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The Effects of Background Stress on Cardiovascular Responses to Acute Stress

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THE EFFECTS OF BACKGROUND STRESS ON CARDIOVASCULAR RESPONSES TO ACUTE STRESS

By
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To my amazing family, my parents, Tom and Juli, and my brother T.J. Thank you for supporting and guiding me and always believing in me.

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ABSTRACT

CHRISTINE M. BOCEK: The Effects of Background Stress
on Cardiovascular Responses to Acute Stress
(Under the direction of Michael T. Allen, Ph.D.)

The goal of this study was to investigate further the nature of the relationship between background stress and cardiovascular response to acute stress. Possible relationships between mood and background stress, and background stress and psychological distress were also explored. The background stress levels of 59 undergraduate students were measured using the Perceived Stress Scale (PSS). Measures of psychological distress were taken using the General Health Questionnaire-12 (GHQ-12), mood was assessed with the Brief Mood Induction Scale (BMIS), and other relevant data were collected. Systolic blood pressure, diastolic blood pressure and heart rate were measured through three 8-minute rest periods, an 8-minute Mood Induction Task, and a 3-minute Mental Arithmetic Task. It was hypothesized that a positive correlation would be present between PSS measures and cardiovascular reactivity, due to the majority of research supporting a theory of heightened reactivity in individuals with higher stress. There was a significant period main effect for all three cardiovascular measures, indicating that the Mental Arithmetic Task did produce reactivity above rest. However, data analyses indicated that there was no significant correlation between background stress and reactivity. It was also hypothesized that there would be a significant positive correlation between PSS measures and changes in negative mood during the Mood Induction Task. T-tests of before and after measures of mood variable

scores on the BMIS indicated change in mood, showing that the mood induction worked. Analyses of data showed no relationship between PSS or GHQ measures and change in negative mood. Hypothesis 3 stated that there would be a significant positive correlation between PSS and GHQ measures. There was evidence of a significant correlation between background stress and measures for psychological distress. It is concluded that the relationship between background stress and reactivity may have a complexity requiring more detailed knowledge of subjects' stress. There is not enough evidence, based on the data collected, to draw conclusions about the relationship between PSS and change in negative mood. Finally, strong correlation between PSS and GHQ measures is supported by prior research. Further research into the relationship between background stress and psychological stress may be of interest.

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LIST OF ABBREVIATIONS

BP	Blood Pressure
HR	Heart Rate
ANS	Autonomic Nervous System
SNS	Sympathetic Nervous System
PNS	Parasympathetic Nervous System
BGS	Background Stress
GSR	Galvanic Skin Reflex
TPR	Total Peripheral Resistance
CV	Cardiovascular
CVD	Cardiovascular Disease
HRV	Heart Rate Variability
EKG	Electrocardiogram
SBP	Systolic Blood Pressure
DBP	Diastolic Blood Pressure
PSS	Perceived Stress Scale
BMIS	Brief Mood Induction Scale
GHQ-12	General Health Questionnaire 12
df	Degrees of Freedom
p	Significance Level
F	F-ratio
ANOVA	Analysis of Variance

INTRODUCTION

The Effects of Background Stress on Cardiovascular Response to Acute Stress

Stress is a pervasive part of human life. Each person may have different coping mechanisms or ways to deal with stress, but there is still an optimum threshold for a healthy amount of stress (Schneiderman, Ironson, & Siegel, 2005). Small everyday stressors may build up or a large scale event may exceed what a person can handle. Either way, the human body has an instinctive reaction to stressful situations (Schneiderman, Ironson, & Siegel, 2005).

The autonomic nervous system (ANS) consists of two separate branches, the sympathetic nervous system (SNS) and the parasympathetic nervous system (PNS) (Hassett, 1978). These two parts of the ANS work as opposing forces to maintain stability within the body, in response to changes in the environment. The main purpose of the SNS is mobilization of the body; activation of this branch is characterized primarily by changes in breathing and blood circulation (Turner, Sherwood, & Light, 1992).

Acute or short-term stress, or the reaction to an immediate threat, causes stimulation of the SNS. Otherwise referred to as the "fight or flight response", this reaction by the body can be measured objectively (Turner, Sherwood, & Light, 1992). Acute stress can be induced in a laboratory setting, and a subject's reaction can then be measured through elevated blood pressure (BP), changes in heart rate (HR), galvanic skin reflex (GSR), or other methods (Hassett, 1978). The body's response to acute stress is highly complex and involves rapid changes that affect the brain, lungs, heart, immune system, metabolism, and skin (McEwen, 2007).

Chronic stress refers to continuing, unresolved stressors of varying degrees; it can also be referred to as long-term stress or background stress. Background stress is more accurately described as a measure of chronic stress without specific duration or currency (how long ago a stressor ended or if it is still ongoing) (Gump & Matthews, 1999). Although some studies have tried to measure chronic or background stress by measuring life events to get a more objective index of chronic stress, this is very difficult to accurately measure. It also does not take into account differences in how people perceive these life events. Therefore, the current study is taking the strategy used by most researchers in this area by asking the perceived stress that people are experiencing. So when we refer to perceived stress, we are actually talking about the amount of background or chronic stress that people feel they are experiencing even though the actual life events may be quite different.

It is the persistent nature of a stressor that makes it chronic. In the case of chronic stress, the body must suppress the immediate "fight or flight response" (Serido, Almeida, & Wethington, 2004). The acute stress response can eventually cause problems if it is continuously (chronically) activated (Schneiderman, Ironson, & Siegel, 2005).

Chronic SNS stimulation of the cardiovascular system, as a result of stress, has been shown to cause persistent increases in blood pressure and vascular hypertrophy. This happens because the muscles that constrict the vasculature become thicker; it eventually causes an elevated resting BP and a tendency to have a vascular response to different stressors (Schneiderman, Ironson, & Siegel, 2005). These changes in BP and vascular response can become compounded with other physiological symptoms and result in numerous cardiovascular problems.

Not only does background stress create a burden upon the body, but several studies indicate that heightened response to acute stress amplifies cardiovascular risk (Siegrist & Klein, 1990). Research has shown continuous exaggerated cardiovascular reactivity, linked to stress, can cause health problems such as atherosclerosis (plaque buildup on the insides of arteries), obstructive coronary heart disease, and possible stroke or cardiac failure (Lovallo & Wilson, 1992). The fact that people with a propensity to have increased cardiovascular reactivity to stressful events have a higher risk for cardiovascular disease (CVD) is called the reactivity model (Pieper & Brosschot, 2005).

The SNS response initiated by the body is also associated with changes in immune response and immune cell traffic. Prolonged activation of immune responses has been correlated with lesser immune system functioning. This happens because even though there may be a greater release of immune cell types, the immune cells function less effectively overall (Pike et al., 1997). Specifically, a lower T cell response and lessened natural killer (NK) cell efficacy, in response to an acute stressor, are associated with those individuals who have a higher chronic stress measurement (Benschop et al., 1994).

In addition to health problems associated with stress, it also appears to accelerate a person's physical aging. The continuous activation of the SNS and its negative effects have been linked with the observation that hardships and a stressful life can "age" a person; this is called the weathering hypothesis (McEwen, 2007). In light of the effects that stress can have on a persons' cardiovascular, immunological and overall health, it is important to better understand the relationship between chronic stress, in the form of background stress, and acute stressors.

The study of the effects of background stress on acute stressors also has significant importance in light of catastrophic events. September 11, 2001, Hurricane Katrina, Three Mile Island and other tragedies provide an opportunity to look into the way stress shapes people's lives (Gump et al., 2005). However, in addition to the large numbers of individuals who are subject to extreme stress from natural disasters, terrorist attacks, and other occurrences (i.e., life events), it is also important to understand how everyday stress (i.e., daily hassles) contributes to and creates chronic stress (Serido, Almeida, & Wethington, 2004). Currently research done to investigate the link between background stress (chronic stress) and acute stress response has suggested two possible ways that acute stress and background stress might interact.

Some studies have found that people who have had a major event in their lives or who have other sources of stress in their lives, causing them to suffer background stress, show heightened responses to acute stress. On the other hand, other studies have found evidence of background stress acting as a sort of inoculation, causing people who are used to background stress to have less reactivity to acute stress.

Studies that have found evidence to support background stress causing an increase in acute stress response tend to think the buildup of stress in an individual's life can make them less able to adapt to new acute stressors. Gump et al. (2005) found that children directly affected by 9/11, tested right after and one year from the attack, showed significantly greater reactivity to acute stress tasks. Though the response diminished over time, the results suggest that a potent background stressor can cause heightened cardiovascular response. Other studies have also found evidence to suggest increased response to chronic stress that does not have a distinct onset (i.e., 9/11) (Matthews et al., 1997). Matthews et al. evaluated chronic stress in children and found those children who reported important or ongoing interpersonal stress had elevated diastolic blood pressure (DBP) and total peripheral resistance (TPR) to acute stressors. Both of these cardiovascular measures reflect increased resistance to blood flow in the peripheral vasculature. The study further examined the children's sociodemographic variables and personality characteristics which might affect acute stress response, and data from these measures did not account for their results.

A study on vital exhaustion also found that background stress can act to diminish a persons' ability to deal with acute stress. Keltikangas-Järvinen & Heponiemi (2004) found participants with higher levels of long-term mental stress had heightened cardiac reactivity to task-induced stress (acute stressors). There was further evidence for vital exhaustion, characterized by extreme fatigue and loss of mental and physical energy, being the result of the body's continuous physiological (SNS stimulation) overreaction to stress. Stress load was seen as the determining factor, along with some individual traits, that caused the incapability to adapt to acute stress (Keltikangas-Järvinen & Heponiemi, 2004).

Pike et al. (1997) focused primarily on the immunological and neuroendocrine aspects of background stress and acute stress interaction, but also showed results for exaggerated sympathetic response in subjects with antecedent (background) life-stress. The outcome of the study was that individuals with higher background stress rated higher subjective distress during tasks and showed heightened cardiovascular reactivity. In other words, the presence of chronic stress affected responsivity to acute stress in a psychological and a physiological way (Pike et al., 1997). Similar effects were found in an experiment comparing physiological reactivity of younger subjects versus older ones (Schneiderman, Ironson, & Siegel, 2005). There was evidence for exaggerated cardiovascular response to acute stress by both young subjects and older subjects. Though heightened acute stress responses in younger individuals in good health were seen as more adaptive or resilient, they were still present, and older individuals in poor health had the highest measure of responsivity. In the older individuals, researchers noted that if the background stress was too strong or persistent, it caused exaggerated reactivity and could possibly be linked to CVD (Schneiderman, Ironson, & Siegel, 2005).

Finally, the majority of studies analyzed by Gump & Matthews (1997), in order to look at whether background stress heightens or dampens reactivity, showed evidence for increased acute reactivity. The study stipulates that the findings of all the studies are subject to such variants as background stress currency and duration. It is also mentioned that personality traits of certain individuals play a large role in acute stress response. However, all of these variants considered, the majority of research is still in support of heightened acute stress response by those with background stress.

The other suggested relationship between background stress and acute stress is that having prior stress acts to repress reactivity. The idea is that people who have background stress have been hardened or desensitized to stress and, therefore, react less to it (Matthews, Gump, & Owens, 2001). There is less evidence for this line of thought.

Siegrist & Klein (1990) found their high stress group, a subgroup with high occupational stress, reacted with a diminished response to acute stress tasks. They explained that long-term exposure to a stressor causes adrenergenic activity and may result in a loss of the efficiency of a persons' cardiovascular system, which in turn causes suppressed reactivity. This constant activity, ongoing autonomic activation, could cause a person to have an exhausted or lessened response as a coping mechanism (Siegrist & Klein, 1990).

Other research has also shown an adaptation to task demands (acute stressors) in those individuals with background (chronic) stress (Schaubroeck & Ganster, 1993). In their experiment, there was a significant negative correlation between stress exposure and reactivity to acute challenges. It was argued that individuals with high amounts of negative background stress demonstrate lower cardiovascular responsivity due to an inability to cope. Ultimately, they found background stress causes diminished reactivity (Schaubroeck & Ganster, 1993). Matthews, Gump, and Owens (2001) discuss in their research the possibility that repeated efforts to cope with chronic stress actually deplete the body's ability to handle new challenges. The results of the study showed those individuals with background stress exhibited a suppressed acute stress response, with some evidence that this effect is more prevalent in women.

Several studies found age to be a factor in whether or not individuals showed heightened or decreased acute stress response. According to Schneiderman, Ironson, & Siegel (2005), acute stress in young, healthy people with background stress can be adaptive and not necessarily unhealthy. Stawaski et al. (2008) also found age played an important role in a person's response to acute stress in light of background stress. They also noted the important role of intraindividual variability in stress perception and reactivity in acute stress response.

In an examination of 19 studies on background stress and reactivity, Gump and Matthews (1999) also found a minority of studies showed reduced reactivity to acute stressors by those subjects with higher background stress. These studies suggested that subjects go through a habituation, and that a person may be able to adapt to low levels of background stress. The low level is key, as they observed habituation occurs, in general, for low or medium intensity stress with increasing exposure, but sensitization (heightened reactivity) occurs for high intensity stress at any frequency. In short, a person with background stress of a non-severe nature may be toughened and have less cardiovascular reactivity in an effort to prepare the body for future stress (Gump & Matthews, 1999).

The purpose of the current study was to assess whether perceived background stress, regardless of the source, affected responses to acute stressors. We designed this study to further investigate the differing opinions as to whether background (chronic) stress makes people more responsive or readies people, making them immune or less responsive. We hoped to find further evidence on whether there would be a positive or negative (or no) relationship between the degree of reactivity to laboratory challenges and perceived background stress. That is, is background stress (perceived stress) related to increased or diminished responses to acute challenges?

In order to further investigate this possible link between background stress and acute stress response we measured subjects' background stress with the Perceived Stress Scale (PSS) and then put them through an acute stressor in a laboratory setting. Our acute stressor was a mental arithmetic task, which is a stress task commonly used to measure reactivity. Cardiovascular reactivity was measured using BP and HR. Although there are conflicting findings assessing the relationship of background stress and acute stress response, we thought that those subjects with higher background stress would show heightened cardiovascular reactivity to the acute stress task, given its more frequent finding in the literature.

The following hypothesis was drawn from the discussed literature:

> **Hypothesis 1**: Scores on the PSS will have a significant positive correlation to HR and BP change during a stressful laboratory task. In other words, those participants with a higher measure of background stress (BGS) will exhibit higher HR and BP levels during the Mental Arithmetic Task. We expect that the Mental Arithmetic Task will be stressful enough to produce a significant reactivity increase. However, it is unclear if subjects will show an increase in reactivity during the Mood Induction Task.

We also hoped to investigate possible connections between background stress and mood. The research found relating to stress and negative mood (affect) seems to support the notion that higher stress contributes to more negative ratings, thoughts, and outlooks in individuals (Matthews, Gump, & Owens, 2001). There is substantial evidence showing that reported exposure to stress is related to increases in negative affect (Stawski et al., 2008). Other research shows that mood can be influenced by such things as pictures, stories, writing and music, and that individuals may assign importance to affective information based on amount of arousal (Clore & Storbeck, 2006). The idea that arousal plays a role in a person applying significance to emotion and feeling is important in that those persons with heightened reactivity (autonomic arousal) to stress are the subjects we hypothesized to have a stronger mood change.

We looked at the evidence for a connection between stress and negative mood and the studies showing the ability to induce mood through different means and combined them. The mood induction part of this study was to see if it was possible to use a song to induce a negative mood state and then measure whether those individuals under greater stress showed a stronger change in mood. The idea is that stress will affect the severity of mood, and the ease with which it is induced.

In order to find a song or music passage that would induce a negative mood, a pilot study was run of eight songs with no words. These songs were akin to classical music, but more contemporary, most of them being parts of movie soundtracks. After looking empirically at the eight songs, two passages of music in the pilot study were found to elicit the greatest increase in sad and gloomy adjective states, and the largest decrease in happiness. These two songs were used as the music passage in this study.

Our thought is those people who are more reactive to stress will have a stronger increase in negative mood and decrease in positive mood.

> **Hypothesis 2:** There will be a significant positive correlation between PSS measures and changes in negative mood during the Mood Induction Task. Those individuals who have a higher background stress level according to the PSS will exhibit a stronger response to negative mood than those individuals with a lower level of background stress.

Finally, we propose to look into the nature of the relationship between background stress and psychological distress. According to Serido, Almeida, and Wethington (2004), background (chronic) stress may have a distinct effect on psychological distress. In their study, they found that six different stress variables were positively correlated with psychological distress. These results were attributed to accumulated life experiences that cause stress overlap and interact (much like the explanation of background stress). The interaction of four of the major life stressors measured seemed to actually predict psychological distress measures in subjects (Serido, Almeida, & Wethington, 2004). A study of students found those with higher measures of chronic stress had exaggerated acute stress response and also had elevated levels of psychological distress (Lepore, Miles, & Levy, 1997). Though there was a significant correlation between background stress and psychological distress, they did not find a correlation between acute (episodic) stress and psychological distress. Lepore, Miles, and Levy (1997) explained that this could possibly be attributed to the persistence of chronic stress causing a "coping cost", or a feeling of increased helplessness in subjects, which causes increased psychological distress over time. Measures of psychological distress in the current study were taken using the general health questionnaire 12 (GHQ-12).

Hypothesis 3: The amount of stress measured with the PSS will be positively correlated with our measure of psychological distress, the GHQ-12.

METHODS

Participants

Participants were 59 undergraduate students at the University of Mississippi. These students were recruited using the online sign up system and fulfilled a required research participation component in their general psychology classes by being involved in this study. All participants signed an informed consent form; both the form and this study were approved by the Institutional Review Board of the University of Mississippi. Each participant filled out a short health questionnaire to screen out those who had identified cardiovascular disorders or high blood pressure, and those who were smokers. There were 7 males and 52 females in the sample. There were 36 whites, 21 African Americans, 1 other ethnicity, and 1 with no ethnicity given.

Physiological Recording Apparatus

A blood pressure cuff was placed on the non-dominant upper arm of the participant. The cuff was connected to a Suntech Tango automated blood pressure monitor (Suntech, Inc., Raleigh, NC) which measured both systolic and diastolic blood pressure as well as heart rate.

The electrocardiogram (EKG) was transduced using 3 disposable silver-silver chloride electrodes (product number TD-142G; Discount Disposables, St. Albens, VT). The three electrodes were placed on the participant's upper body and leg: one below the clavicle on each side of the chest and one on the right leg just above the ankle. The EKG was transduced to measure heart rate variability (HRV) for future analysis. HRV is not reported in this study.

Experimental Tasks

Mood Induction through Music Passage— The mood induction task was an 8-minute long passage of music consisting of two songs. These songs had been piloted in a previous study and were found to have the greatest effect on participant's moods. In the pilot study, both songs caused a significant increase in sad and gloomy feelings, and a significant decrease in happy feelings of participants. The songs were the opening theme song to the movie *Schindler's List* and the "Evenstar" song from the movie *Lord of the Rings: The Two Towers*. Participants were asked to sit quietly in a comfortable chair and focus on the music passage, which they listened to through headphones at a consistent intensity level for all participants.

Mental Arithmetic Task— Participants were asked to subtract from 1,764 by 13's as fast as they could. If the participant subtracted incorrectly, the experimenter corrected them and told them to start again at the next correct answer. The task lasted for 3 minutes.

Questionnaires

Questionnaires used in this study include the perceived stress scale (PSS), the brief mood induction scale (BMIS), and a general health questionnaire (GHQ-12).

Perceived Stress Scale (PSS). The PSS is a 10-item scale which provides a score for the degree to which situations in a person's life are considered stressful by that person. The scale assesses the extent to which participants find their lives unpredictable, uncontrollable, and overloading (Cohen, Kamarck, & Mermelstein, 1983). The scale was designed for examining the role of nonspecific appraised stress in the onset and recovery from disease, behavioral disorders, and as a measure of experienced levels of stress. The scores derived from the scale measure the experienced level of stress as a combination of objective stressful events, coping processes, personality factors, and so forth (Cohen, Kamarck, & Mermelstein, 1983). The PSS has been shown in previous research to have ample internal and test-retest reliability (Cohen, 1986).

Brief Mood Induction Scale (BMIS). The BMIS is a mood adjective scale that asks respondents to rate to what degree they are experiencing 16 adjectives at the moment they fill out the scale. It includes two adjectives from each of eight mood states: happy and lively, loving and caring, calm and content, active and peppy, jittery and nervous, grouchy and fed up, tired and drowsy, and sad and gloomy. The ratings for each adjective range from one (definitely do not feel) to seven (definitely feel), with three (do not feel) and 5 (slightly feel) as labeled ratings in between (Mayer & Gaschke, 1988). The scale, in this study, was used to create an objective measure for change in negative affect from the mood induction task. Participants filled out the BMIS immediately before and after listening to the music passage.

General Health Questionnaire-12 (GHQ-12). The GHQ-12 professes to index psychological well-being; it has been utilized in a multitude of health studies and there are numerous studies validating the measures (Mäkikangas, Feldt, & Kinnunen, 2006). The GHQ-12 has been identified as a useful way to assess the amount of psychological morbidity in a sample and as a way to evaluate effectiveness of treatment (Campbell & Knowles, 2007). The GHQ-12 has been found to evaluate such factors as general dysphoria (feelings of anxiety, restlessness, and dissatisfaction) or depressed mood, stress and coping, and self-esteem or self-worth (Campbell & Knowles, 2007). Though the GHQ exists in several forms, the GHQ-12 has become the most widely used form of the scale due to its fairly good validity (Mäkikangas, Feldt & Kinnunen, 2006).

In addition, a health screening questionnaire which looked for participants who might be smokers or who might have cardiovascular problems, and a demographic questionnaire were given. Other questionnaires looking into narcissism and impulsivity were administered but were not used in this study.

Procedures

Students were asked to meet in the Psychophysiology Laboratory, where they were greeted and given a consent form. If they agreed to be involved in the study, they signed the consent form and then were given a packet to complete. This packet consisted of several questionnaires, including a health screening questionnaire for cardiovascular problems, a demographic questionnaire, general health questionnaire (GHQ-12), Perceived Stress Scale (PSS), and the Barratt Impulsivity Scale (BIS-11).

After completion of the packet, participants had the blood pressure cuff placed on their non-dominant upper arm, and the electrodes for the EKG attached to their torso and leg. They were asked to sit in a comfortable chair and begin the initial rest period of 8 minutes. During the rest periods, participants watched a yoga video. The video was meant to keep participants occupied and keep them from falling asleep. Blood pressure and HR were measured after 3 minutes, 5 minutes and 7 minutes, for this and all rest periods. Following this rest period, participants filled out a BMIS and then listened to a music passage with headphones. The passage consisted of two songs and lasted approximately 8 minutes. BP and HR were taken at the 1:00, 3:00, 5:00, and 7:00 mark of the song period. At the completion of the music passage, the participant was again asked to fill out the BMIS. The participant then entered another 8 minute rest period.

After the second rest period, the participant began the mental arithmetic task. This task lasted 3 minutes. During this time, cuff inflation for BP and HR measurement were started at the :10, 1:10, and 2:10 mark. Once this task was completed, a final 8-minute resting period ensued.

At the completion of the last rest period, the electrodes and blood pressure cuff were removed and any questions that the participant had about the study were answered.

Data Analysis

A series of one-way repeated measures analyses of variance (ANOVA) were performed to examine whether the mental Arithmetic or Mood task produced increases in blood pressure and/or heart rate above levels seen at rest. To examine the relationships between chronic stress and acute stress, we ran Pearson correlation coefficients with the Perceived Stress Scale (PSS) scores compared with the measure of change (reactivity) for heart rate and blood pressure to the mood induction and the mental arithmetic task. We also correlated the amount of negative mood change to the musical passages with the PSS scale to determine whether people under more stress have greater negative mood induction than those with lower chronic stress.

RESULTS

A total of 59 undergraduate students participated in the study. Tables 1 and 2 show the frequencies for gender, ethnicity and age. As shown in Table 1, only 7 of the 59 participants were male, pointing out a large disparity in volunteering for the study among undergraduates taking psychology classes.

Table 1: Frequencies for Gender and Ethnicity

Demographic	Frequency	Percent
Females	52	88
Males	7	12
Caucasian	36	61
African American	21	35.6
Other	1	1.7
None Ethnicity Selected	1	1.7

Table 2: Frequency for Age

Age	Frequency	Percent
18	29	49.2
19	16	27.1
20	6	10.2
21	2	3.4
22	2	3.4
27	2	3.4
32	1	1.7
Not Reported	1	1.7

To examine whether cardiovascular levels differed as a result of the task manipulation, systolic blood pressure (SBP), diastolic blood pressure (DBP) and heart rate (HR) were analyzed separately using one-way repeated measures analyses of variance (ANOVA) run on SPSS. Blood pressure and heart rate were compared at Rest Period 1, Mood Task, and Math Task, and these three time periods constituted the period within-subject factor. A significance level (α) of .05 was used in the analyses.

The ANOVAs ran on SBP, DBP and HR all showed significant period main effects (SBP: $F(2,112) = 30.5, p<.001$; DBP: $F(2,112) = 42.1, p<.001$; HR: $F(2,110) = 129.1, p<.001$). Post-hoc tests using t-tests with Bonferroni adjustments indicated the same pattern for all three variables. That is, levels of SBP, DBP and HR were significantly higher during the math task (Mental Arithmetic Task) than during the mood task (Mood Induction Task) or Rest 1. Thus, the Math Task produced significant elevations in blood pressure and HR over resting levels, but Mood Task did not. SBP and DBP levels are illustrated in Figure 1, and HR levels are in Figure 2, indicating that use of the Mental Arithmetic Task as an acute stress task was effective.

Figure 1: SBP and DBP During Rest, Mood Task, and Math Task

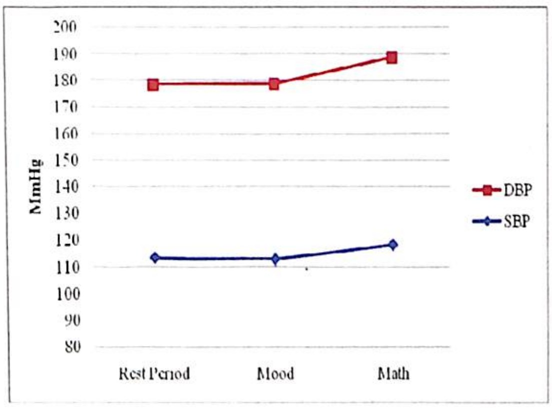
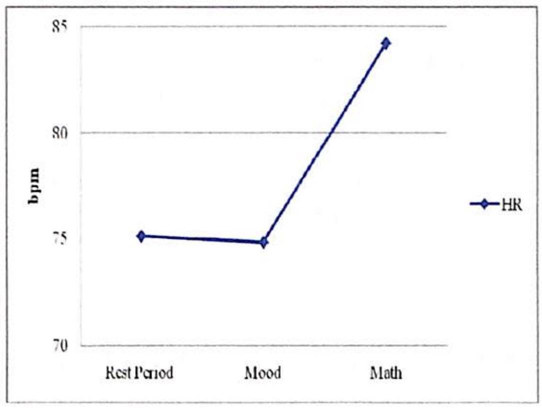


Figure 2: HR During Rest, Mood Task, and Math Task



Even though the current study was primarily concerned with the PSS, we also looked at correlations with the GHQ in order to explore more about psychological distress. These correlations are also reported.

To explore hypothesis 1, we computed correlations between the PSS and change scores for blood pressure and heart rate. Change scores were computed by subtracting Rest 1 levels from the levels of the Mood Task and the Math Task. We also correlated scores on the GHQ (psychological distress) with cardiovascular change scores.

Table 3 presents the correlations of the PSS and GHQ with cardiovascular change scores. Although there were a few correlations that approached significance, the only significant one was a negative correlation between GHQ and change in DBP during the Mental Arithmetic Task. Thus the only correlation that was significant between cardiovascular change scores and one of our stress measures was a negative one. This lends limited support to the notion that reactivity is diminished in a stressful situation in individuals with higher psychological distress. Though the data did not yield many significant results, there was a visible trend in data for a negative relationship between reported measures for perceived stress (PSS) and psychological distress (GHQ) and subjects' reactivity during the Math Task.

Table 3: Correlations of SBP, DBP, and HR Changes with PSS and GHQ Levels

	SCMOOD	SCMATH	DCMOOD	DCMATH	HRCMOOD	HRCMATH
PSS	0.116	-0.076	0.184	-0.18	0.017	-0.194
GHQ	0.053	-0.182	-0.048	-0.306*	0.039	-0.164

*p<.05 Note: N=58, MOOD indicates the Mood Induction Task, MATH indicates the Mental Arithmetic Task, SC indicates SBP change, DC indicates DBP change, and HRC indicates HR change.

Hypothesis 2 stated that there would be a significant positive correlation between PSS measures and change in negative mood ratings. In order to find out if the music passage did change mood significantly we computed one-sample t-tests of change in measures of sad, happy and gloomy to see if there was significant change due to mood induction. The mood variables came from the Brief Mood Induction Scale (BMIS); out of 16 variables, three were chosen for analyses due to significant changes during the music passage in our pilot study. Listening to the music passage resulted in a mean increase of .63 on the mood rating for sad, an increase of .38 for gloomy, and a decrease of -.34 for happy. One-sample t-tests indicated that the changes in sad ($t(56) = 3.091$; $p = .003$) and happy ($t(57) = -2.149$; $p = .036$) were significant, whereas the change in gloomy did not quite reach statistical significance ($t(57) = 1.820$; $p = .074$). These changes reveal that there was an increase in negative mood and a decrease in positive due to mood induction; thus the music passages were effective.

However, there was no indication of a relationship between the changes in mood (happy, sad and gloomy) and the measures for the PSS and GHQ. We did not find any evidence of a significant positive correlation, or any correlation, between PSS measures and changes in negative mood during the Mood Induction Task. The correlations between PSS and GHQ and the mood variables are in Table 4 below.

Table 4: Correlations of PSS and GHQ with Change in Mood Variables

	CHANGE GLOOMY	CHANGE SAD	CHANGE HAPPY
PSS	-0.119	-0.03	-0.088
GHQ	-0.074	-0.061	-0.114

*p<.05 Note: N=57

Thus, there were not any data pointing to those individuals who have a higher background stress level according to the PSS exhibiting a stronger response of negative mood to the music passages than those individuals with a lower level of background stress.

Hypothesis 3 was that the amount of stress measured with the PSS would be positively correlated with our measure of psychological distress, the GHQ-12. There was evidence to support this. Examination of the hypothesis yielded a significant correlation between PSS scores and GHQ scores, ($r = .718$; $p < .001$). As level of perceived stress reported by a subject increases so does the psychological distress reported through the GHQ.

Due to the fact that the large majority of our participants were female, we wondered whether the results would be different using only females. Analyses of data from only female subjects, concerning PSS scores and HR and BP, yielded no significant correlations. As mentioned before, initial analyses of data had indicated a slight favor, though not significant, toward higher PSS scores showing lessened reactivity. When female subjects' data was analyzed there was a decrease in these measures. There were no significant correlations between either of the PSS and GHQ scores and either HR or SBP using female subjects only.

However, there was a significant relationship, in female subjects only, between GHQ score and change in DBP during the Mental Arithmetic Task, -.331 ($p = .018$). A higher score on the GHQ was associated with lower DBP increases to the task. Table 5 provides the correlations between DBP changes and PSS and GHQ scores.

Table 5: PSS and GHQ Score Correlations to DBP Change-Females Only

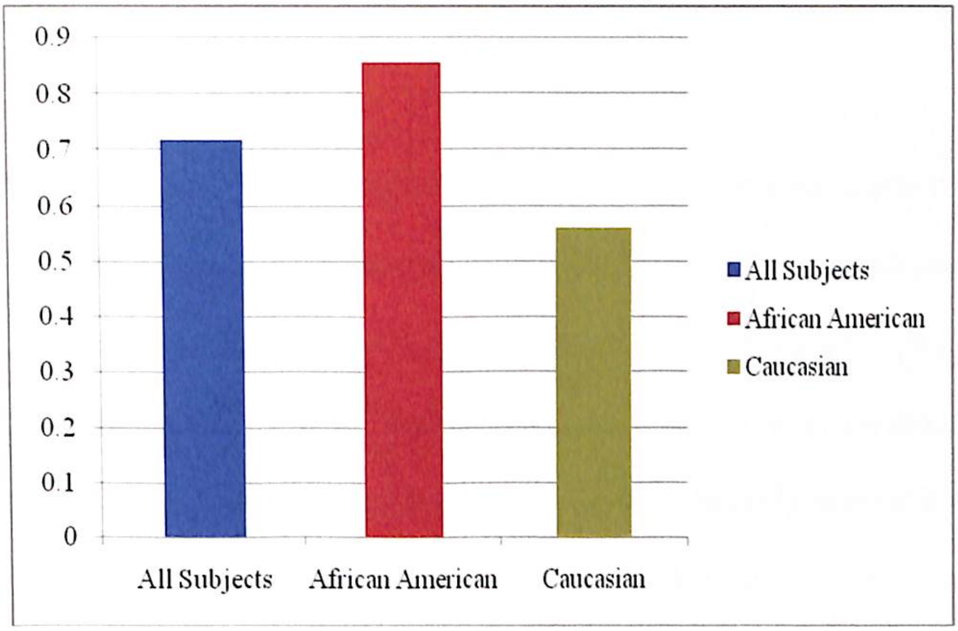
	DCMOOD	DCMATH
PSS	0.126	-0.216
GHQ	-0.114	-0.331*

*p<.05 Note: N=52, DC is a measure of change, DBP is a level measure

Finally, hypothesis 3 was supported due to the high correlation between the PSS and the GHQ for our entire sample. As we had a fairly large number of African-Americans as well as Caucasian participants, we decided to run correlations of PSS and GHQ on each ethnicity group separately. We decided to do this on the basis of research indicating that background stress may be experienced differently by African-Americans as compared to Caucasians (Pieterse and Carter, 2007).

The correlation between PSS and GHQ scores was higher for African Americans than Caucasians. African Americans had a correlation of .855 ($p < .001$), whereas Caucasians had a correlation of .561 ($p < .001$). This indicates there is a much stronger correlation between background stress and psychological distress in African Americans. Figure 3 below illustrates the differences in correlation based on ethnicity.

Figure 3: Correlations between the PSS and the GHQ Based on Ethnicity



DISCUSSION

It was hypothesized that those subjects with higher scores on the PSS would exhibit heightened cardiovascular reactivity, particularly during the Mental Arithmetic Task. This hypothesis was based on a majority of previous research. However, this relationship was not found. Data collected actually tended to lend limited support towards the opposing theory for reactivity, that those with a heightened PSS score showed lessened reactivity. It is important to note that this indication of a negative relationship between PSS scores and HR and BP measures did not yield significant correlations.

Thus, there is not enough significant data to draw a well-founded conclusion. The results found, leaning toward lessened reactivity, are in conjunction with some previous research, as discussed in the introduction. These studies make up a substantial minority of the information concerning the relationship between background stress and reactivity.

The data collected indicates the acute stressor used in this study, the Mental Arithmetic Task, did act to raise HR and BP. The effectiveness of the laboratory stressor is important due to some prior research indicating that reactivity relationships can be heavily reliant on the duration and effectiveness of the stress task. In an analysis run by Gump and Matthews (1999), it was found that when the mean task duration was 4.3 minutes it yielded a negative association, or less reactivity, while an increased task duration, with a mean of 6.9 minutes, showed positive association, or higher reactivity.

In this case, the task raised HR, SBP and DBP, but the task only lasted 3 minutes, which may have affected measures for reactivity.

Concerning correlations for reactivity and PSS and GHQ measures, the large portion of females in the subject pool may have also played a major role in the results found. Out of the 59 subjects, 52 were female. The disparity in number of male and female subjects could have influenced data especially if there were a difference between the relationship of reactivity to PSS and GHQ measures of males and females. With the data collected, we do not know whether relationships differ by gender because there were not enough males to test for it.

Another problem may have been the age range for our subjects. While there was one subject aged 32, the rest of the group was in their teens and twenties. Prior research has shown there is a difference in reactivity in age, with younger people having a more adaptive reactivity response and less health risk from stress than older individuals (Schneiderman, Ironson, & Siegel, 2005). The young people run in this study may have been more adaptive in their reactivity. It is possible that an older group of participants may have shown greater cardiovascular reactivity and perhaps more significant relationships with PSS and GHQ. Further studies in the area might address this age issue.

The results from this study do not give much evidence toward either of the two stances on background stress and reactivity that we hoped to explore. Rather it seems to add to the notion of the complexity of background stress and it effects. Several prior studies indicate that there are compounded interactions of several variables involved in stress (Schneiderman, Ironson, & Siegel, 2005). According to their study, an individual's reactivity to stress is affected by the nature, number, and persistence of the stressors.

These factors are in addition to the variables within each individual, including biological vulnerability (i.e., genetics, constitution) and learned patterns of coping (Schneiderman, Ironson, & Siegel, 2005).

These different aspects of stress may affect the way in which an individual reacts (Gump & Matthews, 1999). According to Gump and Matthews' (1999) study, there are three different parts to a stressor that create its effect on a person: currency (how recently a stressor has occurred or if it is currently happening), duration (the length of time for which a stressor has gone on), and potency (the strength of the stressor or its ability to do damage).

Furthermore, stressors can be of different natures. Matthews, Gump and Owens (2001) explain there are different domains of stress that combine to form what is holistically referred to as background stress. While the PSS is an effective measure of general background stress, it does not delve into the domain or type of stress. The importance of knowing the source of the stressors comes from finding that individuals' reactivity actually varied not only based on stress level, but also based on stress type (Gump & Matthews, 1999). Gump and Matthews (1999) came up with three major domains of stress, though many others exist. The three are occupational stressors (including people complexity and mental demands), environmental stressors (such as where a person lives), and family stressors (based on established hierarchy and family cohesiveness and openness to expression). A "mixed domain" group was also used in the analysis.

Findings by Gump and Matthews (1999) in an analysis of 19 prior studies showed reactivity levels varied based on domain. Studies of occupational stress generally found that an increase in stress was associated with a decrease in reactivity. Environmental stressors showed a positive correlation: as the level of stress increased, so did reactivity. Results from studies on family stressors found varied relationships, reporting a negative, positive or no relationship between family stress and reactivity. The mixed domain studies were also composed of varied results. The analysis concluded that the relationship between history of stress experience and acute stress responses may be complex enough to produce heightened acute stress responsivity under some conditions and lessened responsivity under other conditions (Gump & Matthews, 1999).

It is suggested that future studies try to maintain an even number of male and female subjects, and perhaps include a wider age range of subjects. Future research may also be helped by extending the length of the stress task. Though the Mental Arithmetic Task was effective, as mentioned before, prior research has pointed to duration of a laboratory stressor as a key factor for gaining proper measures of reactivity. Finally, it is recommended that additional questionnaires be given or interviews done, to delve into the nature of subjects' stress. Though the PSS gives a blanket measure of stress, a more detailed knowledge of which domains of stress a subject is experiencing could give further explanation to the interaction between domains and varied reactivity.

It was also hypothesized that those exhibiting a higher PSS measure would show a more dramatic change in the Mood Induction Task. This was based on the thought that higher PSS measures would correlate with heightened reactivity, and, in turn, those who were more reactive cardiovascularly would exhibit stronger mood change. The data indicated that neither perceived stress nor psychological distress was related to emotional change in the Mood Induction Task. This lack of significant correlation happened despite that an increase in stress was associated with a decrease in reactivity. Environmental stressors showed a positive correlation: as the level of stress increased, so did reactivity. Results from studies on family stressors found varied relationships, reporting a negative, positive or no relationship between family stress and reactivity. The mixed domain studies were also composed of varied results. The analysis concluded that the relationship between history of stress experience and acute stress responses may be complex enough to produce heightened acute stress responsivity under some conditions and lessened responsivity under other conditions (Gump & Matthews, 1999).

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The final hypothesis for this study was that PSS scores for subjects would be positively correlated with their GHQ-12 scores. In other words, as a subject's background stress measure increased, so would their psychological distress measure. Results did indicate a significant correlation between these two measures. This result fits the findings of previous research. The correlation has been attributed to a number of different variables, but most prominently to the sense of being overwhelmed and rundown in those individuals with higher stress levels; this, in turn, leads to higher levels of psychological distress (Lepore, Miles, & Levy, 1997).

Additionally, the correlation between PSS and GHQ-12 scores was broken down by ethnic groups to see if there was any significant difference. It was found that African Americans had a much higher correlation, .855 ($p < .001$), than Caucasians, .561 ($p < .001$).

There has been very little research into racial differences in background stress and psychological distress. Pieterse and Carter (2007) proposed that higher stress and psychological distress in African Americans is due to discrepancies in education, employment, health, and wealth, as well as discrimination in several areas. Race-related occurrences and circumstances, components of racism-related stress, have important implications for the general well-being of African-Americans and are part of African-American individuals' background stress. Race-related stress is an additional component of background stress for minorities, and is defined as "the race-related transactions between individuals or groups and their environment that emerge from the dynamics of racism, and that are perceived to tax or exceed existing individual and collective resources or threaten well-being"(Pieterse & Carter, 2007). The study explains, however, that racism-related stress is not just due to the surface racism or perceived discrimination, but the actual hardships and discrepancies in environment, occupation, and so forth.

It is arguable that besides individual factors that play a role in stress and well-being, African-American subjects are suffering an additional stress, in the form of racism-related stress. This extra component to their background stress may be what contributed to the much stronger correlation between PSS scores (background stress) and GHQ-12 scores (psychological well-being) in African-American subjects in the current study. This is an interesting finding that should be followed up in future studies of background stress.

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