly elevated when making threat appraisals than when making challenge appraisals during anticipatory academic stressors.

Hypothesis 2 Preliminary Discussion

The potential situational moderating effect of stress appraisal, specifically challenge and threat appraisals, was tested in this study. Threat appraisals are determinations that a stressor is something that current resources cannot meet; it is not something that can be

accomplished. Challenge appraisals are defined as a determination that the stressor is difficult but can be accomplished (Blascovich & Mendes, 2000; Seery et al., 2004).

Contrary to the original predictions, the present study found that for men challenge appraisals were associated with elevated cardiovascular outcomes, while threat appraisals were associated with lower or no change in cardiovascular activity. These findings are consistent with the argument that during times of increased stress cardiovascular responses decreases because the body gives up, and there is little mobilization of resources.

In support of these findings, other studies have found that men have elevations in cortisol when making challenge appraisals during academic stressors, and that men have elevated heart rates when making challenge appraisals (Ennis, Kelly, & Lambert, 2001). However, findings from previous studies on the physiological influence of threat and challenge appraisals have been mixed. Some studies have found that threat appraisals are associated with greater cardiovascular response (Conley & Lehman, 2007; Seery et al., 2004). This is expected because the body activates to meet the demands of a stressful event, leading to increased physiological responses. Other studies have found that it is challenge appraisals that induce elevations in cardiovascular activity (Quigley et al., 2002). The logic behind these findings is that if a task is not viewed as achievable (threat appraisal), participants may simply give up. In contrast, consistent with the patterns observed in this study, when faced with a challenging situation, physiological resources may be mobilized to meet the challenge (Quigley et al.).

Analysis of Hypothesis 3 and 4

The third and fourth hypotheses investigated the potential moderating influences of test anxiety (worry and emotionality) and behavioral inhibition on cardiovascular reactivity

to academic stressors. As shown in Table 6, each analysis was conducted looking at the association between the level 1 variables when considering the level 3 variable of test anxiety or behavioral inhibition. The level 3 moderators were entered as grand mean centered. To test the moderating effect of test anxiety/behavioral inhibition, group mean centered measures of academic stressors were used to predict cardiovascular outcomes, and the level 3 moderators of test anxiety/behavioral inhibition were used to predict the slope of academic stressors on cardiovascular outcomes. All analyses were repeated including gender as a moderating variable.

Table 6

Example of models used to test hypothesis 3 and 4

Level 1

Cardiovascular Outcome =

$\pi_0 + \pi_1(\text{Academic Stress Rating}) + \pi_2(\text{Covariate}_1) + \ldots$

$\pi_k(\text{Covariate}_k) + e$

Level 2

$\pi_0 = \beta_{00} + r_0$

$\pi_1 = \beta_{10} + r_1*$

$\pi_2 = \beta_{20} + r_2*$

$\pi_k = \beta_{k0} + r_k*$

Level 3

$\beta_{00} = \Upsilon_{000} + u_{00}$

$\beta_{10} = \Upsilon_{100} + \Upsilon_{101}(\text{Test Anxiety/Behavioral Inhibition}_1) + u_{10}*$

$\beta_{20} = \Upsilon_{200} + u_{20}*$

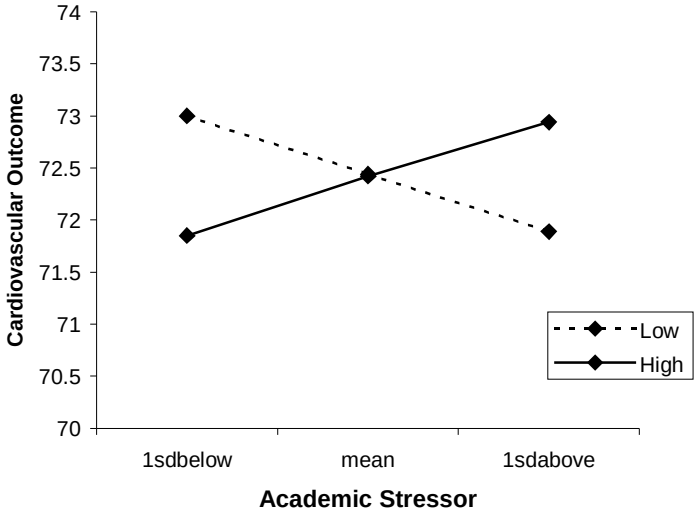
$\beta_{k0} = \Upsilon_{koo} + u_{k0}*$

Note. *Models were initially estimated as random effects at both L2 and L3 (as shown), but if a random component was not statistically significant ($p > .10$), effects were estimated as fixed. All analyses for SBP and DBP were estimated as fixed. The covariate standing was estimated as random in tests of HR.

Trends in Test Anxiety and BIS

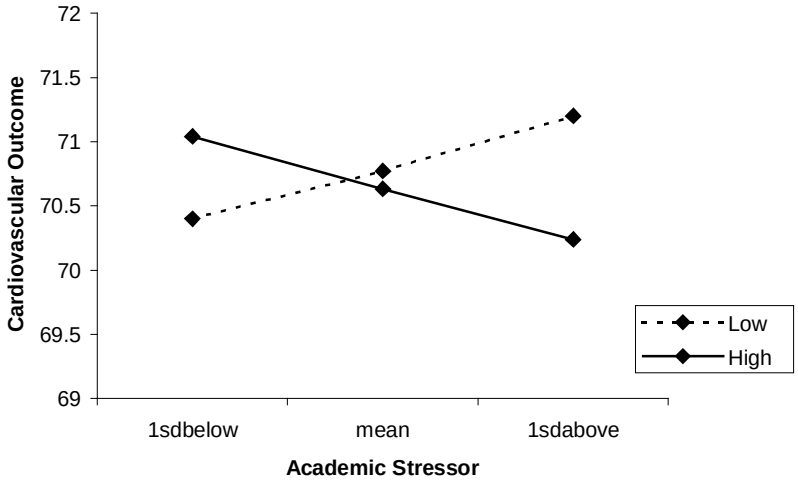
The clarity of the remaining analyses is greatly increased by identifying three distinct patterns of results. In the first pattern which will be called high elevation, men with high levels of the level 3 moderating variables (test anxiety or BIS), showed elevations in cardiovascular activity during more stressful academic events (see Figure 3 for example). In contrast, low anxiety men showed either lower activation or no difference in activation during more stressful academic events. This pattern is typically reversed and non-significant for women.

Figure 3. Example of the men's results for the high elevation pattern.



The second pattern as seen in Figure 4, called the low elevation pattern, showed the opposite effect. Specifically, men low in the level 3 moderating variables showed elevations in cardiovascular activity during more stressful academic events. Men who were high in level 3 variables showed either no association or lower levels of cardiovascular

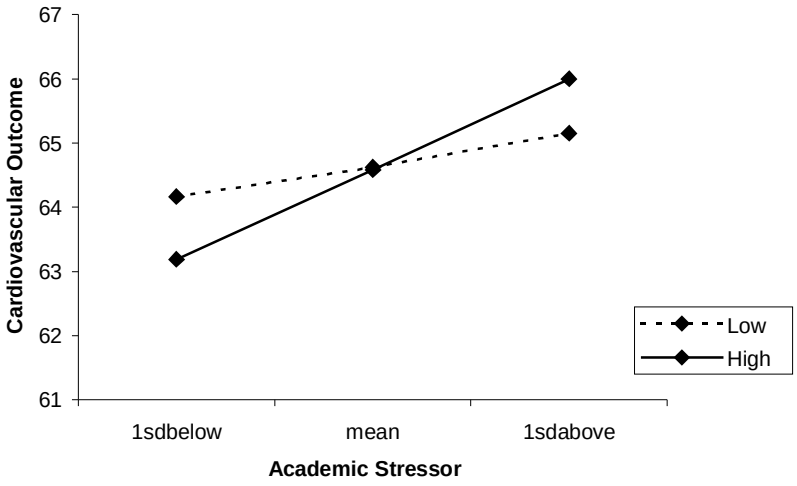
Figure 4. Example of the low elevation pattern.



activity during more stressful academic events. This pattern was often reversed and non-significant for women.

In the final pattern, men elevated, men high in the level 3 variables showed greater elevations in their cardiovascular activity during more stressful academic events, while men low in level 3 variables often showed less dramatic elevations in cardiovascular activity during more stressful academic stressors (see Figure 5). In contrast, women tended to display a non-significant pattern of responding consistent with the men's low elevated pattern described above. Specifically, women high in level 3 variables tended to have lower cardiovascular activity during more stressful academic events.

Figure 5. Example of the men elevated pattern.



These classifications will be used to categorize and explain the results found in the following sections. Because over 30 analyses were conducted in testing hypothesis three and four, only the statistically significant interactions between the level 3 moderating variables and the academic stressors will be reported in the following sections.

Hypothesis 3

The third hypothesis investigated the potential moderating influences of test anxiety (worry and emotionality) on cardiovascular reactivity to academic stressors. Specifically, this study explored whether the two subcomponents of the individual difference variable test

anxiety (worry and emotionality) moderated the association between academic stressors and cardiovascular activity. It was predicted that participants higher in test anxiety would have elevated cardiovascular responses during stressful academic events.

Results for Hypothesis 3: Worry

Within-Day Survey

Acute academic stressors. Individual differences in worry did not moderate the relationship between acute academic stressors, measured throughout the day, and SBP, DBP, or HR. However, the influence of worry on cardiovascular reactivity to acute academic stressors differed for men and women. Follow-up analyses indicated that worry moderated that effect of acute academic stressors on cardiovascular activity for men ($\beta = 0.08$, t (272) = 4.301, $p < 0.001$), but not for women. Specifically, consistent with the high elevation pattern high worry men had significantly elevated SBP during more stressful acute academic events, while low worry men showed no difference in SBP during more stressful acute academic stressors. In contrast, high worry women had non-significantly lower SBP during acute academic stressors, and low worry women had a non-significant elevation in SBP during acute academic stressors.

Anticipatory academic stressors. Worry did not moderate the relationship between the within-day measure of anticipatory academic stressors and cardiovascular activity. However, the influence of worry on cardiovascular reactivity during anticipatory academic stressors differed for men and women. Specifically, worry was found to have an influence on the association between anticipatory academic stressors and DBP for men ($\beta = 0.02$, t (272) = 0.008, $p = 0.015$), and not for women. Paralleling the high elevation pattern, follow-up analyses indicated that high worry men had elevated DBP during anticipatory academic

stressors, while low worry men showed no difference in the DBP during more stressful anticipatory academic stressors. High worry women had lower, although not significantly lower, DBP during anticipatory academic stressors, and low worry women had a non-significant elevation in DBP during anticipatory academic stressors.

End of Day Survey

Acute academic stressors. Overall, worry did not moderate the relationship between acute academic stressors, measured at the end of each day, and SBP, DBP or HR. However this relationship did differ for men and women on SBP and HR, but not DBP. Specifically, follow-up analyses indicated that when moderated by worry, acute academic stressors predicted higher SBP for men (β = -0.19, t (252) = -4.36, $p <$ 0.001), but not for women. Consistent with the low elevation pattern, low worry men had significantly elevated SBP during more stressful acute academic stressors, while high worry men showed no difference in SBP during more stressful acute academic events. Low worry women had lower SBP during more stressful acute academic stressors, while high worry women had a non-significant elevation in SBP during more stressful acute academic stressors.

A different pattern was seen for HR during acute academic stressors for men (β = -0.55, t (252) = -4.413, $p <$ 0.001). Specifically, low worry men had slightly lower HR during more stressful acute academic events, while high worry men had significantly lower HR during acute academic stressors. Additionally, high worry women had a non-significant elevation in HR during more stressful acute academic stressors, while low worry women had non-significantly lower HR during acute academic stressors. This pattern was not frequently seen in other results.

Anticipatory academic stressors. Worry did not moderate the relationship between anticipatory academic stressors and SBP, DBP, or HR. When sex differences were considered, worry moderated the association between anticipatory academic stressors and SBP and DBP for men and women differently. For SBP, follow-up analyses indicated that men displayed a pattern consistent with the high elevation pattern ($\beta = 0.13$, t (266) = 2.679, $p = 0.008$). Specifically, high worry men had elevated SBP during more stressful anticipatory academic stressors, while low worry men had marginally lower SBP during anticipatory academic stressors. High worry women had non-significantly lower SBP during anticipatory academic stressors, while low worry women had non-significant elevations in SBP during anticipatory academic stressors.

On the other hand, for DBP follow up analyses indicated that men displayed a pattern consistent with the men elevated pattern ($\beta = 0.12$, t (266) = 3.846, $p < 0.001$). Specifically, regardless of worry level men had elevated DBP during more stressful anticipatory academic events. Although the trend was non-significant, high worry women had lower DBP during more stressful anticipatory academic stressors, while low worry women showed elevated DBP during anticipatory academic stressors rated as more stressful.

Results for Hypothesis 3: Emotionality

Within-Day Survey

Acute academic stressors. Individual differences in emotionality did not moderate the relationship between stressful acute academic stressors and SBP, DBP, or HR. However, when sex differences were considered emotionality moderated the association differently for men and women. Follow-up analyses indicated that emotionality moderated the effect of acute academic stressors on SBP for men ($\beta = 0.08$, t (272) = 3.432, $p = 0.001$), but not for

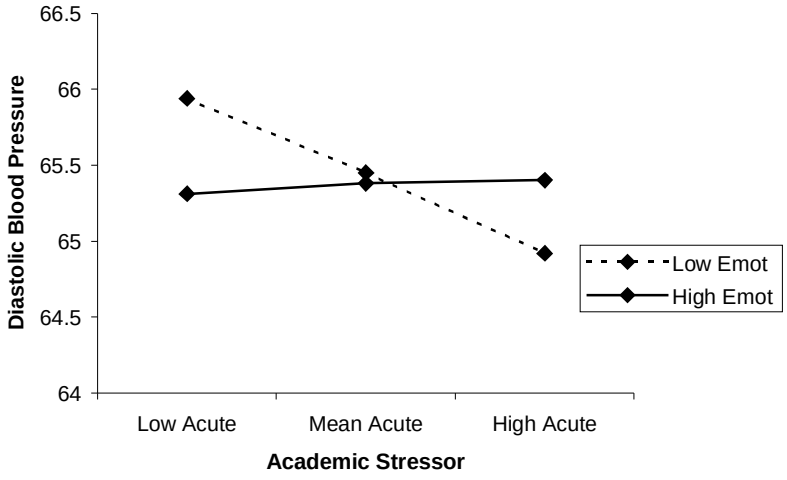
women. High emotionality men had significantly elevated SBP during more stressful acute academic events, compared to marginal elevations in SBP among low emotionality men; which is consistent with the high elevation pattern. High emotionality women had non-significantly lower SBP during more stressful acute academic stressors, while low emotionality women had non-significant elevations in SBP during acute academic stressors.

Anticipatory academic stressors. Although emotionality did not moderate the relationship between anticipatory academic stressors and cardiovascular activity, the relationship was found to differ between men and women. Follow-up analyses indicated that men displayed a pattern consistent with the men elevated pattern ($\beta = 0.02$, t (272) = 2.314, p = 0.021). Specifically, both high and low emotionality men had significantly elevated DBP during more stressful anticipatory academic stressors. High emotionality women had non-significantly lower DBP during more stressful anticipatory academic stressors, while low emotionality women had non-significantly elevated SBP during anticipatory academic stressors.

End of Day Survey

Acute academic stressors. As shown in Figure 6, across participants emotionality influenced the strength of the association between acute academic stressors, as determined by information collected at the end of each

Figure 6. Influence of acute academic stressors on DBP when moderated by emotionality.



day, and DBP (β = 0.05, t (1415) = 2.528, p = 0.012), but not SBP or HR. Specifically, participants high in emotionality had similar DBP during more stressful acute academic stressors, while participants low in emotionality had lower DBP during more stressful acute academic stressors.

The influence of emotionality on the relationship between acute academic stressors and cardiovascular responses also differed between men and women. Specifically, emotionality moderated the association between acute academic stressors and HR for men (β = -0.38, t (252) = -5.396, $p < 0.001$), but not for women. Follow-up analyses revealed that during especially stressful acute academic activities high emotionality men had significantly lower HR, while low emotionality men showed marginally lower HR. In contrast, high emotionality women had non-significantly elevated HR during more stressful acute academic stressors, while low emotionality women had non-significantly lower HR.

Emotionality also moderated the association between acute academic stressors and SBP for men (β = -0.11, t (252) = -2.766, p = 0.007), and not for women. During acute academic stressors low emotionality men had a significant elevation in SBP during more stressful acute academic stressors, while high emotionality men showed marginal elevations in SBP during more stressful acute academic stressors, which is consistent with the low elevation pattern. In contrast, high emotionality women had a non-significant elevation in SBP during more stressful acute academic stressors, while low emotionality women showed non-significantly lower SBP during acute academic stressors.

For DBP, follow-up analyses indicated that women displayed a pattern consistent with the high elevation pattern (β = 0.06, t (1158) = 4.006, $p < 0.001$). Specifically, high emotionality women had a small elevation in DBP during more stressful acute academic

stressors, while low emotionality women had considerably lower DBP during acute academic events they described as more stressful. High emotionality men also showed greater elevations in DBP during more stressful acute academic stressors compared to low emotionality men, but this pattern was non-significant.

Anticipatory academic stressors. Consistent with the pattern for acute academic stressors shown in Figure 6, across all participants emotionality did influence the relationship between anticipatory academic stressors and SBP ($\beta = 0.03$, t (1491) = 2.241, $p = 0.025$). Specifically, individuals high in emotionality had marginally elevated SBP during more stressful anticipatory academic stressors, while individuals low in emotionality had lower SBP during anticipatory academic stressors.

The influence of emotionality on the relationship between anticipatory academic stressors and cardiovascular responses differed between men and women. Follow-up analyses indicated that men showed a pattern of responding that was consistent with the men elevated pattern ($\beta = 0.16$, t (266) = 5.834, $p < 0.001$**)**. Specifically, during more stressful anticipatory academic stressors regardless of their emotionality level men had elevated DBP. While high emotionality women had lower, although not significantly lower, DBP during anticipatory academic stressors compared to low emotionality women. This same pattern existed for HR, although neither simple effect was significant when men and women were analyzed separately.

Hypothesis 3 Preliminary Discussion

Test anxiety can be thought of as a negative emotional state that can occur before, during, or after academic situations (King et al., 2000). This study looked at two components of test anxiety: worry and emotionality. Worry was defined as concern over failure and

concern over the potential consequences of failure. Emotionality was defined as negative emotions, such as arousal and unease that may occur during a stressful event (King et al.). This hypothesis predicted that participants higher in test anxiety would have elevated cardiovascular responses during stressful academic events. Across all participants acute academic stressors were associated with elevations in DBP, while anticipatory academic stressors were associated with elevations in SBP for participants higher in emotionality. However, these patterns did change when men and women were considered separately. For example, during more stressful anticipatory academic events men high and low in emotionality had elevated DBP. Additionally, during acute academic stressors, as measured by the within-day assessments, participants high in worry or in emotionality had elevated SBP. Overall, the predictions made for test anxiety in this study were supported in that participants higher in test anxiety did tend to have elevated cardiovascular responses during more stressful academic situations. These results are consistent with previous studies that have found that individuals lower in test anxiety tend to have less cardiovascular reactivity to academic events than participants with higher levels of test anxiety (Huwe et al., 1998).

Hypothesis 4

The fourth hypotheses investigated the potential moderating influence of behavioral inhibition (BIS) on cardiovascular reactivity to academic stressors. The predictions regarding BIS were purely speculative, but it was anticipated that participants higher in BIS responding would have elevated cardiovascular responses during stressful academic events.

Results for Hypothesis 4

Within-Day Survey

Acute academic stressors. Behavioral inhibition (BIS) moderated the strength of the relationship between acute academic stressors, as measured throughout the day, and DBP (β = -0.02, t (1528) = -2.295, p = 0.022), but not SBP or HR. The pattern for DBP was consistent with the low elevation pattern. Specifically, across all participants individuals low in BIS had elevated DBP during more stressful acute academic events, while participants high in BIS had lower DBP during more stressful acute academic stressors. The relationship between BIS, acute academic stressors and cardiovascular activity did not differ between men and women.

Anticipatory academic stressors. BIS did not moderate the association of anticipatory academic stressors with cardiovascular activity. However, for DBP the role of BIS in this association did differ for men and women. Specifically, follow-up analyses indicated that BIS moderated the association between anticipatory academic stressors and DBP for men (β = 0.01, t (272) = 2.447, p = 0.015), but not for women. Regardless of BIS level men had significantly elevated DBP during more stressful anticipatory academic stressors, consistent with the men elevated pattern. Conversely, low BIS women had elevated DBP during more stressful anticipatory academic stressors, and high BIS women had lower DBP during anticipatory academic stressors, but this pattern was not significant.

End of Day Survey

Acute academic stressors. BIS did not moderate the association between acute academic stressors and cardiovascular activity for the academic stress ratings collected at the end of each night. However, BIS did influence HR during acute academic stressors as

measured by the end of day dichotomous variables (β = -3.39, *t* (1415) = -2.005, *p* = 0.045). Across all participants a pattern similar to the low elevation pattern emerged. Specifically, individuals low in BIS had elevated HR during more stressful acute academic events, while individuals high in BIS had lower HR during acute academic stressors.

When sex differences were considered, BIS had a unique moderating effect for men and women. Follow-up analyses revealed that men displayed a pattern similar to the men elevated pattern (β = -0.07, *t* (252) = -3.106, *p* = 0.003), and regardless of BIS level men had significantly elevated SBP during more stressful acute academic stressors. Low BIS women had non-significantly lower SBP during acute academic stressors, while high BIS women had a non-significant elevation in SBP.

Anticipatory academic stressors. BIS did not moderate the association between anticipatory academic stressors and SBP, DBP, or HR for the academic stress ratings collected at the end of each night. However, when the dichotomous end of day variables were analyzed, BIS was found to influence the strength of the association for anticipatory academic stressors and SBP (β = 2.09, *t* (1491) = 2.27, *p* = 0.023), but not for DBP or HR. Specifically, across all participants a pattern similar to the high elevation pattern emerged where individuals high in BIS had elevated SBP during more stressful anticipatory academic stressors, while individuals low in BIS had lower SBP during anticipatory academic stressors.

The moderating role of BIS on the relationship between anticipatory academic stressors and DBP differed for men and women. Follow-up analyses indicated that regardless of BIS level men had significantly elevated DBP during more stressful anticipatory academic stressors (β = 0.10, *t* (266) = 4.229, *p* < 0.001); consistent with the men elevated pattern.

While women high in BIS had non-significantly lower DBP during more stressful anticipatory academic stressors, and low BIS women had a non-significant elevation in DBP during more stressful anticipatory academic stressors.

Hypothesis 4 Preliminary Discussion

Because no previous studies have examined the role of BIS in predicting cardiovascular reactivity to academic stressors, the predictions in this study were purely speculative. However, based on previous research looking at the relationship between BIS and negative emotions (Amodio et al., 2007; Gray, 1990) it was predicted that participants higher in BIS would have elevated cardiovascular responses during stressful academic events; this prediction was partially supported. This study found that for both men and women, those higher in BIS tended to have lower HR and DBP during acute academic stressors, while participants higher in BIS had elevated SBP during anticipatory academic stressors. It is unclear why high BIS was associated with elevated BP during anticipatory academic stressors, but with lower HR and DBP during more stressful acute academic stressors. It is interesting that when gender differences were considered this pattern changed. Specifically, during acute and anticipatory academic stressors men had elevated cardiovascular responses, regardless of their BIS level. Future research needs to further explore the relationship between stressful academic events, behavioral inhibition, and cardiovascular responses to further clarify these relationships.

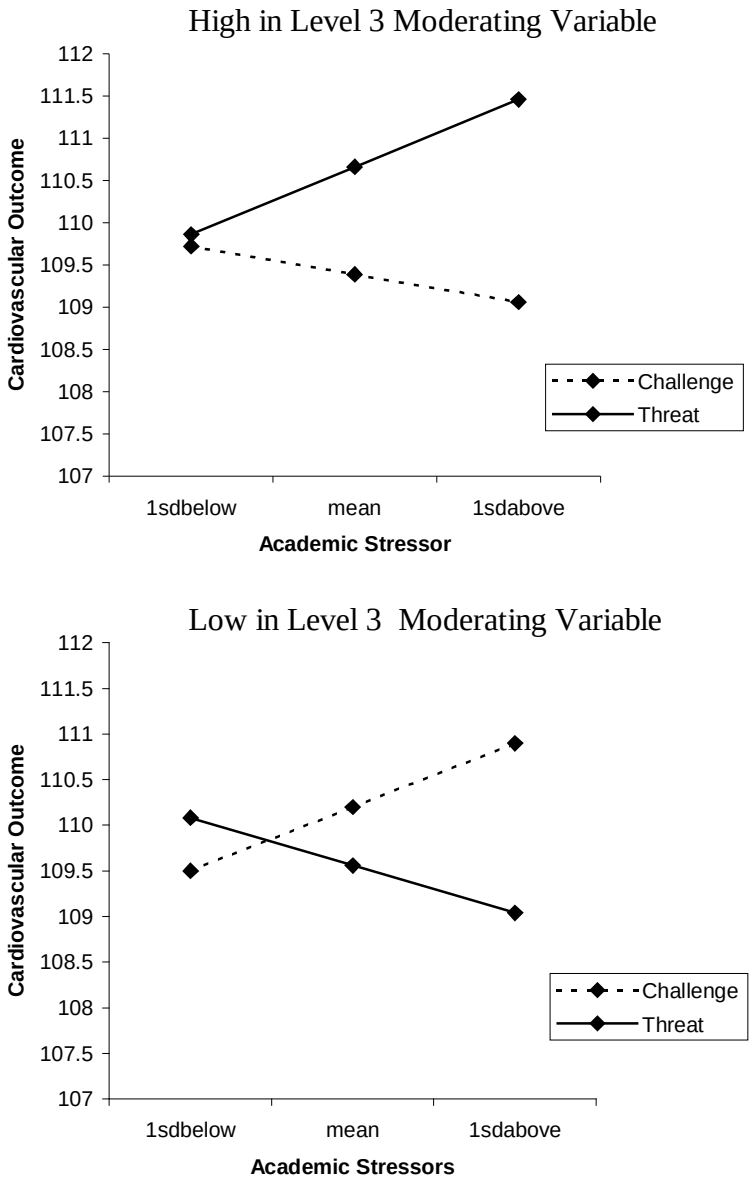
Exploratory Analyses

To further understand the data, an additional set of analyses were conducted investigating how both stress appraisals and the level 3 individual difference variables (worry, emotionality, and behavioral inhibition) worked together to moderate the association

between academic stressors and cardiovascular responses. Because these analyses are exploratory, no hypotheses were developed and gender differences were not explored.

One distinct pattern emerged from these analyses, the high threat/low challenge elevation pattern. In this pattern participants high in the level 3 moderating variable (worry, emotionality, or BIS) who made threat appraisal had elevated cardiovascular activity, while individuals who made challenge (low threat) appraisals had no difference or lower cardiovascular activity (see Figure 7). In contrast, as Figure 7 shows, participants low in the moderating variable who made challenge appraisals had elevated cardiovascular activity, while participants who made threat appraisals had either no difference or lower cardiovascular responses during academic stressors.

Figure 7. Example of the high threat/low challenge elevation pattern.



Worry and Stress Appraisal

Within-Day Survey

Acute and anticipatory academic stressors. Worry and stress appraisal did not influence the strength of the association between cardiovascular activity and acute academic stressors or anticipatory academic stressors.

End of Day Survey

Acute academic stressors. Interaction of worry and stress appraisal jointly moderated the association between acute academic stressors and DBP ($\beta = 0.296$, t (1362) = 3.227, p = 0.002). Specifically, consistent with the high threat/low challenge pattern, during more stressful acute academic stressors individuals high in worry who made threat appraisals had elevated DPB, while participants high in worry who made challenge appraisal had lower DBP. Additionally, participants low in worry who made threat appraisals had lower DBP, and those who made challenge appraisals also had lower DBP during more stressful acute academic stressors.

Anticipatory academic stressors. Worry and stress appraisal also moderated the association between anticipatory academic stressors and SBP ($\beta = 0.002$, t (1434) = 2.519, p = 0.012). Specifically, during more stressful anticipatory academic stressors participants high in worry who made threat appraisal had elevated SBP, while those high in worry who made challenge appraisals had no difference in their SBP during more stressful anticipatory academic stressors. Additionally, individuals low in worry who made threat appraisals had lower SBP, while participants low in worry who made challenge appraisals had elevated SBP during more stressful anticipatory academic stressors, which is consistent with the high threat/low challenge elevation pattern of responding shown in Figure 7.

Emotionality and Stress Appraisal

Within-Day Survey

Acute academic stressors. Emotionality and stress appraisal moderated the strength of the association between acute academic stressors and SBP (β =0.003, t (1470) = 2.203, p = 0.0028). Consistent with the high threat/low challenge elevation pattern, during more stressful acute academic stressors participants high in emotionality who made threat appraisals had elevated SBP, while individuals high in emotionality who made challenge appraisals had lower SBP. Additionally, participants that were low in emotionality who made threat appraisals had lower SBP, while participants low in emotionality who made challenge appraisals had elevated SBP during more stressful acute academic stressors.

Anticipatory academic stressors. Emotionality and stress appraisal did not moderate the association between anticipatory academic stressors and cardiovascular activity.

End of Day Survey

Acute academic stressors. Emotionality and stress appraisal moderated the strength of the association between acute academic stressors and HR (β = 0.004, t (1362) = 2.182, p = 0.029) and DBP (β =0.003, t (1362) = 2.192, p = 0.028). Specifically, during more stressful acute academic stressors participants high in emotionality who made threat appraisals had elevated DBP, while participants high in emotionality who made challenge appraisals had lower DBP. During more stressful acute academic stressors participants low in emotionality showed no difference between their threat and challenge appraisals on DBP.

For HR, during more stressful acute academic stressors participants high in emotionality who made threat appraisals had elevated HR, while participants who made challenge appraisals had lower HR during more stressful acute academic stressors. However,

participants low in emotionality who made challenge appraisals during more stressful acute academic stressors had elevated HR, while participants who made threat appraisals showed no difference in their HR, which is consistent with the high threat/low challenge elevation pattern.

Anticipatory academic stressors. Emotionality and stress appraisal did not moderate the association between anticipatory academic stressors and cardiovascular activity as indicated by the end of day participant stress ratings. However, emotionality and stress appraisal did moderate the association between anticipatory academic stressors and HR (β = 0.185, t (1435) = 2.12, p = 0.034), as determined by the end of day dichotomous variables. Consistent with the high threat/low challenge elevation pattern, participants high in emotionality who made threat appraisals had elevated HR, while those who made challenge appraisals had lower HR during more stressful anticipatory academic stressors. Low emotionality individuals who made challenge appraisals had elevated HR during more stressful anticipatory academic stressors, while low emotionality participants who made threat appraisals had lower HR.

BIS and Stress Appraisal

Within-Day Survey

Acute and anticipatory academic stressors. Worry and stress appraisal did not influence the strength of the association between cardiovascular activity and acute academic stressors or anticipatory academic stressors.

End of Day Survey

Acute academic stressors. BIS and stress appraisal did not moderate the association between acute academic stressors and cardiovascular activity.

Anticipatory academic stressors. BIS and stress appraisal moderated the association between anticipatory academic stressors and HR (β = 0.004, t (1435) = 2.258, p = 0.024). As shown in Figure 7 and consistent with the high threat/low challenge elevation pattern, during more stressful anticipatory academic stressors participants high in BIS who made threat appraisals had elevated HR, and participants high in BIS who made challenge appraisals showed lower HR. Conversely, participants low in BIS who made threat appraisals had lower HR, and participants low in BIS who made challenge appraisals had elevated HR.

BIS and stress appraisal also moderated the association between anticipatory academic stressors and SBP (β = 0.003, t (1434) = 2.476, p = 0.014). During more stressful anticipatory academic stressors participants high in BIS who made threat appraisals had elevated SBP, and participants high in BIS who made challenge appraisals showed a marginal elevations in SBP. In contrast participants low in BIS who made threat appraisals had lower SBP, and participants low in BIS who made challenge appraisals had elevated SBP.

Exploratory Analysis Preliminary Discussion

The exploratory analyses in this study revealed that the influence of stress appraisal on cardiovascular responses during stressful academic events depends on dispositional characteristics. For example, individuals *high* in test anxiety who made threat appraisals during acute and anticipatory stressors had elevated HR and SBP, while individuals high in test anxiety who made challenge appraisals during academic stressors had lower cardiovascular responses. This finding is consistent with the prediction that threat appraisals would be associated with elevated cardiovascular activity. However, when individuals *low* in test anxiety made threat appraisals during anticipatory and acute academic stressors they had

lower HR and SBP, while individuals low in test anxiety who made challenge appraisals had elevated cardiovascular responses. This is consistent with the findings from Quigley et al. (2002) that challenge appraisal are associated with cardiovascular activity.

This pattern suggests that understanding how challenge and threat appraisals influence cardiovascular responses during stressful academic events depends on individual differences in test anxiety. A similar pattern was seen for HR during anticipatory academic stressors for BIS. It is possible that individual differences not investigated in this study may help to further clarify the relationship between academic stressors, threat/challenge appraisal and cardiovascular responses. For example, previous studies have shown that active coping is associated with elevated cardiovascular responses during stressful situations appraised as challenging, while active coping is associated with lower cardiovascular responses during stressful situations appraised as threatening (Tomaka, Blascovich, Kelsey, & Leitten, 1993).

GENERAL DISCUSSION

This study found that during times of increased academic stress men experienced increases in their SBP, DBP and HR. These changes in cardiovascular activity were moderated by stress appraisal and individual differences in test anxiety and BIS. The pattern for women was much less consistent, indicating that men had more predictable cardiovascular reactivity to academic stressors.

Gender Differences

This gender difference in cardiovascular reactivity to academic stressors was unexpected, but not unprecedented. Several studies have found that males show greater reactivity to stress than females (Ennis et al. 2001; Weekes et al., 2006). For example, Ennis et al. (2001) found that females had lower cortisol then men in anticipation of an academic stressor. Additionally, boys exposed to chronic negative events have been found to have higher DBP than females (Brady & Mathews, 2006).

Taylor et al.'s (2000) tend and befriend theory provides one possible explanation for why females showed less consistent patterns of reactivity during stressful academic events. The tend and befriend theory proposes that, in contrast to the traditional fight or flight response, women tend to respond to stressful situations with affiliation. Specifically, women are more likely to seek social connections or to draw on their friendships during stressful times. Therefore, during stressful situations women may not rely as heavily on the fight-or-flight response, which includes elevated blood pressure and elevated heart rate. During stressful situations the hormone oxytocin is released, and oxytocin is associated with affiliative behaviors in women (Taylor, 2006). As oxytocin increases women's affiliative behaviors also tend to increase. Animal research has shown that increasing the level of

oxytocin leads to a reduction in the physiological stress response (Taylor). Likewise, when oxytocin is paired with positive social interactions women show a less extreme stress response.

It is important to note however, that this sample included a relatively small number of men (n = 10). This small number of men makes it more likely that specific cases were driving the results, especially those interactions between gender and individual differences in test anxiety and BIS. Analysis of the distribution of men and women showed that test anxiety was positively skewed for men, while BIS was negatively skewed. The gender specific findings in this study should be replicated with a larger sample of men.

Within Day Survey vs. End of Day Survey

This study is in a unique position to compare within day assessments with short-term retrospective assessments. Both types of assessments were used in this study because each provides a different perspective on the same academic stressor. The within day survey allowed participants to provide information on stressful academic events as they were occurring, while the end of day survey allowed participants to reflect back on the day and identify the stressors that they felt were the most stressful. Although other studies have found that within-day assessments and retrospective assessments do not always correlate (Stone et al., 1998), this study found that academic stressors reported on the end of day survey were also typically reported on the within day survey. Of course, participants reported more acute and anticipatory academic stressors on the within day survey than the end of day survey.

One implication of this difference is that the end of day survey likely captures only more stressful or enduring daily academic stressors. Because the within day survey may be completed as the stressors is actually occurring, it is more likely to capture only the primary

appraisal of the situation. Primary appraisals are the initial judgments about how a potential stressors may effect one's well-being (Folkman & Lazarus, 1985). Once a situation is appraised as stressful, secondary appraisals occur and coping resources are mobilized. Cardiovascular activation and the duration of the stress response are a function of both primary and secondary appraisals. On the end of day survey, participants were asked to report only their most stressful experiences from that day; the minor stressors or those that were easily addressed through the secondary appraisal process are not likely to be reported. Despite (or maybe because of) the fewer number of stressors reported on the end of day survey this method of stressor identification was more successful at predicting cardiovascular activation than the within day assessment. This may be because the threshold for what was considered as a stressor was higher on the end of day assessment method.

Another difference between the within day survey and the end of day survey is the potential for bias in the recall and rating of academic stressors. The misattribution of arousal theory (Schachter & Singer, 1962) suggests that misattribution can occur when physical or emotional arousal caused by one event is attributed to a separate event. Walking fast or arguing with a friend can all induce psychological and physiological arousal. A person may recognize his/her own arousal, which may have been captured on the ambulatory blood pressure monitor, and associate current activities with that arousal. Because the length of time between arousal and assessment is greater for the end of day reports, this method of stressor identification may be more affected by such biases.

Implications and Applications

Future studies might replicate the findings of this study and could expand this work in several ways. An important extension would be to replicate in a different sample. The

participants in this study were primarily college freshman and sophomores. Younger and older participants may show different cardiovascular responses to daily academic stressors. Additionally, as is clear from the generally low scores on test anxiety and behavioral inhibition, this was not a clinical sample. The patterns of reactivity seen in this study might differ considerably when using a clinical sample.

Addressing this topic in a younger sample has particular relevance because emphasis on standard testing is increasing in today's school system, and students are taking standardized tests at younger and younger ages. Intervention programs may help mediate the potential negative effects of daily academic stressors on cardiovascular responses. For example, with training individuals high in test anxiety can learn to respond to academic stressors with lower anxiety, potentially preventing the elevations in their cardiovascular activity they would normally experience during testing situations. If a test anxiety reduction class that promotes stress reduction techniques is not available, participation in study groups and fewer assignments may be helpful to students with particularly high test anxiety.

While daily academic stressors do not show any immediate health effects, it is important to remember that over time daily academic stressors may contribute to the development of long-term health problems, especially in men. These health problems can include heart disease, hypertension (Matthews, et al., 2003; Treiber et al., 2003), and a weakened immune system (Evans, et al., 1994). Because students are likely to be in school for 16 years or more before obtaining a four-year degree, early intervention is important to preventing these negative health consequences.

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Appendix A

CONSENT TO PARTICIPATE IN RESEARCH

Everyday Life and Blood Pressure at Western Washington University

Purpose and Benefit:
Ambulatory blood pressure measurement is the state of the art method for assessing blood pressure. Because multiple measurements are taken over the course of a day as people go about daily routines, ambulatory blood pressure monitoring makes it possible to study people's responses to everyday life events. Relatively few studies have examined how psychological factors may influence the extent to which daily life experiences may translate into temporary increases in blood pressure. This study will help to improve scientific understanding of how normal life activities are related to physical health.

I UNDERSTAND THAT:

1) As part of this study I will wear a blood pressure monitor for 4 school days, and respond to brief questions on a Palm Pilot during the day, and provide some additional information before I go to bed. I will report to Miller Hall each morning, where I will be fitted for the monitor. I'll leave the monitor on for the entire day. It will inflate approximately every hour, and I will complete a short set of questions on the Palm Pilot immediately following each blood pressure measurement. I will need to refrain from vigorous physical activity on days when I am wearing the cuff. The questions will relate to recent social interactions and school-related events. My final visit will be a session where I will return the equipment and complete additional questionnaires. This session should take approximately 45 minutes, and other morning sessions should take approximately 30 minutes, in addition to the assessments throughout the day. The total time commitment is therefore estimated to be approximately 5 hours.

2) There are no anticipated risks with participation. The blood pressure cuff may be uncomfortable or annoying at times, but should never be painful. You will benefit from the study by receiving a report on all of your blood pressure readings at the end of the study, receiving materials on stress and coping in everyday life. Participants who return the equipment and have complete data (at least 40 blood pressure and Palm Pilot responses over 4 days, 4 evening surveys, and the final questionnaire) will receive 5 Experimetrix credits and a gift certificate.

3) My participation is voluntary, I may choose not to answer certain questions or withdraw from participation at any time, and my data will be erased and not used in the study. However, I must return all equipment. I understand that the researcher will continue to contact me if I have not returned the ambulatory blood pressure monitor and the Palm Pilot. Failure to return equipment will be considered theft.

4) I understand that all information is gathered in this study is confidential. Code numbers rather than names will be assigned to all completed forms, and all personally

identifying information will be destroyed by the investigator after the data have all been collected. My name will not be associated with any of my responses at any time.

5) My signature on this form does not waive my legal rights of protection.

6) This experiment is conducted by Kristen Conley, under the supervision of Dr. Barbara Lehman. If you have any questions about the study, please contact Kristen at (360)650-6421 (lab) or (360)201-6251 (cell/pager), or by email at dailybp@gmail.com. If you have any questions about your participation or your rights as a research participant, contact Geri Walker, WWU Human Protections Administrator (HPA), (360) 650-3220, geri.walker@wwu.edu. If during or after participation in this study you suffer from any adverse effects as a result of participation, please notify the researcher directing the study or the WWU Human Protections Administrator.

SIGNATURE OF RESEARCH PARTICIPANT

I have read the above description and agree to participate in this study.

_____ _____

Participant's Signature Date

_____

Participant's PRINTED NAME

NOTE: Please sign both copies of the form and retain the copy marked “Participant.”

Appendix B

Research Equipment Use Agreement

Research Equipment Description: **Spacelabs Medical ABP Monitor**
Arm cuff with hose
Carrying case
Shoulder strap
Palm Pilot

I have agreed to participate in a research project conducted by Dr. Barbara Lehman. As part of Dr. Lehman's project, I have been assigned the use of the research equipment described above. I am aware that the monitoring device I am using is a delicate piece of equipment and due to the high cost of replacement it is necessary to ensure that that monitor and its accessories are returned in proper working order. I hereby agree to the following:

- To use and care for the equipment in a responsible manner and in accordance with instructions provided by Dr. Lehman and her research team.
- To protect the equipment from theft, loss, damage and deterioration.
- Not disassemble or make any alterations or modifications to the equipment.
- To keep the equipment in my custody and not to loan, or otherwise provide the equipment to any other person.
- Inform Dr. Lehman's team immediately of any problem, malfunction, loss, damage or theft of the equipment. To report problems, call (360)650-6421 (lab) or (360)201-6251 (cell/pager), or email dailybp@gmail.com.

I agree to return the equipment in the same condition as originally delivered.

I have read and understand this Research Equipment Use Agreement.

_____	_____	_____
Signature of Student	Date	AMBP#
_____	_____	
Name of Student (Please Print)	W#	

Appendix C

Everyday Life and Blood Pressure at Western Washington University

Participant FAQ: Daytime Reports and Blood pressure Readings

You should leave the ambulatory blood pressure monitor (ABPM) on your body at all times during the day on the days when you are participating in the study. You should also keep the Palm Pilot with you at all times during this study, as well.
This equipment must be kept dry, and should not be dropped!
If equipment is damaged, please turn off equipment and immediately contact the Experimenter.

During the daytime, the monitor is set to record your blood pressure once per hour.

When the cuff is going off:

- Please allow your arm to hang loosely, slightly away from the body.
- Please keep your arm as still as you can. This includes keeping your hand still!
- Please ensure that the cuff is in the proper position. The bottom of the cuff should be about two fingers above your elbow-crease, and the white arrow should be pointing at the center of that crease.
- It may be uncomfortable at first, but you should get used to it with time.

After each blood pressure reading, you need to answer the questions on the palm pilot.

- To activate the Palm Pilot, turn it on. The on switch is the small button on the bottom left, with the green vertical line on it.
- To have a Palm Pilot response "count" for a "slider scale" question, you must move the slider at least a little bit, and then press "done." We interpret an untouched slider to mean that the question must have been skipped by mistake.

Before bed, for the night. (Not to be confused with taking naps during the daytime.)

- Please remove the blood pressure cuff, wrap the tube neatly around the cuff, and store in a safe place. *You'll need to bring all materials with you for your appointment the next morning.*
- Complete the end-of-day survey. It's located online at http://myweb.students.wwu.edu/zollwek/eod_survey.htm (Paper copies available by request.) Be sure to include your 3-digit participant ID number (available on your appointment card).

Troubleshooting!

- If the cuff starts to go off and you need to postpone that reading (because you are driving, etc.) you may manually stop it, and manually restart it at a later time.
    - **To stop the reading, mid-inflation:** Push the blue button once.
    - **To restart the reading:** Push the blue button again, a few minutes later.
    - **To turn the cuff off:** Flip the little switch towards the bottom of the cuff
- **Sometimes, the cuff will inflate twice in about two minutes' time.** Typically this means that the first attempt to get a reading didn't work. Please make an effort to hold especially still during the second inflation.
    - If it re-takes several readings in one day, please contact us ASAP. (There may be a technical problem.)
- **In the unlikely event that the monitor or cuff causes extreme pain or pain not normally associated with blood pressure measurement, please stop the measurement by hitting the blue stop/start button on the top of the monitor.**
    - If this happens, please contact us ASAP!!!
- **Contact us immediately if experience pain or if the equipment is lost or damaged.** If you have you have any questions about the study, problem with the Palm Pilot or blood pressure cuff, please also contact us.

Our 24-hour technical help & emergency phone number is:

(360) 201-6251

(Please leave a message with your problem & contact number. We'll call back soon!)

Other contact information:
Lab phone (if running late) (360) 650-6421 e-mail for non-emergency questions: dailybp@gmail.com

Appendix D

SESSION #1 *Please check equipment each time!*

Date ____ / ____ / _____	Time	Participant #	AMBP#	Palm #

Researcher (your name): _____

1. Ask: "Are you left-handed or right handed?"
   ☐ Left Handed
   ☐ Right Handed

2. Because blood pressure is often related to height and weight, I need to take your weight now. Please step on the scale. Participant weight (in pounds, to nearest .5 lb as measured by scale)

   [ ]

3. Can you tell me your height? Participant height (self-report) _____feet _____inches

4. Approximately how many hours of sleep did you get last night? [ ] hours. Note to nearest ½ hour

5. Do you have a family history of hypertension (high blood pressure)?
   Mother (yes/no) _____
   Father (yes/no) _____
   Siblings (# with hypertension, out of total # of siblings) _____/_____
   Grandparents (# with hypertension, out of total # of grandparents) _____/_____

6. Measure upper part of the non-dominant arm, at the widest part. Note below
   -Arm circumference, in cm [ ]

   Choose Cuff Size Chosen:
   ☐ Small: 17-26 cm
   ☐ Regular: 24-32 cm
   ☐ Large: 32-42 cm
   ☐ x-Large: 38-50 cm

7. Place cuff on arm and activate BP monitor. Feel for arterial pulse first, put arrow over artery. Be sure the cuff is equally tight at top and bottom, and that edges are smooth.

8. Time AMBP was activated: _____. Take test reading by pushing the blue button, and look at reading after pump is finished. Test reading:

Systolic: [ ] Diastolic: [ ] Heart Rate: [ ]

9. Activate Palm Pilot, and go through questionnaire with participant. Answer any questions.

10. Press button twice to activate automatic readings. One additional BP reading will be taken at this time. (Reading results may or may not show up. If reading shows up, record the data below.)

Systolic: | Diastolic: | Heart Rate:

Appendix E

SESSION _____(INDICATE 2, 3 or 4) *Please check equipment each time*

Date ____ / ____ / _____	Time	Participant #	AMBP #	Palm #

Researcher (your name): _____

1. Recharge new batteries for AMBP (15 minutes).
2. As soon as participant arrives, ask, "Could you tell me about your experience wearing the BP cuff yesterday? Did you have any problems with it? Were you able to wear it the whole day?" [*Note any problems or comments.*]

3. Download AMBP data (using directions), and Palm Pilot data (using directions).

4. After AMBP data has been downloaded, disconnect and quickly replace the batteries (if they are out for more than 1 minute, the monitor will need to be re-initialized). If you are able to change the batteries quickly, you should NOT need to initialize the monitor.

5. Did you have any difficulty with the Palm Pilot?[*Note any problems or comments.*]

6. Did you complete the end-of-day survey on the computer last night?
   ☐ Yes
   ☐ No
   If no, ask "Would you prefer to use a paper version?" Provide paper versions for remaining days.

7. Approximately how many hours of sleep did you get last night? ☐ hours. Note to nearest ½ hour.

8. Place cuff on arm and activate BP monitor. Feel for arterial pulse first, put arrow over artery. Be sure the cuff is equally tight at top and bottom, and that edges are smooth. Be sure to adjust cuff to address any discomfort experienced the previous day. You may want to consider a different size cuff.

9. Time AMBP was activated ☐. Take test reading by pushing the blue button one time. Assuming the monitor was not re-initialized, you only need to press the button once.

10. Thank the participant, and confirm the time of the next appointment.

Appendix F

FINAL SESSION *Please check equipment each time!*

Date ____ / ____ / _____	Time	Participant #	AMBP#	Palm #

Researcher (your name): _____

1. Have participant sign in upon arrival. Ask them to take a seat while you download the AMBP data (print two copies) and the Palm data.

2. Then ask, "Could you tell me about your experience wearing the BP cuff? Did you have any problems with it? Were you able to wear it the whole day?" [*Note any problems or comments.*]

3. "Did you have any difficulty with the Palm Pilot? Did you feel that the questions effectively captured your experiences throughout a day?" [*Note any problems or comments.*]

4. "Did you complete the end-of-day survey on the computer last night?"
   - ☐ Yes
   - ☐ No

5. Approximately how many hours of sleep did you get last night? ☐ hours. Note to nearest ½ hour

6. Start MediaLab (using instructions). "Please complete the final portion of this study now. This should take about 30-40 minutes. Please keep yourself focused on the task, and refrain from distracting activities (e.g., talking on your cell phone). Let me know if you have questions. When you are about half way through you will be asked to have one of us start the second portion of the questionnaire for you."

7. Make sure all equipment has been returned in ORIGINAL condition (place a check mark next to each item returned). Please note any damage, and contact me ASAP. Be sure to place items in need of recharging in appropriate bin, or recharge them!
   - ☐ Monitor
   - ☐ Blue case for Monitor
   - ☐ Cuff
   - ☐ Batteries
   - ☐ Palm Pilot
   - ☐ Stylus
   - ☐ Carrying bag

8. How many AMBP assessments were completed? ☐

9. Did this person complete at least 40 BP and Palm readings, completion of end of day surveys, and completion of MediaLab surveys?
   - ☐ Yes
   - ☐ No

10. When participant has finished, follow the debriefing protocol. Note any comments on reverse.

Appendix G

Debriefing procedures

- As participants to come to the table for debriefing. Tell them that the purpose of this study was to investigate the influence of daily life events on blood pressure. We looked at social and academic stressors that are likely to have been stressful for college-age students. The study is important because it helps to explain some of the processes by which daily events may influence health. The questionnaires you just completed may help us to understand individual differences in the effect that daily experiences have on blood pressure.

- "Do you have any questions about the study?"

- We have a printout that summarizes your blood pressure readings over the course of the study. Although normal *resting* blood pressure is typically around 120/80 (on average), measures taken throughout the course of a day typically fluctuate—so don't worry about any particular reading. Systolic BP is the top number (e.g., 120), and that is the maximum pressure put on your arteries (when your heart is contracting). The bottom number is diastolic BP, which is the pressure when your heart is resting between beats. [*If blood pressure readouts are not available, inform them that their readouts will be emailed to them later in the day and they can print them out at their leisure.*]

- Provide participants with their blood pressure readouts. Your reading gives you information about your "healthy" blood pressure. These can be used to establish a baseline, should problems arise later in life). You have readings for systolic BP (peak pressure of blood in artery), diastolic BP (pressure when the heart is at rest), and heart rate.
    - Remind participants that fluctuation in BP is a completely normal part of everyday life. BP tends to be highest when you are at school or work, and lowest during leisure or sleep times.
    - If you have further questions about your readout, or want to know more, please consult the materials and/or make an appointment at student health to discuss the reading. (Show where the phone number is.)
    - On your next checkup, it might be useful for you to take along a copy of these readings to leave with your doctor. That way the Dr. can answer any questions, and will also have a record of your BP readings.
    - *If asked:* Typical systolic BP ranges between 90 and 129, while typical diastolic BP ranges between 60 and 80. Low blood pressure by itself isn't a problem, and you can have very low readings and it can work for your body. Low BP is only diagnosed (and is only a problem) if you have symptoms of low BP (e.g., dizziness when standing up, chest pain). But people who are active, don't smoke, and generally take care of themselves tend to have lower BP. If you are worried about your BP, talk to your doctor.

- Okay, I know that some of the questions you answered on the computer just now may have made you think about some sensitive topics. I also know that through this study you have been focusing on the events that have happened over the course of these days, and on your

emotional and physical responses to those events. Because of this, we are giving everyone information about campus health and psychological services.

- Review the brochures.
- The counseling center is on the 5th floor of Old Main (reachable by the *South* elevator). The counseling center can be used to provide information on different stress management techniques and personal counseling.

- Any questions?

- Thank you so much for participating. If appropriate, say "You have qualified for the iPod drawing. This should take place close to the end of Spring quarter." You will hear from us close to the end of Spring quarter. You'll probably get an email if you are not selected, and an email and/or phone call if you are.

- In the meantime, please choose a prize from our "Goodie Bag".

- Thank you for your help. If you have any remaining thoughts or questions, please email the dailybp@gmail.com account, and we'll get back to you.

Appendix H

Within-Day Questionnaire

000|TO ENSURE PROPER READING Was this the first thing you saw when turned on the palm pilot?

No (Go to 001)
Yes (Go to 067)

001|At The time that the blood pressure reading occurred, how happy did you feel?

"Less" to "more" (slide bar)

002|How tired did you feel?

"Less" to "more" (slide bar)

003|How anxious did you feel?

"Less" to "more" (slide bar)

004|How sad did you feel?

"Less" to "more" (slide bar)

005|How worried did you feel?

"Less" to "more" (slide bar)

006|How much strain did you feel?

"Less" to "more" (slide bar)

007|How frustrated/angry did you feel?

"Less" to "more" (slide bar)

008|How stressed did you feel?

"Less" to "more" (slide bar)

009|To what extent were your feelings influenced by participating in this study?

"Less" to "more" (slide bar)

010|At The time that the blood pressure reading occurred, where were you?

Home
School
Work
Vehicle
Outside
Other

011|At The time that the blood pressure reading occurred, what was your posture?
- Standing
- Sitting
- Lying Down

012|At The time that the blood pressure reading occurred, how comfortable were you with the temperature?
- Cold
- Chilly
- OK
- Warm
- Hot

013|Think about your physical activity in the 10 minutes before the blood pressure reading. Describe your physical movement:
- None (sitting/napping)
- Limited (standing)
- Light (walking)
- Moderate (jogging)
- Heavy (running)
- Extreme (sprinting)

014|At The time that the blood pressure reading occurred were you engaged in any of the following leisure activities?
- Video game
- Movie/TV
- Recreational reading
- Attending event (sports, concert...)
- Driving
- Other
- Not participating in a leisure activity

015|At The time that the blood pressure reading occurred were you talking?
- Yes No

016|Consumption since last BP reading?
- Check all that apply
  - Food
  - Alcohol
  - Caffeine
  - Drug/medicine
  - Cigarette
  - Other

017|In the last 10 minutes...Did you need to work hard?
- “Less” to “more” (slide bar)

018|In the last 10 minutes...Could you do something else if you chose to?
"Less" to "more" (slide bar)

019|In the last 10 minutes...Were difficulties piling up?
"Less" to "more" (slide bar)

020|In the last 10 minutes...Were your thoughts about things upsetting you?
"Less" to "more" (slide bar)

021|In the last 10 minutes...Were you thinking about or participating in social events?
Yes (Go to 022)
No (Go to 029)

022|For the recent social activities, were they stressful for you?
"Less" to "more" (slide bar)

023|For the recent social activities, who were you interacting with?
Check all that apply
Spouse/Partner
Sibling
Parents
Other relatives
In-laws
Son/Daughter

024|For the recent social activities, who were you interacting with?
Check all that apply
Boyfriend/Girlfriend
Classmate/Co-worker
Friend
Teacher/Supervisor
Acquaintance
Stranger

025|For the recent social activities, what type of interaction was it?
In person
Talking on telephone
Computer/Texting
Speaking in front of a group

026|For the recent social activities, how many people were involved?
0
1
2
3-8
8-15

16+

027|For the recent social activities, how close did you feel to the person(s) involved?
"Less" to "more" (slide bar)

028|For the recent social activities, was there discussion of personal feelings?
"Less" to "more" (slide bar)

029|In the 10 minutes prior to the blood pressure reading, were you thinking about participating in academic activities?
Yes (Go to 030)
No (Go to 051)

030|For the recent academic activities, were they stressful for you?
"Less" to "more" (slide bar)

031|What kind of academic activity was it? Studying for an exam?
Yes (Go to 032)
No (go to 033)

032|How stressful was it?
"Less" to "more" (slide bar)

033|Schoolwork
Yes (Go to 034)
No (go to 035)
034|How stressful was it?
"Less" to "more" (slide bar)

035|Taking exam
Yes (Go to 036)
No (go to 037)

036|How stressful was it?
"Less" to "more" (slide bar)

037|Taking a Quiz
Yes (Go to 038)
No (go to 039)

038|How stressful was it?
"Less" to "more" (slide bar)

039|Writing a paper
Yes (Go to 040)
No (go to 041)

040|How stressful was it?
"Less" to "more" (slide bar)

041|Participating in Class
Yes (Go to 042)
No (go to 043)

042|How stressful was it?
"Less" to "more" (slide bar)

043|Active in class
Yes (Go to 044)
No (go to 045)

044|How stressful was it?
"Less" to "more" (slide bar)

045|Attending lecture
Yes (Go to 046)
No (go to 047)

046|How stressful was it?
"Less" to "more" (slide bar)

047|Thinking about school
Yes (Go to 048)
No (go to 049)

048|How stressful was it?
"Less" to "more" (slide bar)

049|Other
Yes (Go to 050)
No (go to 051)

050|How stressful was it?
"Less" to "more" (slide bar)

051|In the last 10 minutes, were you thinking about or participating in other important activities?
Yes (Go to 052)
No (go to 053)

052|How stressful was it? Please describe this event on your end of day survey tonight
"Less" to "more" (slide bar)

053|For the following questions, Think of what you were doing the 10 minutes prior to the BP reading: Was the situation stressful?
"Less" to "more" (slide bar)

054|Was the situation fair?
"Less" to "more" (slide bar)

055|Did you feel the outcome was good?
"Less" to "more" (slide bar)

056|Did your activities make you feel uncomfortable?
"Less" to "more" (slide bar)

057|Did what you were doing have long term consequences for you?
"Less" to "more" (slide bar)

058|Was what you were doing related to the future?
"Less" to "more" (slide bar)

059|Was the outcome of what you were doing important to you?
"Less" to "more" (slide bar)

060|Were you successful at what you were doing?
"Less" to "more" (slide bar)

061|Was what you were doing manageable?
"Less" to "more" (slide bar)

062|Did you have control over the outcome?
"Less" to "more" (slide bar)

063|Did you have the ability to succeed at what you were doing?
"Less" to "more" (slide bar)

064|Did you worry about others' reactions?
"Less" to "more" (slide bar)

065|Was anyone treating you badly?
"Less" to "more" (slide bar)

066|Approximately how long ago did the blood pressure monitor activate?
Just now
05 minutes ago
10 minutes ago
20 minutes ago
30 minutes ago

45 minutes ago
More than 60 minutes ago

067|This final question is to ensure no responses were made accidentally or incorrectly. Did you answer all the questions intentionally and accurately? If not then please redo the questionnaire
Yes No

Appendix I

Complete this before you go to bed each night that you have used the blood pressure cuff.

Your feelings today

This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word.

Indicate to what extent you felt this way during the day today. Use the following scale to record your answers:

1	2	3	4	5
Very slightly or Not at all	A Little	Moderately	Quite a bit	Extremely

---

1. Interested
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

2. Distressed
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

3. Excited
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

4. Dissatisfied with myself
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

5. Upset
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

6. Happy
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

7. Strong
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

8. Guilty

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

1	2	3	4	5
Very slightly or Not at all	A Little	Moderately	Quite a bit	Extremely

9. Scared

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

10. Irritated at others

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

11. Hostile

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

12. Enthusiastic

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

13. Proud

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

14. Irritable

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

15. Alert

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

16. Ashamed

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

17. Inspired

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

18. Sad

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

19. Nervous

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

20. Disgusted

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

21. Angry with myself

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

1	2	3	4	5
Very slightly or Not at all	A Little	Moderately	Quite a bit	Extremely

22. Attentive

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

23. Determined

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

24. Jittery

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

25. Active

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

26. Afraid

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Today's Events

1. How many quizzes did you take today?

- ☐ None
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4 or more

2. How many exams did you take today?

- ☐ None
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4 or more

3. How many papers or take-home exams did you have due today?

- ☐ None
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4 or more

4. Approximately how many hours did you spend in class today?

- ☐ None
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ 6 or more

5. How many arguments did you have with your romantic partner, friend, or family members?

- ☐ None
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4 or more

Today's Stressful Events

Please think back on today and list all of the stressful academic, social, and other events you experienced throughout the day. Using the form below, please indicate what the stressful event

was, why that event was stressful, and approximately when it occurred. After identifying the stressful event, please use the scale below each question to rate the stressfulness of the event.

1a. Please briefly describe one **Academic, Social or Other** stressful event that occurred today.

1b. Please describe why this event was stressful to you

1c. Please rate the stressfulness of this event on the bar below

Not at All Extremely

1d. This event was:

- ☐ Academic
- ☐ Social
- ☐ Other

1e. Approximately when did this event occur? (ex: 4:30pm, 11:00am)

1f. Did you report on this event when you were completing any of your Palm Pilot reports?

- ☐ Yes
- ☐ No

If yes, approximately what time did you complete that report?

REPEATED 6 TIMES, OR UNTIL NO MORE ACADEMIC STRESSORS REMAINED

Consumption

1. Did you take any prescription or over-the counter medication today (not including birth control)?

- ☐ Yes
- ☐ No

a. If yes, please indicate the type of medication

a. Dosage:

b. Time of Day:

2. Did you take birth control today?

- ☐ Yes
- ☐ No
- ☐ Not Applicable (N/A)

3. Approximately how many cigarettes did you smoke today? (Please fill in the number of cigarettes. Enter "0" for no cigarettes.)

4. Approximately how many alcoholic drinks did you consume today? (Please fill in the number, assuming one beer = one glass of wine = 1 shot of hard alcohol. Enter "0" for no alcohol.)

5. At any point today did you self-medicate for stress?

- ☐ Yes
- ☐ No

6. Please indicate any other substances you consumed today (remember this information is completely confidential).

- ☐ None
- ☐ Marijuana
- ☐ Stimulant drugs (e.g., cocaine)
- ☐ Hallucinogens
- ☐ Other (Please indicate below what substance you consumed)

Participant Information

1. **3 Digit Participant ID number** (NOT your WWU student number):

2. Day in study:

- ☐ Day 1
- ☐ Day 2
- ☐ Day 3
- ☐ Day 4
- ☐ Other (Day 5, Day 6, etc.)

Appendix J

Using the guidelines below, you will make three determinations for each description in the spreadsheet: 1. Is it an academic stressor? 2. Is it a social stressor? 3. Is it an "other" stressor? You will assign a 0 or a 1 for each of three types of stressors.

Stressors are experiences that threaten a self-relevant goal (i.e. graduating from college, passing an exam/test, etc.). Academic stressors are self-relevant thoughts or events relating to school performance or to overall school success. Social stressors are self-relevant thoughts or events relating to social performance that are threats to a goal (having a healthy romantic relationship or getting along with roommates). Other stressors are thoughts or events relating to self relevant goals that are not social or academic. These stressors might relate to physical health or safety, to financial stability, or to some other self-relevant goal.

When coding, you need to take into consideration why the student indicated that the event was stressful. If no indication is given that the event has had an impact on a self-relevant goal of the student, it should not be classified as a stressor (as such it would receive a score of "0"). Additionally, if a student lists an exam as a stressor, but also indicates that it was really no "big deal," or "not really stressful" this would be classified as a non-stressor (and receive a score of "0"), indicating it was not threatening a self-relevant goal. Another example, ignoring homework might initially be seen as a non-stressful event. But it becomes stressful if the student expresses concern that the failure to complete the assignment could result in class failure.

Note that it is possible for you to decide an event is a stressor in more than one domain. For example, a group project for class might be academically stressful if there are concerns about how the project might influence academic performance, but it might also be a social stressor if the individual concerned about the group interactions getting in the way of an important social relationship.

Academic Stressors: events that have the potential to influence an important academic goal
Code as 1
Common examples:

- Working on and/or turning in Homework
- Worry about academics
- Taking notes in class
- Not understanding lecture material

Social Stressors: events that have the potential to influence an important social goal
Code as 1
Common examples:

- Fight with significant other
- Roommate tension
- Group project gone awry
- Trouble with co-workers

Other Stressors: events that have the potential to influence an important goal that is not academic or social
Code as 1
Possible examples

- Concerns about physical health or safety
- Financial problems
- Anything that threatens an important self-relevant goal that is not academic or social in nature

Non Stressors
Code as 0
Common examples:

- Nothing stressful happened today/N/A
- Taking notes in class
- Trying to stay awake in class

Appendix K

Academic stressors are self-relevant thoughts or events relating to school performance or to overall school success. Acute stressors are typically defined as short-term, immediate threats to a goal (i.e. most exams/tests, etc.). Anticipatory stressors are longer-term events that have the potential to influence a major goal *in the future* (homework, etc.). For this study, the key distinction between anticipatory and acute stressors is whether the goal is currently being threatened (acute) or if the threat is impending (anticipatory).

When coding, you first need to consider whether the event threatened a goal related to academics. For example, ignoring homework might initially be seen as a non-stressful event. But it becomes stressful if the student expresses concern that the failure to complete the assignment could result in class failure or have another consequence that is important to the student.

If the event was a stressor it is then important to determine why the student indicated the event was stressful. Your coding choice will depend on whether the stressor is immediate (acute, coded as 2) or in the future (anticipatory, coded as 1).

Acute Academic Stressors: Short-term, immediate threats to a goal. ***Code as 2***

Common examples:

- Taking a Test/Exam
- Public speaking
- Getting a bad grade

Anticipatory Academic Stressors: Events that have the potential to influence a major goal in the future.

Common examples: ***Code as 1***

- Working on and/or Turning in Homework
- Worry about academics
- Taking notes in a stressful class
- Studying
- Not understanding lecture material

Appendix L

Please indicate which response would best summarize your feelings just **prior to the final examination in an important course.** There are no right or wrong answers. Do no spend too much time on any one statement, but give the answer which seems to describe how you generally feel.

1. I feel confident and relaxed while taking tests.
   Almost never
   Sometimes
   Often
   Almost always

2. [a] While taking examinations I have an uneasy, upset feeling.
   Almost never
   Sometimes
   Often
   Almost always

3. [b] Thinking about my grade in a course interferes with my work on tests.
   Almost never
   Sometimes
   Often
   Almost always

4. [b] I freeze up on important exams.
   Almost never
   Sometimes
   Often
   Almost always

5. [b] During exams I find myself thinking about whether I'll ever get through school
   Almost never
   Sometimes
   Often
   Almost always

6. [b] The harder I work at a test, the more confused I get.
   Almost never
   Sometimes
   Often
   Almost always

7. [b] Thoughts of doing poorly interfere with my concentration on tests.
   Almost never
   Sometimes
   Often
   Almost always

8. [a] I feel very jittery when taking an important test.
   Almost never
   Sometimes
   Often
   Almost always

9. [a] Even when I'm well prepared for a test, I feel very nervous about it.
   Almost never
   Sometimes
   Often
   Almost always

10. [a] I start feeing very uneasy just before getting a test paper back.
    Almost never
    Sometimes
    Often
    Almost always

11. [a] During tests I feel very tense.
    Almost never
    Sometimes
    Often
    Almost always

12. I wish examinations did not bother me so much.
    Almost never
    Sometimes
    Often
    Almost always

13. During important tests I am so tense that my stomach gets upset.
    Almost never
    Sometimes
    Often
    Almost always

14. [b] I seem to defeat myself while working on important tests.
    Almost never
    Sometimes
    Often
    Almost always

15. [a] I feel very panicky when I take an important test.
    Almost never
    Sometimes
    Often
    Almost always

16. [a] I worry a great deal before taking an important examination
    Almost never
    Sometimes
    Often
    Almost always

17. [b] During test I find myself thinking about the consequences of failing.
    Almost never
    Sometimes
    Often
    Almost always

18. [a] I feel my heart beat very fast during important tests.
    Almost never
    Sometimes
    Often
    Almost always

19. After an exam is over I try to stop worrying about it, but I can't.
    Almost never
    Sometimes
    Often
    Almost always

20. [b] During examinations I get so nervous that I forget facts I really know.
    Almost never
    Sometimes
    Often
    Almost always

Note: a = questions related to emotionality, b = questions related to worry

Appendix M

Listed below are a number of statements concerning personal attitudes and characteristics. Please read each statement and consider the extent to which you TYPICALLY OR GENERALLY agree or disagree with it, using the scale below each statement.

1. When I see an opportunity for something I like, I get excited right away.
   Strongly Disagree
   Disagree
   Neutral
   Agree
   Strongly Agree

2. [a] I worry about making mistakes.
   Strongly Disagree
   Disagree
   Neutral
   Agree
   Strongly Agree

3. I'm always willing to try something new if I think it will be fun.
   Strongly Disagree
   Disagree
   Neutral
   Agree
   Strongly Agree

4. I go out of my way to get things I want.
   Strongly Disagree
   Disagree
   Neutral
   Agree
   Strongly Agree

5. [a] Even if something bad is about to happen to me, I rarely experience fear or nervousness.
   Strongly Disagree
   Disagree
   Neutral
   Agree
   Strongly Agree

6. When good things happen to me, it affects me strongly.
    Strongly Disagree
    Disagree
    Neutral
    Agree
    Strongly Agree

7. [a] I have very few fears compared to my friends.
    Strongly Disagree
    Disagree
    Neutral
    Agree
    Strongly Agree

8. When I get something I want, I feel excited and energized.
    Strongly Disagree
    Disagree
    Neutral
    Agree
    Strongly Agree

9. [a] Criticism or scolding hurts me quite a bit.
    Strongly Disagree
    Disagree
    Neutral
    Agree
    Strongly Agree

10. I crave excitement and new sensations.
    Strongly Disagree
    Disagree
    Neutral
    Agree
    Strongly Agree

11. When I go after something I don't hold back.
    Strongly Disagree
    Disagree
    Neutral
    Agree
    Strongly Agree

12. [a] If I think something unpleasant is going to happen I usually get pretty "worked up."
    Strongly Disagree
    Disagree
    Neutral
    Agree
    Strongly Agree

13. When I want something, I usually go all-out to get it.
    Strongly Disagree
    Disagree
    Neutral
    Agree
    Strongly Agree

14. [a] I feel pretty worried or upset when I think or know somebody is angry at me.
    Strongly Disagree
    Disagree
    Neutral
    Agree
    Strongly Agree

15. If I see a chance to get something I want, I move on it right away.
    Strongly Disagree
    Disagree
    Neutral
    Agree
    Strongly Agree

16. It would excite me to win a contest.
    Strongly Disagree
    Disagree
    Neutral
    Agree
    Strongly Agree

17. I will often do things for no other reason than they might be fun.
    Strongly Disagree
    Disagree
    Neutral
    Agree
    Strongly Agree

18. [a] I feel worried when I think I have done poorly at something.
    Strongly Disagree
    Disagree
    Neutral
    Agree
    Strongly Agree

19. When I'm doing well at something, I love to keep at it.
    Strongly Disagree
    Disagree
    Neutral
    Agree
    Strongly Agree

20. I often act on the spur of the moment.
    Strongly Disagree
    Disagree
    Neutral
    Agree
    Strongly Agree

Note: a = questions related to BIS