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Gender differences and the relationships of perceived background stress and psychological distress with cardiovascular responses to laboratory stressors

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ABSTRACT

The primary aim of this study was to evaluate the relationships of perceived background stress and self-reported psychological distress on cardiovascular reactivity during acute laboratory stressors. The Perceived Stress Scale (PSS) was used as the measure of perceived background stress, and the General Health Questionnaire (GHQ) was used as the measure of psychological distress. A secondary aim was to examine whether background stress and psychological distress affected the susceptibility to induction of a negative mood using music. Heart rate (HR) and blood pressure (BP) were measured in 149 female and male college students at rest and during a stressful mental arithmetic (MA) task and a mood induction procedure. Higher scores on the GHQ were associated with lower systolic BP reactivity during the MA task by all participants. Higher scores on the PSS and GHQ were also associated with lower diastolic BP and HR reactivity, but only in females. Thus, higher self-reports of background stress and psychological distress tended to result in blunted reactivity to an acute laboratory challenge. Higher levels of background stress and psychological distress were not associated with greater susceptibility to a negative mood induction. This study adds to the growing literature indicating that potentially negative health outcomes may be associated with diminished cardiovascular reactivity under certain conditions.

1. Introduction

A large body of literature has examined the potential significance of exaggerated cardiovascular responses to both psychological and physical acute stressors. Many of these studies have sought to illuminate the hemodynamic and autonomic nervous system adjustments to various acute stressors in order to more clearly understand the potential deleterious effects of frequent exaggerated responses. For example, Obrist et al. (1986) hypothesized that individuals who were prone to show large and frequent sympathetically-mediated cardiovascular responses to psychological stressors might be at risk to develop hypertension. Unlike exercise where large increases in cardiac output were accompanied by decreases in total peripheral resistance due to tissue demand for oxygen, psychological stressors often increased heart rate and cardiac output without the need for increased oxygen consumption or carbon dioxide removal by body tissues (Langer et al., 1985; Sherwood et al., 1986; Turner et al., 1983). These "metabolically inappropriate" responses give rise to an overperfusion of blood to tissue beds. This line of research has recently been re-examined using more technologically sophisticated cardiovascular measures and more provocative stressors. Carroll et al. (2009b) used Doppler echocardiography to measure stroke volume and cardiac output and the paced auditory serial addition test (PASAT; Gronwall, 1977) to explore whether cardiac output during the PASAT was metabolically exaggerated relative to that during mild exercise as based on oxygen consumption. Consistent with the earlier studies, the psychological stressor did result in greater increases than would be expected on the basis of metabolic demand. Balanos et al. (2010) followed up this study by finding that the exaggerated cardiac responses seen during the PASAT task indicated greater beta-adrenergic activation than parasympathetic response.

Regardless of the mechanisms of action, of which there are undoubtedly many, the notion that elevated or exaggerated responses to psychological stressors could have pathogenic effects on the development of hypertension or coronary heart disease has been dubbed the "reactivity hypothesis," and it has been thoroughly conceptualized in papers such as Krantz and Manuck (1984) and Manuck (1994). With regard to the development of hypertension, a number of longitudinal studies with large sample sizes from a variety of populations have shown a positive association between the magnitude of cardiovascular reactivity during acute stressors and blood pressure levels at follow-up (Carroll et al., 2001; Matthews et al., 1993; Markovitz et al., 1998; Treiber et al., 1997). Other studies have shown that higher levels of cardiovascular reactivity also predict outcomes associated with coronary heart disease such as increased left ventricular mass (e.g., Georgiades et al., 1997).

There is also a large body of literature examining the effects of chronic or background stress on various pathological health endpoints, leading researchers to explore whether background stress may

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impact the magnitude of physiological responses to more acute stressors. (In keeping with the suggestion by Gump and Matthews (1999), we use the term "background" stress as a broader term than "chronic" stress.) Indeed, some have suggested that the impact of background stressors on health outcomes could be at least partially mediated by increases in cardiovascular reactivity (e.g., Lepore et al., 1997). A number of studies have therefore examined whether elevated background stress would result in either heightened or dampened responses to acute stressors. Both possibilities seem plausible. One might imagine that chronic exposure to stress could result in heightened acute responses due to a reduction in coping mechanisms with resultant response sensitization. But one could also imagine habituation of the acute response with increased stress depending upon such factors as duration and intensity of the background stress. The relationship between acute stress response and level of background stress is clearly a complex one, as factors such as the type of acute stressor and the type, intensity, and duration of the background stress are obviously important.

In fact, the literature examining the relationship between acute stress response and background stress has been mixed. In a review of the relevant articles on this topic in 1999, Gump and Matthews found that about half of the studies that they reviewed reported that higher levels of background stress resulted in an elevation of acute stress responses. However, a number of the studies found either no effect of background stress or diminished acute responses. It should be pointed out that the studies analyzed by Gump and Matthews identified background stress in a number of different ways, including long-term life events, daily hassles, job strain, and general occupational stress. A more recent and comprehensive meta-analysis and review of this topic by Chida and Hamer (2008) pointed out the complexities of the relationships due to such factors as type of background stress and acute stressor, as well as which physiological measure is being considered. For example, anxiety, neuroticism or negative affect was associated with decreased cardiovascular reactivity, but hostility, aggression or Type A behavior was associated with increased cardiovascular reactivity. Phillips (2011) has recently reported that depression and poor self-reported health were associated with lower heart rate and blood pressure reactivity. Chatkoff et al. (2010) have also pointed out that the relationships between background and acute stressors sometimes may be better conceptualized as a nonlinear relationship rather than a linear one. They report that a quadratic trend better modeled the relationship of perceived background stress and diastolic blood pressure (DBP) reactivity to acute stressors, in that females reporting moderate levels of stress had lesser DBP responses to laboratory stressors than those reporting either low or high levels of stress.

The findings of a nonlinear relationship between background stress and cardiovascular reactivity are paralleled by models relating cardiovascular reactivity to health outcomes as described in Carroll et al. (2009a). Citing studies indicating that lower reactivity may be associated with negative health outcomes such as obesity or addiction whereas higher reactivity may be associated with adverse cardiovascular disease outcomes, Carroll et al. (2009a) propose that nonlinear models may better reflect the complex relationships between various negative health outcomes and reactivity. Thus, the reactivity hypothesis of exaggerated cardiovascular reactivity being associated with negative health outcomes may need to be expanded to incorporate the findings of blunted reactivity being associated with outcomes such as greater obesity (e.g., Carroll et al., 2008) or decreased immune response (e.g., Bosch et al., 2005).

Our primary goal for the present study was to further explore the effects of background stress on acute cardiovascular response in a group of young adults. Although background stress can obviously be caused by many factors of varying intensity and duration (Gump and Matthews, 1999), we were most interested in the individuals' own perceptions of ongoing stress in their lives. Given that there have been reported relationships between cardiovascular reactivity and psychological disorders such as anxiety and depression (see Phillips, 2011), we also wished to assess the participants' self-reports of psychological distress.

There has been considerable interest for many years in potential gender differences in the experience and appraisal of stress, both in the work environment and in interpersonal relationships. In a meta-analysis of 119 studies of stress experiences, Davis et al. (1999) found that women experienced more stress than men along a number of dimensions. The small but significant gender differences were consistent across a number of types of stressors and age groups. Thus, it seemed quite possible that women would report more background stress than men. In addition, many studies have found gender differences in cardiovascular responses to laboratory stressors (e.g., Allen and Matthews, 1997; Allen et al., 1993). It has been speculated that sex role socialization may result in men being more competitive than women, and therefore that men might show greater cardiovascular reactivity to competitive laboratory stressors that involve challenges to their intelligence or physical abilities than women (Lash et al., 1995). Given the potential gender differences in stress appraisal and cardiovascular response to challenges, we wanted to assess whether the relationships between background stress and acute stress responses were different for men and women.

A secondary and more peripheral goal of this study was to explore whether increased perceived stress was related to greater susceptibility to the effects of a negative mood induction. We speculated that individuals who report being under higher levels of background stress would have a greater change in negative mood when listening to mood altering music. Music is a commonly used method to induce changes in mood. For example, mood induction using music has been utilized to attempt to characterize mood states via the cardiovascular and respiratory patterns observed during those mood states (Etzel et al., 2006). There is also a large body of literature on the effects of chronic stress on mood levels in individuals with mood disorders (e.g., Kim et al., 2007), indicating that the amount of experienced stress is related to mood levels. But we have been unable to find studies that have examined whether background stress influences the degree to which music could induce a negative mood.

We therefore designed the present study to explore whether perceived background stress and psychological distress were related to the degree of heart rate and blood pressure reactivity to a stressful mental arithmetic task and a period of listening to music chosen to induce a negative mood. Given the mixed literature on the relationship of background stress and cardiovascular reactivity to acute stressors, we were uncertain whether the relationship would be positive or negative (or null) during the mental arithmetic task. We did not expect any significant degree of cardiovascular response during the mood induction period, but we hypothesized that individuals with higher levels of background stress would show larger changes in negative mood as a result of exposure to music.

2. Methods

2.1. Participants

Participants were 149 undergraduate students at the University of Mississippi who were recruited from the subject pool for the course in general psychology; they received credit for the required research participation component of the course. Each participant read and signed an informed consent form; the form and the study were approved by the Institutional Review Board of the University of Mississippi. Smokers and anyone with a history of cardiovascular disorders were excluded from the study. Equipment problems and failure to answer all items on questionnaires reduced the sample size on some of the measures. There were 65 males and 84 females in the sample. The self-reported ethnicity breakdown was 97 Whites, 47