

Cardiovascular Reactivity,
Stress, and Dietary Sodium,
in the Canadian Black Population

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Abstract

Cardiovascular Reactivity, Stress, and Dietary Sodium,
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The present study examined patterns of cardiovascular reactivity in Black individuals (generally considered to be vascular responders) to various types of laboratory stressor tasks, under different levels of dietary sodium. Seventeen healthy Black male and female university students, aged 18-30 years, each participated in a 21-day experimental protocol, where they were twice exposed to three laboratory stressors, after a 10-day regular-diet period and after an 10-day high sodium-diet period (in counterbalanced order). The laboratory stressors were a 4-min Cold Pressor task, a 3-min Discrimination Recall task, and a 3-min computerized Math task. Cardiovascular reactivity measures examined included systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR), cardiac output (CO), stroke volume (SV) and total peripheral resistance (TPR). Mood states were also measured, with the administration of a State Affect Questionnaire, before and after each stressor task, in each diet condition. The results suggest that among Blacks, there is variation in patterns of cardiovascular reactivity, depending on stressor task characteristics. Blacks were most vascularly reactive to the Cold Pressor task, and least vascularly reactive to the Discrimination Recall task. The results offer no support for the hypothesis that Black individuals would be more vascularly reactive under the condition of a high sodium diet compared to their regular diet. Evidence that participants were most angry on the Discrimination Recall task, and further evidence of a negative correlation with anger and TPR, and a positive correlation with anger and CO and HR, in responses to the

Discrimination recall task, suggest a differential relation between the mood state, anger, and various components of cardiovascular reactivity in Black individuals. No strong conclusions can be made from the results obtained in the present study, given the possibility of confounding influences of uncontrolled factors such as family history, salt-sensitivity, and gender, as well as the limited sample size and the associated limited power of analyses.

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Cardiovascular Reactivity, Stress, and Dietary Sodium,
in the Canadian Black Population

Hypertension, chronically elevated arterial pressure, is an important factor in the development of cardiovascular diseases, including heart failure, coronary heart disease and stroke (Report of the Joint National Committee on the Detection, Evaluation, and Treatment of High Blood Pressure, 1984). In a small percentage of cases hypertension is traced to identifiable disorders (secondary hypertension), however in the majority of the cases the origin of elevated blood pressure is indeterminate (essential hypertension). Essential hypertension is a complex and multifactorial disorder (Weiner & Shapira, 1987). A consistent finding in epidemiological literature is that this disorder is more prevalent and associated with greater morbidity and mortality, in Black than White Americans (Burt et al., 1995; Gillum, 1994). Hypertension among young adult Black Americans is approximately two times greater than for White Americans (He & Welton, 1997). In addition, hypertension in Blacks compared to Whites is more likely to develop at a younger age (Berenson, Voors, Dalferes, Webber, & Schuler, 1979; Falkner, 1993), to be more severe, and to progress more rapidly with age (Hildreth & Saunders, 1991).

Among the many factors that have been proposed to be related to the pathogenesis of hypertension in both Blacks and Whites, cardiovascular reactivity, stress, and dietary sodium are particularly important and well-documented risk factors (Anderson, McNeilly, & Myers, 1992; Harrell, Merritt, & Kalu, 1998; Krantz & Manuck, 1984; Umemura et al., 1992). Furthermore, in addition to individual effects, it appears that sodium and behavioural stress interact in augmenting blood pressure (Anderson, Kearns, & Better, 1983; Miller, Friese, & Sita, 1995). However, the nature of the interaction between these risk factors, in particular

the mechanisms involved, is not clear. For instance, it is not known whether the relation is such that cardiovascular reactivity to stress serves to potentiate the effects of high sodium in influencing the disease process, or whether this interaction occurs by some other means (Blascovich & Katkin, 1993). Thus, the relation between sodium, stress and cardiovascular reactivity remains unclear and warrants further investigation. This study examined these risk factors as they may moderate hypertension within the Canadian Black population.

Stress and Cardiovascular Reactivity

Cardiovascular reactivity is usually understood to reflect the physiological changes from a baseline state to some type of psychological or physical challenge or stressor (Manuck, Kasprovicz, Monroe, Larkin, & Kaplan, 1989). It is thought that individuals showing sympathetically mediated exaggerated cardiovascular responses to stressful challenges may be more at risk for the development of cardiovascular syndromes such as hypertension or coronary heart disease (Falkner, 1984; Falkner, Kushner, Onesti, & Angelakos, 1981; Schieken, 1984). In fact, epidemiological studies have demonstrated an association among environmental stressors, higher blood pressures and hypertension-related mortality (Harburg et al., 1973; James & Kleinbaum, 1976).

Cardiovascular reactivity to controlled laboratory stressors has also been shown to be predictive of hypertension. Experimental studies suggest that hyper-responsiveness to well-defined laboratory stressors, such as mental arithmetic, or the cold pressor test (application of iced water to some body part, typically the hand, the foot, or the forehead), may be characteristic of individuals who eventually go on to develop hypertension (Falkner et al., 1981). Falkner and colleagues found that reactivity to a 10-

min mental arithmetic laboratory task predicted subsequent hypertension development in offspring of hypertensives in a longitudinal study, while Menkes and colleagues (1989) found a relation between cold pressor responses and future hypertension. To examine the influence of the sympathetic nervous system on cardiovascular reactivity in response to laboratory stressors, noninvasively measured impedance radiographic-based measurements have been used.

It is well documented that Blacks have augmented cardiovascular responses compared to Whites (e.g., Light, Obrist, Sherwood, James, & Strogatz, 1987). Several factors have been proposed to be associated with the increased cardiovascular reactivity seen in Blacks. Among these, higher level of psychosocial stress, enhanced sympathetic responses to such stress, and increased vascular reactivity to sympathetic stimulation (Calhoun, 1992) are some of the factors that have been suggested to contribute to the higher rate in the development of hypertension in Blacks compared to Whites. Potential components of psychosocial stress in Blacks in the United States include socioecological stress, higher rates of poverty, higher unemployment, lower socioeconomic status, more crowded housing, and exposure to racism (Anderson, Myers, Pickering, & Jackson, 1989; Calhoun, 1992). Such environmental stressors may lead to chronically elevated levels of autonomic arousal (Krantz, Contrada, Hill, & Friedler, 1988), which are thought to interact with other risk factors, leading to elevated hypertension and cardiovascular disease in Blacks (Kumanyika & Adams-Campbell, 1991).

Individual Characteristics and Cardiovascular Reactivity

One characteristic of cardiovascular reactivity that may contribute importantly to

the development of hypertension is that responses exhibited by individuals show consistency over time (Manuck, Kasprovicz, & Muldoon, 1990). That is, consistent patterns of cardiovascular reactivity occur in individuals when they are faced with similar stressors or challenges over time. As such, it is believed that exaggerated cardiovascular reactivity patterns, which are constantly elicited, may result in the triggering of maladaptive physiological processes leading to the development of essential hypertension (Allen, Sherwood, Obrist, Crowell, & Grange, 1987). For example, Folkow (1978) proposed that repetitive and exaggerated peripheral vascular resistance in Blacks, when they are exposed to stress, may contribute to an increased risk for the development of hypertension in that peripheral vascular adaptation to stress, such as structural changes in the arterial walls, may lead to increased resistance reactivity, which is an initiating factor in the hypertensive disease process.

In addition to augmented cardiovascular reactivity, the differential prevalence of hypertension in Blacks and Whites may be linked to differences in *profiles or patterns* of cardiovascular reactivity in these two populations. It is known that Whites and Blacks, exhibit stereotypically different patterns of responses to stressors with different behavioral demands. Several studies looking at such race differences in stress-induced reactivity (e.g., Anderson, Muranaka, Williams, & Houseworth, 1988; Light, et al., 1987) suggest that in addition to the greater increases in cardiovascular reactivity in response to laboratory stressors seen in Blacks, the hemodynamic mechanisms producing the blood pressure responses to stress may be different in Blacks and Whites. Specifically, blood pressure reactivity appears to be predominantly mediated by vascular vasoconstriction (increases in total peripheral resistance and decreases in heart rate) in Blacks compared to

Whites, who demonstrate a predominantly cardiac reactivity pattern (including decreases in total peripheral resistance and increases in heart rate). This is evidenced in studies such as those by Fredrikson (1986) and Falkner and Kusher (1989), which compared racial differences in cardiovascular reactivity to mental stress in hypertensive Black and White adults and found that Blacks had greater vascular responses compared to Whites, who had greater cardiac responses. In addition, enhanced hemodynamic responses to physiological or psychological stressors, mediated largely through an increase in peripheral vascular resistance or vasoconstriction, have been reported in normotensive Blacks in many studies (Anderson et al., 1989; Calhoun, 1992). This stereotypical pattern of response seen in Blacks is most clearly seen in laboratory studies that use the cold pressor task, a stimulus that elicits a substantial vascular pattern of reactivity (e.g., Anderson, Lane, Muranaka, Williams, & Houseworth, 1988).

The vascular reactivity pattern typical of Blacks is an alpha-adrenergic pattern, which is stimulated by the release of Norepinephrine (NE) during sympathetic nervous system activity; in blood vessels, NE preferentially binds to alpha-adrenoceptors to cause smooth muscle contraction and vasoconstriction. On the other hand, the cardiac reactivity pattern typical of Whites is a beta-adrenergic pattern, which is stimulated when NE released by sympathetic nerves preferentially binds to beta2 adrenoceptors in the heart causing increases in heart rate, force of contraction and dilation of coronary arteries (Ahlquist, 1948). Sympathetic hyper-reactivity via stimulation of the adrenoceptors has been associated with various cardiovascular diseases (Esler & Kaye, 2000). The specific contributions of these physiologic mechanisms in the regulation of blood pressure is supported by studies which show that these mechanisms can be pharmacologically

blocked or circumvented with alpha- or beta-blockers, which are used in the treatment of hypertension (Shapiro, Krantz, & Grim, 1986). In particular, beta-blockers lower blood pressure by acting on the nervous system to slow the heart rate and reduce the force of the heart's contractions whereas alpha-blockers act on the nervous system to dilate arteries and reduce the force of the heart's contractions.

There is substantial evidence suggesting that Whites have a sensitivity to beta-adrenergic influences and Blacks have a sensitivity to alpha-adrenergic influences. This is supported in studies, such as that by Stein, Lang, Singh, He, and Wood (2000), who compared alpha-adrenergic mediated vasoconstrictor and beta-adrenergic vasodilator sensitivity and their relation to sympathetic activity in Blacks and Whites. These investigators infused phenylephrine, an alpha-adrenergic agonist directly into the brachial artery in healthy normotensive White and Black individuals and found that vascular alpha-adrenergic vasoconstrictor sensitivity is increased in normotensive Black men. In addition, Stein and colleagues used a standard laboratory stressor task, the cold pressor, to compare alpha- and beta-adrenergic responses in Blacks and Whites and found that, consistent with the results of other such studies discussed previously, this resulted in greater increase in peripheral vascular resistance in Blacks (an alpha-adrenergic response).

Laboratory Stressors Characteristics and Cardiovascular Reactivity

Despite the overall racial stereotypical differences in cardiovascular reactivity demonstrated in Whites and Blacks (cardiac versus vascular responders), other factors, including the nature of the stressor task, influence the actual reactivity pattern exhibited

by a particular individual. In general, there is an overall modal response to a particular stressor task that most individuals exhibit (Allen, Shelley, & Boquet 1992). Specifically, certain kinds of stressful tasks administered in the lab are more likely to produce cardiovascular responses indicative of strong sympathetic beta-adrenergic influences of the heart, referred to as “beta stressors”, whereas certain kinds of stressor tasks, “alpha-stressors”, produce responses that are more indicative of alpha-adrenergic influences of the peripheral vascular system (Obrist, 1981). Furthermore, certain tasks can be viewed as falling at different points on the spectrum bounded by these two profiles. These tasks are considered “mixed” alpha/beta stressors.

It has been suggested that an important qualitative feature of stressful tasks that determine the pattern of cardiovascular response elicited (alpha versus beta), depend on whether the task requires the person to cope “actively” or “passively” with stress (Light, 1981; Obrist, 1981). The term “active-coping” is used to describe the behavioral challenges that tend to elicit the fight-flight response in humans (Obrist). A number of different laboratory stressor tasks elicit this type of cardiovascular mobilization that is mediated by the sympathetic nervous system. Such tasks demand an active engagement of some behavioral skill that is instrumental in successful performance of the task, for example, aversive time reaction tasks, which involve the threat of shock (Obrist), mental arithmetic tasks (Brod, Fencl, Hejl, & Jirka, 1959), as well as real-life stressors such as public speaking (Gliner, Bunnell, & Horvath, 1982). These tasks tend to evoke sympathetic nervous system responses that predominately stimulate beta-adrenergic receptors and result in cardiac responsivity. Other tasks that involve more “passive coping” are associated with sympathetic activation leading to cardiovascular reactivity

mediated by predominately alpha-adrenergic stimulation and results in vascular reactivity, particularly vasoconstriction. The cold pressor task is the most widely studied stressor in this category (Peckerman et al., 1991), it being a potent elicitor of vascular reactivity. "Passive coping" is pronounced in stressor tasks such as the cold pressor, where the individual is forced to passively tolerate the stimulus with little opportunity to escape it, short of stopping the task. It should be noted that the differentiation between active and passive coping is always relative since some degree of active coping by the participant is often exercised despite the experimenter's manipulation of the task outcome (Garcia-Leon, Reyes del Paso, Robles, & Vila, 2003).

Certain tasks, as mentioned before, fall more in the middle of the "active" (beta) and "passive" (alpha) spectrum of responses and as such produce a mixed alpha/beta response in individuals (Schneiderman & McCabe, 1989). This pattern may reflect characteristics of the behavioral stressor task itself and its context, in addition to differences in individual history, in perceptual and response styles, among other variables (Garcia-Leon et al., 2003). A task that falls in this category is the Anger Recall (AR) task, which is comprised of stressful challenges of various types. It is an emotionally based cognitive task that can be considered to involve interpersonal challenge or at least the recall of such challenge. Several investigations have confirmed the role of anger in evoking an increase in cardiovascular reactivity (e.g., Bongard, Pfeiffer, Al'Absi, Hodapp, & Linnenkemper, 1997). Berkowicz (as cited in Garcia-Leon, Reyes del Paso, Robles, & Vila, 2003) describes the emotion of anger as referring to the temporal experience of subjective feelings including annoyance, irritation, lack of control and frustration. Such feelings are produced by situations in which the individual feels injured,

deceived, betrayed, physically or psychologically controlled against his/her will, and by situations when the achievement of a goal is blocked. The experience of anger is a complex phenomenon and, in general, has been associated with both alpha- and beta-adrenergic influences (Bongard et al.). In addition to the emotional and cognitive aspects of the AR task, such a task also involves a speech component, which evokes blood pressure changes on its own and this adds to the variance in the cardiovascular response elicited in the individual (Why et al., 2003). Another stressor task that has similar characteristics to the AR task, is the 'Discrimination Recall' task, which is employed as a mixed alpha-beta stressor in the present study.

Evidence from the literature reviewed above suggests that the ultimate response elicited in an individual during a stressor is an interaction of both individual response characteristics and stressor type characteristics. In this respect, when the stressor task's characteristics and the individual's characteristics are both alpha-adrenergic types, it is not surprising that a potent vascular response is elicited, as in studies described previously with Black individuals exposed to cold pressor stressor tasks. Interestingly, a predominant vascular (alpha) response is repeatedly demonstrated in Blacks even when exposed to predominantly beta stressors such as mental arithmetic, suggesting that for this particular group, despite the stressor task characteristics, an overriding influence of individual response characteristics predominates (Light et al., 1987).

Sodium, Cardiovascular Reactivity, and Stress

Thus far, from the literature reviewed above, several lines of evidence implicate stress as a mediator of cardiovascular reactivity in individuals, in particular, a mediator of vascular

reactivity in Blacks. Another factor thought to have an important controlling influence on blood pressure and subsequent hypertension is dietary sodium. Epidemiological studies suggest that variations in the prevalence of hypertension among different societies and cultures may be partly due to differences in salt intake. For example, societies where salt consumption is less than one gram per day have little or no hypertension (Dahl, 1972; Freis, 1976; Poep, 1976). On the other hand, societies such as those in regions of Japan, where the salt ingestion is more than 20 grams per day, have hypertension in 30 to 40 percent of the adult population (Freis, 1976; Sasaki, 1962).

Several lines of evidence also implicate sodium as a mediator of heightened cardiovascular reactivity in Blacks. Studies show that sodium retention may be induced by heightened sympathetic activity to stress (Weinberger, Luft, & Henry, 1982). Blacks secrete less sodium in urine than Whites and exhibit greater cardiovascular reactivity to sodium loading (Luft, Grim, & Weinberger, 1985). Studies also indicate that, in both humans and spontaneously hypertensive rats, sodium may augment blood pressure through heightened vasoconstriction than by increasing cardiac output (Nilsson, Fly, Friberg, Kalstrom, & Folkow, 1985). This suggests that sodium may be a principal physiological mechanism involved in racial differences in vascular reactivity. Furthermore, evidence suggests there may be an interaction between behavioral stress and dietary sodium in the development of hypertension. In a study by Anderson and colleagues (1983), dogs were given continuous saline infusion (salt-loading) and shock-avoidance stress for two weeks. The combination of high salt and daily stress resulted in significant and progressive increases in blood pressure. Importantly, however, neither the saline infusion nor the avoidance stress alone was sufficient to raise blood

pressure. Thus, sodium and stress appear to interact to influence cardiovascular reactivity and augment blood pressure levels. This is supported in studies such as that by Falkner, Onesti, and Angelakos (1981), who investigated the effects of stress, dietary salt and parental history in normotensive adolescents and found that high salt significantly increased cardiovascular reactivity in those with a positive family history of hypertension. In a similar study, Miller, Friese, and Sita (1995) found that sodium loading interacted with stress to increase reactivity (total peripheral resistance) in individuals with a family history of hypertension. Miller and colleagues suggest that the exposure to both stress and a high sodium intake may serve to potentiate sympathetic nervous system activity underlying cardiovascular reactivity.

While the mechanisms by which sodium interacts with stress in augmenting blood pressure are still not clear today, substantial evidence exists which links high sodium intake (as with evidence reviewed previously for stress) with altered functioning of the adrenergic receptors. In particular, experimental evidence suggests that sodium raises blood pressure by stimulating a number of vasoconstrictive mechanisms (Gavras, 1986). Alpha2-adrenergic receptors, have been shown to be involved in this process. It was found that feeding high salt diets to spontaneously hypertensive rats (SHR) resulted in altered densities of alpha2 receptors (Bresnahan, Gavras, Hatinoglou, Muller & Gavras, 1986; Morris, Devynck, Woodcock, Johnson, & Meyer, 1981). Studies also indicate that change in sodium intake affects the density of alpha2-adrenoceptors in the kidneys of Dahl and Sabra rats (Pettinger et al., 1982; Sanchez & Pettinger 1981). The kidneys regulate the excretion and retention of salt and water in the body and, as such, play a vital role in determining blood pressure. More recently, Khalid, Giudiceli, and

Dausse (2001) found that, after 6 weeks of high-salt diet, Sabra rats showed significant increases in blood pressure and up-regulated gene expression and density of alpha-adrenoceptors. Thus, evidence from animal research points to the pivotal role of the alpha-adrenergic receptors in salt-induced hypertension.

Several reports suggest that salt intake changes alpha-adrenoceptor density in humans as well. Umemura and colleagues (1992) examined human platelets in vitro and reported an increase in the density of alpha₂-adrenoceptors in young men with a positive family history of hypertension, following a 7-day low sodium diet. Skrabal, Kotanko, Meister, Doll, and Gruber (1987) measured alpha₂ receptors on platelets of healthy young men and beta₂ receptors on lymphocytes during changes in salt intake and found an up-regulation of alpha and a down-regulation of beta-adrenoceptors after an increase in salt intake from 50 to 200 mmol sodium per day, as well as a substantial change in the alpha₂/beta₂-adrenoceptor ratio. Such a response would affect simultaneous enhanced alpha₂ mediated vasoconstriction and reduced beta₂-mediated vasodilation during a high salt intake. Skrabal and colleagues proposed that the increase in the alpha₂ /beta₂ ratio by high salt intake may trigger a cascade of intracellular events resulting in the initiation of the hypertensive process.

Summary, Rationale, and Hypotheses

Research suggests that Black individuals are more “vascular”/alpha-adrenergic responders to stress and this might contribute to the higher prevalence of hypertension and cardiovascular diseases found in this population. Alpha-adrenergic stimulation is believed to be involved in “passive” tasks such as the cold pressor task, which typically

elicits a pronounced vascular response (large increases in total peripheral resistance, and little or no response in heart rate and cardiac output). Conversely, Beta-adrenergic stimulation is believed to be predominantly involved in “active” stressor tasks such as mental arithmetic, which typically elicits a pronounced cardiac response (large increases in heart rate and cardiac output and a smaller decrease in total peripheral resistance). Certain tasks such as the Discrimination Recall task used in the present study have mixed alpha/beta characteristics and are expected to produce a mixed vascular/cardiac response. Based on the stereotypical individual response characteristics of Black individuals (alpha-adrenergic/vascular responders) and stressor task response eliciting characteristics (alpha-adrenergic, beta-adrenergic, mixed alpha/beta adrenergic), it is likely that these characteristics interact in determining the ultimate cardiovascular response of these individuals when exposed to particular stressors. Research also implicates higher levels of dietary sodium in enhanced cardiovascular reactivity and cardiovascular diseases, and sodium (similar to stress) has been shown to have effects on cardiovascular reactivity via alpha/beta-adrenergic receptors. As such, it was expected that cardiovascular reactivity to stressors would be different in conditions involving different levels of sodium consumption.

The main goal of the present study was therefore, to examine the patterns of hemodynamic responses of Black individuals (known to be alpha-adrenergic responders) to stressor tasks with alpha-, beta-, or mixed alpha/beta- eliciting characteristics, in two dietary conditions (regular diet compared to a sodium loaded diet). Participants were exposed to three counterbalanced stressors, a 4-min Cold Pressor task (an alpha-adrenergic stressor), a 3-min computerized subtraction Math task (a beta-adrenergic

stressor), and a 3-min Discrimination Recall task (a mixed alpha-/beta-adrenergic stressor) in each of the two dietary conditions. Dependent measures included the following cardiovascular measures: diastolic blood pressure (DBP), systolic blood pressure (SBP), heart rate (HR), cardiac output (CO), stroke volume (SV), total peripheral resistance (TPR), left ventricle ejection time (LVET), and pre-ejection period (PEP). To measure the effects of state affect/mood, on cardiovascular responses, the State Affect visual analog scale measuring 13 different mood states, was administered before and after each stressor task.

It was hypothesized that, Black individuals would have the greatest vascular profile of cardiovascular reactivity to the Cold Pressor task (a task that typically elicits a potent vascular response), the least vascular pattern of reactivity to the Math task (a task that typically elicits a predominant cardiac pattern of response), and an intermediate level of vascular reactivity to the Discrimination Recall task (a task that is expected to produce a mixed vascular/cardiac pattern of response). It was further hypothesized that, Black individuals would have greater cardiovascular reactivity on tasks in the high dietary sodium condition compared to their reactivity in the regular dietary condition.

Method

Participants

Black males and females ($N = 21$), between the ages of 18 and 30 years were recruited from the Concordia University student population to participate in the study. All individuals completed a screening Health Questionnaire (see Appendix A). Individuals who reported any physical (see health questionnaire) or psychological health problems and/or regularly used medication that affected blood pressure were not selected for the study. Individuals who were accepted to participate in the study had to have been born in Canada or have lived in Canada at least since the age of 12 years. This was necessary to control to some degree for the social climate experienced by Black individuals living in a predominantly White culture. This social climate is a factor, which in combination with other factors, is thought to influence the development of hypertension.

Information on family history was also collected, and individuals who reported a comorbid condition of hypertension and diabetes in either parent were also excluded from the study. This study is part of a larger ongoing study that is examining several risk factors of hypertension. In addition to stress, cardiovascular reactivity, and dietary sodium, which are addressed in this study, factors such as family history of hypertension and 24-hr ambulatory blood pressure patterns are part of the larger, ongoing study and were not addressed in this one. Participants also completed a package of questionnaires at home and, on two occasions, activity diaries (while wearing the ambulatory blood pressure monitor), to be used in the larger study.

Physiological measures and apparatus

SBP and DBP measurements (in mmHg) were obtained at 1-min intervals using an IBS Model SD-700A Automatic Blood Pressure and Pulse Rate Monitor (IBS Corporation, Waltham, Mass, USA). The blood pressure cuff was placed on the non-dominant arm. Additional cardiovascular measures taken include HR (in bpm), SV (in ml), CO (in l/min.), PEP (in msec), LVET (in msec), and TPR (in dyne-sec.cm⁻⁵). HR is the number of heartbeats each minute. SV is the quantity of blood ejected by the heart during a single cardiac cycle. CO is the total volume of blood ejected by the heart during a period of time, typically, as is the case in the present study, 1 min. PEP is the time interval from the beginning of electrical stimulation of the ventricles to the opening of the aortic valve. LVET is the time interval from the opening to the closing of the aortic valve. TPR is the resistance to blood flow throughout the entire cardiovascular system.

Values for the measures of HR, SV, CO, PEP, LVET, and TPR were obtained noninvasively using a Minnesota Impedance Cardiograph (Model 304A, Instrumentation for Medicine, Greenwich, Conn, USA), an IBM compatible personal computer, EKG spot electrodes, and the Cardiac Output Program (C.O.P. Version 2.1, Bio-impedance Technology, Chapel Hill, North Carolina, USA). The impedance cardiography utilized a tetrapolar electrode-band configuration. The inner two recording electrode-bands were placed around the base of the participant's neck and around the thorax over the tip of the xiphoid process. The outer two electrode-bands were placed around the neck and the thorax at least 3 cm apart from each of the inner electrode bands.

The ECG signal was recorded independently using three spot electrodes. Two electrodes were placed on either side of the torso below the ribcage and a ground

electrode was positioned on the right hipbone. The ECG signal was filtered through a Coulbourn Instruments bandpass filter (Coulbourn Instruments, Allentown, Penn, USA) and then routed to the Minnesota Impedance Cardiograph. Within every measurement minute, 55 s of recordings were obtained and processed by the C. O. P. system, yielding ensemble averaged values for HR, SV, CO, PEP, LVET, and TPR.

Psychological Measures

State Affect Questionnaire. A State Affect Questionnaire, (See Appendix B) was employed to determine the participant's current state affect at six times (pre-task and post-task for each of the three tasks) during the cardiovascular reactivity testing session. This measure consists of 13 affective terms including: *agreeable, happy, tense, anxious, discouraged, irritated, annoyed, angry, depressed, and guilty*. Subjects rated their current affective state on the visual analogue scale by marking a vertical stroke at a point along a 12-cm line with endpoints labeled *not at all* and *very*. Points on the line were measured and given numerical values for data analysis.

Laboratory Stressor Tasks

Computerized Math Subtraction Task. The mathematical subtraction task (Math task) consisted of the Computerized Subtraction Task Version 1.21 computer program (Turner, Sherwood, & Lutz, 1989), an IBM PC computer, and a computer mouse. The Math task was 3 min long, and consisted of a series of mathematical subtraction equations presented with either correct or incorrect solutions. During the task, 60 equations were sequentially presented on the monitor. Each equation was presented for a

duration of 3 s, first appearing as white characters against a black background and switching to yellow characters if the participant did not respond within the first 2 s. Participants used the right or left computer mouse buttons to indicate whether the solution on the screen was correct or incorrect. Auditory feedback, either a high- or low-pitched tone, informed the participant whether he/she had answered correctly or incorrectly, respectively. No tone was emitted if the participant failed to respond within the allotted time and that trial was scored as incorrect. The subtraction equations fluctuated in terms of level of difficulty, being easier or more difficult depending on each participant's performance. The Math task was designed so that each participant attained a 50 to 60 percent correct response rate. That is, the equations become easier or more difficult depending on each participant's performance. See Appendix C for Math task instructions.

Cold Pressor Task. The Cold Pressor stimulus consisted of a cold gel pack (temperature approximately 4 °C), which was positioned across the forehead of the participant while the participant's head was supported comfortably against the back of the padded armchair in which he/she was sitting in. The cold pack was held to the participant's forehead for 2 min, taken off for 1 min, then followed by the application of a similar cold pack of the same temperature for another 2 min. See Appendix D for Cold Pressor task instructions.

Discrimination Recall Task. The participant was asked to recall, and talk about an incident in his/her past when he/she felt discriminated against. The participant was asked to re-experience, as much as possible, the situation and his/her feelings at the time. The task lasted for 3 min. The experimenter used prompts to elicit feelings and details of the

event for the duration of the 3 min, as needed. Prompts used included, “How did that make you feel?”; “What did you say?”; “What did you do?”. See Appendix E for Discrimination Recall task instructions.

Dietary Manipulation

Dietary Sodium. Participants were given a 10-day supply of dietary sodium materials to be consumed, in addition to their regular diet. Identical daily portions were packaged separately in sealed zip-locked plastic bags. Each zip-locked bag contains a packet of Lipton Noodle Soup (84 g) with NaCl content of 10.6 g, and a smaller sealed plastic bag with 4.4 g of NaCl (table salt). Participants were given a detailed instruction sheet for this diet period (see Appendix F).

Dietary Compliance Verification

Urine Collection. Participants were given a 3-L brown translucent urine collection jar for overnight urine collection, and two 12-ml labeled test-tubes (one for each diet period) to collect and return urine samples to the lab for analysis of dietary compliance. Participants were also given detailed written instructions on the urine collection procedure (see Appendix G).

Setting

The lab testing procedure was carried out in a quiet room, with a comfortable, reclining armchair. Two-way mirrors and the use of a “walkie-talkie” baby monitor (900 MHz Grow-With-Me-Monitor) enabled communication and synchronization of the physiological recording of cardiovascular measures with the laboratory stress procedure,

which was carried out in adjacent rooms by two experimenters. Experimenter A, a female, who interacted with the participants, remained constant throughout the 21-day protocol. Experimenter B, who monitored the physiological equipment (the COP system) in the adjacent room, varied, and had no interactions with the participants.

Procedure

Each individual participated in a 21-day experimental protocol, which consisted of two counterbalanced periods: a 10-day regular diet period and an 11-day salt-loaded diet period (on the eleventh day, the participant is 10 days salt-loaded). Prior to beginning the protocol, participants were invited into the laboratory where the study was explained in detail by the experimenter. Participants were then required to read and sign a consent form (see Appendix H), and subsequently to see the study's physician to undergo a general medical examination, which provided information on previous and current physical and mental health, and family medical history (see Appendix I). Participants who were approved by the physician presented themselves to the laboratory where instructions were given for the first diet period, and four appointments to complete the protocol were scheduled on specific days within the 21-day experimental period: Appointments were scheduled on the ninth and tenth days of the regular diet period, and on the tenth and eleventh days of the salt-loaded diet period. Participants were given a package of questionnaires, which they were required to complete at home and return at a later date.

The dietary sodium materials were given to the participants just prior to beginning the salt-loaded phase of the protocol, and female participants were required to undergo a

urine-based pregnancy screen in the laboratory at that time. The participant was allowed to proceed with the protocol if the pregnancy screen was negative.

On Day 9 of the regular diet phase and on Day 10 of the salt-loaded diet phase, participants came to the lab for approximately 30 min, between 7 and 10 a.m. Prior to this visit participants were reminded by telephone or e-mail not to consume alcohol, coffee, or have any recreational drugs or cigarettes from the previous evening (6 p.m.) and that they were required to abstain until the day after, when the laboratory testing would be complete. At the beginning of this visit, questionnaires that were completed at home were collected by the experimenter, and the participant was reminded of the steps of the procedure to be completed at the laboratory that day. Participants were seated in the armchair and resting blood pressure levels were taken, prior to being instrumented with a programmed ambulatory blood pressure monitor to be worn for 24 hr and returned to the experimenter at the scheduled visit the next morning (part of the procedure for the larger study). Participants were given a plastic bag with the urine collection materials and verbal and written instructions for collecting urine for a 12-hr period that night. Participants were also given an activity diary to fill out during waking hours for the next 24-hr period (to be used in the larger study). Participants were reminded to complete the data collection section (on the urine instruction sheet) with information on the first and last times of urine collection and the total urine output quantity, and to return this to the experimenter along with the urine sample the following morning.

Participants returned to the lab on Day 10 of the regular diet period and Day 11 of the sodium-loaded period for a session, which lasted approximately 90 min. The urine samples, any completed questionnaires, the activity diary, and the urine instruction sheet

with the completed data collection information, were collected, and the participant was de-instrumented of the ambulatory blood pressure monitor. The urine sample was placed in the freezer. The experimenter (Experimenter A) reminded the participant of the procedure for that day and proceeded to instrument the participant with the physiological equipment for cardiovascular measurement recording. The participant was then seated in the armchair and reclined to an approximately, 60°- angled position. Experimenter A instructed the participant regarding the order of administration of the stressor tasks (counterbalanced across participants), explained the instructions for each task, and showed the participant a sample of the State Affect Questionnaire which was to be filled out before and after each task. Calibration of the COP system was carried out simultaneously by Experimenter B in the adjacent room. Experimenter B communicated to Experimenter A when the stress procedure was ready to begin, at which time Experimenter A dimmed the lights and left the testing room, instructing the participant to relax, but not to fall asleep.

The participant rested for 10-min, then cardiovascular measures were taken for 4 min for the pre-task baseline period. Experimenter A then re-entered the testing room, turned the lights up, and handed the participant the State Affect Questionnaire to complete (approximately 1 min), then administered the first stressor task. Experimenter B communicated by monitor to Experimenter A when to begin and end the task. A post-task State Affect Questionnaire was completed by the participant immediately upon task completion, and then Experimenter A left the room, dimming the lights again. Cardiovascular measures were recorded throughout this period. Cardiovascular measures continued to be taken for a 4-min recovery period. The participant then rested for 5

minutes. Following this, an identical procedure was completed for the second and third tasks.

At the end of the testing procedure, the participant was de-instrumented and asked if he/she had any questions. The participant was given instructions and/or dietary materials for the next diet period, if applicable. If it was the end of the 21-day protocol, participants were paid \$100 for their participation. This study employed no deception, and was approved by the Human Subjects Ethics Committee of Concordia University.

Urine Analysis

Participants' urine samples were analyzed at the Montreal General Hospital. Levels of sodium obtained allowed for the verification of dietary compliance.

Data Reduction and Analyses

Cardiovascular data during the testing sessions were reduced in the following manner: for each cardiovascular measure, values collected during the last 4 min of baseline testing (rest period) were averaged to obtain a mean baseline value. All values collected during the Math task were averaged across the 3 min of the task yielding a mean math task value. A mean Discrimination Recall task value was obtained in the same way. A mean Cold Pressor task value was obtained from the 4 min of active cold pressor application (measures from the 1-min break in the middle of this task were not included). Change scores were used in all cardiovascular stress analyses given the uncertainty regarding validity of impedance-derived volume measures when absolute values are employed (Sherwood, Allen, & Fahrenberg, 1990). Baseline - task change scores were

obtained by subtracting the task mean from the mean of the immediately preceding baseline period for each measure. Analyses of cardiovascular responses to stressor tasks were carried out on baseline - task change scores. Change scores for cardiovascular measures were calculated in both the regular diet and the sodium-loaded diet periods. Subsequently, differences between change scores for these two periods were analyzed.

For each affective measure, values collected prior to the stressor task were considered baseline-affect values. Baseline - stress affect change scores values were calculated by subtracting baseline-affect values from the affect values obtained immediately following the stressor task. Analysis was carried out on these change scores. These data were analyzed using ANOVAs. Univariate analyses were used, in keeping with the majority of research in this area that use univariate, rather than multivariate, analyses (e.g., Larson & Langer, 1997; Suarez & Williams 1989). Additional analyses were carried out using correlations and *t* tests.

Results

Dietary Compliance

Dietary compliance was assessed by comparing sodium levels in the regular diet condition versus the sodium diet condition. The criterion for assessing compliance required that participants' sodium level in the high-sodium diet condition be higher than their sodium level in the regular-diet condition. Participants' sodium levels in each diet condition are presented in Table 1. These analyses revealed that 4 of the 21 participants who completed the study were not compliant with the dietary protocol. As such, data for these participants were not included in the analyses for this study, resulting in a reduced sample from 21 to 17 participants. To determine whether the sodium content of these 17 participants' urine was significantly higher in the high sodium condition versus the regular diet condition, paired *t* tests were conducted with measures of the sodium content of urine for each dietary condition. A significant effect was found for dietary compliance, $t(17) = 7.17, p < .01$.

Participant Characteristics

Participants who were included in the analyses were 8 males and 9 females. Descriptive statistics of participants' demographic characteristics of age, height and weight are presented in Table 2.

Cardiovascular Analyses

Baseline Analyses. To assess whether participants differed in cardiovascular measures at rest prior to the stressor tasks, a series of 2(diet conditions) \times 3(stressor

Table 1**Participants' Urine Sodium Content in the Regular Diet versus the Sodium Diet**

Participant #	Sodium Content (mmol/L)	
	Regular Diet	Sodium Diet
101	138	199
102	16	222
*103	*177	*52
105	94	197
107	146	242
108	63	100
109	42	126
110	161	196
112	56	118
113	182	260
*114	*181	*74
115	107	164
116	144	243
117	155	190
118	215	310
*119	*172	*160
120	102	284
121	132	201
122	173	207
123	32	117
*124	*119	*111

Note. * represents data that were omitted from the analyses due to dietary noncompliance.

Table 2

Demographic Characteristics of Participants

	Minimum	Maximum	Mean	<i>SD</i>
Height (ins)	60	74	67.62	3.86
Weight (lbs)	115	240	161.41	30.11
Age (yrs)	19	28	22.47	2.85

tasks) repeated measures ANOVAs were conducted on average baseline scores for each cardiovascular measure. Such analyses provided an indication of recovery of cardiovascular responses to stress, to baseline resting measures, between stressor tasks. To this effect, baseline measures for second stressor task served as recovery measures for the first stressor task and likewise, baseline measures of the third stressor task served as recovery measures for the second stressor task. No main effect for task was found, indicating that participants did not differ on baseline cardiovascular measures before each task and that there were no cardiovascular reactivity carry-over effects between the various stressor tasks in each diet condition. A main effect for diet condition was found for HR, $F(1, 15) = 5.69, p < .032$. Participants had significantly higher heart rate baselines measures on all tasks in the sodium-diet condition compared to the regular-diet condition. No interaction effects for baseline cardiovascular measures were found. Means and standard deviations for baseline cardiovascular measures before each stressor task, in each diet condition, are presented in Table 3.

Baseline versus Stress Analyses. To first assess whether there were significant changes from baseline to stress for each cardiovascular measure for *each* of the stressor tasks, paired *t* tests were conducted with baseline and stress cardiovascular response measures for each stressor task, in each diet condition. For the Cold Pressor task, significant effects were found for the following, in the regular and sodium diet conditions respectively: SBP, $t(17) = 2.22, p < .042$; $t(17) = 5.022, p < .001$, DBP, $t(17) = 2.89, p < .012$; $t(17) = 4.21, p < .002$, and TPR, $t(17) = 4.68, p < .001$; $t(17) = 4.34, p < .002$. For the Discrimination Recall task significant effects of cardiovascular response changes from baseline to stress were found for the following, in the regular diet and sodium diet

Table 3

Means and Standard Deviations of Cardiovascular Reactivity Baseline Measures as a Function of Stressor Task and Sodium

CVR Measures	<u>Regular Diet</u>						<u>Sodium Diet</u>					
	CP		DR		M		CP		DR		M	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
HR	67.28	9.6	67.29	10.3	66.13	11.1	63.90	10.2	64.13	10.1	63.58	9.5
SV	122.72	36.4	116.16	35.9	121.07	39.3	126.78	38.3	123.89	33.2	127.14	39.0
CO	8.25	2.4	7.81	2.4	7.98	2.5	8.02	2.2	7.89	2.0	8.03	2.3
PEP	98.50	19.3	98.82	18.5	100.09	17.7	100.50	16.8	100.22	14.9	100.18	15.9
LVET	302.60	26.1	292.27	37.7	298.59	33.8	299.56	42.5	300.30	40.3	299.53	42.1
SBP	112.45	8.2	110.38	8.8	111.53	9.9	111.64	6.0	110.95	8.6	112.08	6.4
DBP	71.30	10.0	70.86	9.0	71.41	9.0	71.30	7.9	72.51	7.6	71.08	8.0
TPR	949.69	475.9	1009.71	539.6	993.29	527.8	941.83	405.3	949.33	355.7	960.53	448.6

conditions respectively: HR, $t(17) = 4.98, p < .001$; $t(17) = 4.72, p < .001$, CO, $t(17) = 4.45, p < .001$; $t(17) = 3.17, p < .007$, SBP, $t(17) = 3.47, p < .004$; $t(17) = 3.00, p < .010$, and DBP, $t(17) = 4.01, p < .002$; $t(17) = 4.44, p < .001$. For the Math task, significant differences were found for the following, in the regular and sodium diet conditions respectively: HR, $t(17) = 4.42, p < .001$; $t(17) = 4.37, p < .001$, CO, $t(17) = 3.61, p < .003$; $t(17) = 4.49, p < .001$, LVT, $t(17) = -3.77, p < .003$; $t(17) = -2.43, p < .028$, SBP, $t(17) = 2.46, p < .027$; $t(17) = 2.13, p < .050$, and TPR, $t(17) = -2.38, p < .031$; $t(17) = -3.49, p < .004$. In addition, in the Math task, significant differences were found for PEP, $t(17) = -2.45, p < .027$ in the regular diet condition only, and for DBP, $t(17) = 2.18, p < .045$ in the sodium diet condition only.

Cardiovascular Reactivity as a Function of Diet and Stressor Task. To assess whether participants differed in cardiovascular reactivity across stressor tasks in the regular and high sodium diet conditions, 2×3 repeated measures ANOVAs were conducted on the change scores for each measure of cardiovascular reactivity. Means and standard deviations for cardiovascular response measures as a function of stressor task and dietary condition are presented in Table 4. Significant differences in cardiovascular responses to stressor tasks (main effects) were found for the following: DBP $F(1,15) = 9.61, p < .004$; TPR, $F(1,15) = 12.20, p < .001$; HR, $F(1, 15) = 28.04, p < .001$; CO, $F(1,15) = 24.36, p < .001$ and PEP, $F(1, 15) = 4.65, p < .017$. DBP increased in response to all stressor tasks. The increases in DBP for the Cold Pressor task and the Discrimination task were not significantly different, however, they were significantly greater than DBP response for the Math task. As shown in Figure 1, TPR increased for the Cold Pressor task but decreased for the Discrimination Recall and Math tasks. In

Table 4

Means and Standard Deviations of Cardiovascular Reactivity Change Scores as a Function of Stressor Task and Sodium

CVR Measures	Regular Diet						Sodium Diet					
	CP		DR		M		CP		DR		M	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
HR	-0.12	3.4	13.13	11.0	6.61	6.4	-0.43	3.4	12.17	10.3	7.79	7.7
SV	-2.09	9.0	-2.18	13.9	-1.62	8.8	-4.35	11.3	-1.66	13.8	-0.08	8.4
CO	-0.20	0.6	1.26	1.0	0.68	0.7	-0.34	0.6	1.32	1.6	0.97	0.9
PEP	0.62	3.9	-2.23	7.2	-3.80	4.7	0.46	4.5	-3.29	8.0	-3.93	7.0
LVET	1.96	15.8	-8.85	29.0	-7.38	8.3	1.38	9.9	-6.44	25.7	-4.86	9.3
SBP	7.01	10.4	10.37	10.6	5.29	8.5	9.26	6.9	8.77	11.6	3.62	6.6
DBP	7.71	10.7	7.46	8.1	0.77	5.3	9.33	9.6	7.77	6.9	3.06	6.4
TPR	103.30	95.8	-89.40	274.4	-68.15	110.1	167.92	154.6	-71.07	215.4	-72.47	79.4

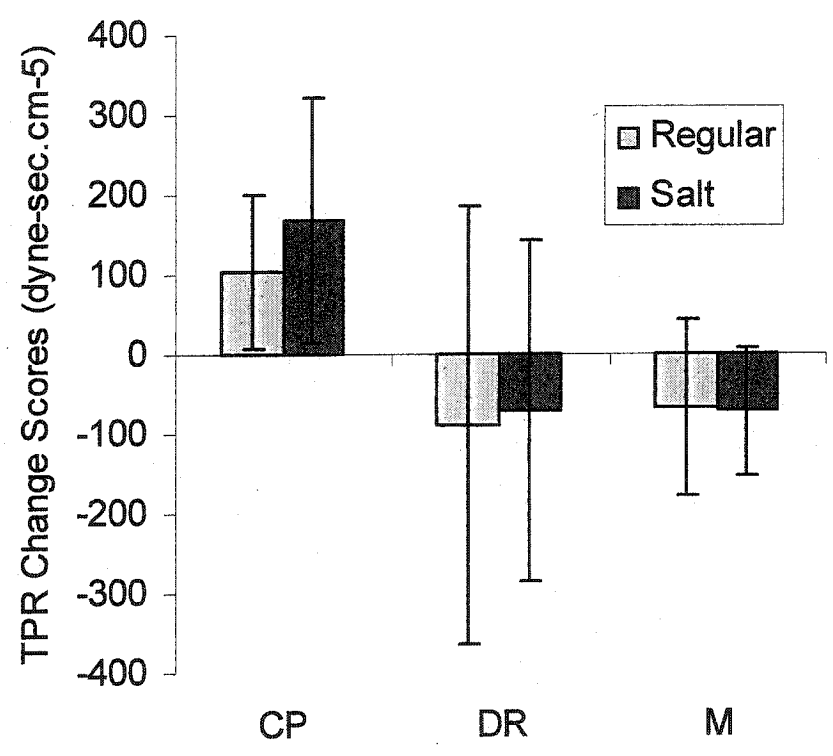


Figure 2. Total Peripheral Resistance (TPR) change scores as a function of stressor task and dietary sodium

Note. CP = Cold Pressor; DR = Discrimination Recall; M = Math

addition, the increase of TPR in the Cold Pressor task was significantly different from the decreases in the latter two stressor tasks, while there was no significant difference between the TPR response in these latter two tasks. As shown in Figures 2 and 3 respectively, HR and CO decreased for the Cold Pressor Task but increased for the Discrimination Recall and Math tasks. HR measures were significantly different for all tasks compared to each other. CO measures were significantly different for the Cold Pressor task compared to the Discrimination Recall task and the Math task, but were not significantly different between the latter two tasks. No significant differences in SV, or SBP were observed for stressor tasks, no significant effect was found for sodium, and no interaction effects were found.

State Affect Analyses

Baseline Analyses. To assess whether participants differed in state affect measures prior to beginning stressor tasks, 2×3 repeated measures ANOVAs were conducted on average baseline affective ratings for each stressor task, in each diet condition. Means and standard errors for baseline state affect measures are presented in Table 5. A significant effect, $F(1, 15) = 5.55, p < .033$, was found for the state affect, *irritated*, in the regular versus the sodium diet condition. Participants were more irritated at baseline before beginning stressor tasks in the sodium condition compared to the regular diet condition. No significant effects for baseline affect differences were found for stressor tasks.

State Affect as a Function of Diet and Stressor Task. To assess whether participants differed in state affect changes in response to stress and sodium for the

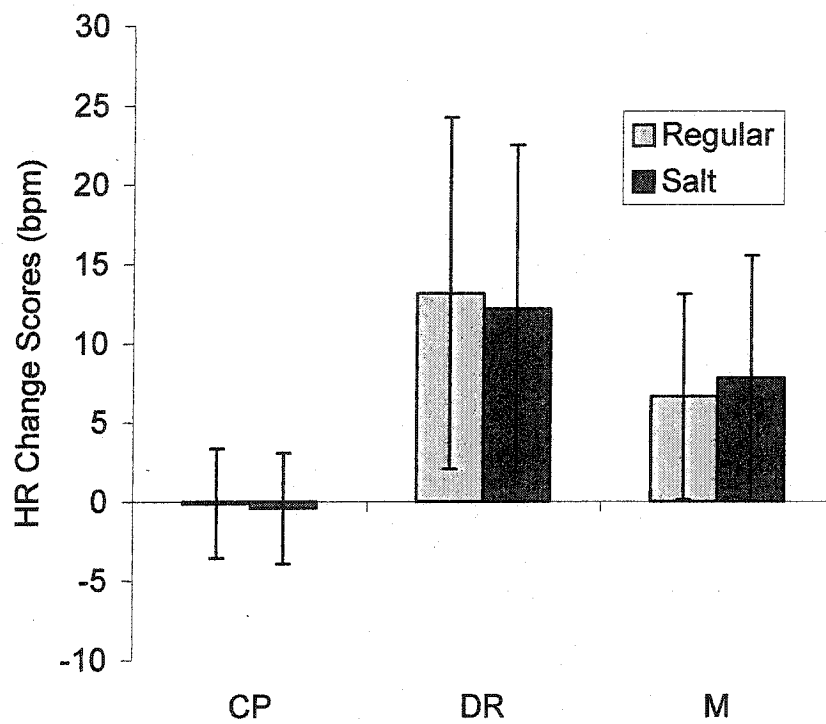


Figure 2. Heart Rate (HR) change scores as a function of stressor task and dietary sodium

Note. CP = Cold Pressor; DR = Discrimination Recall; M = Math

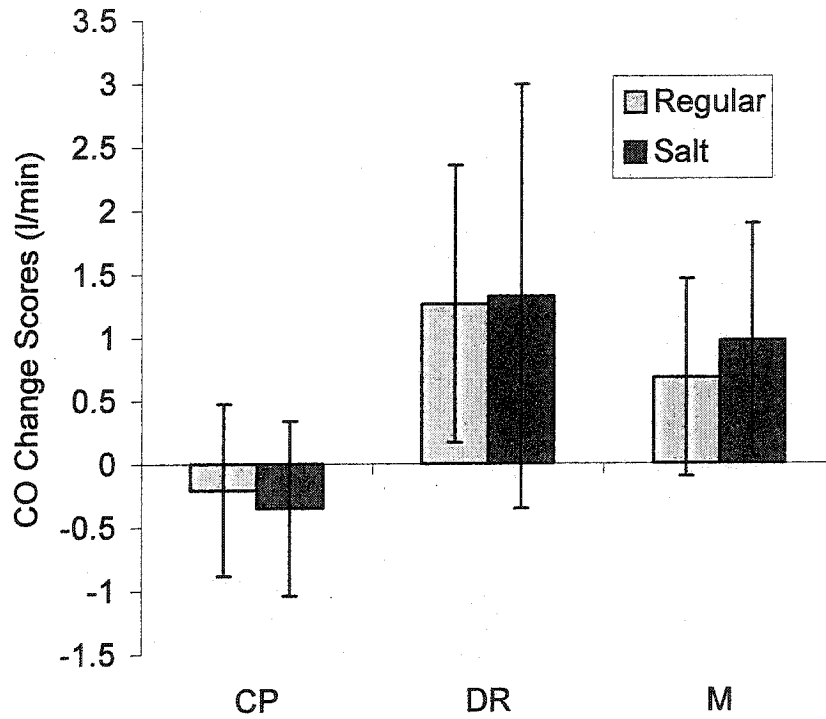


Figure 3. Cardiac Output (CO) change scores as a function of stressor task and dietary sodium

Note. CP = Cold Pressor; DR = Discrimination Recall; M = Math

Table 5

Means and Standard Deviations of Baseline State Affect Measures
as a Function of Stressor Task and Sodium

State Affect	<u>Regular Diet</u>						<u>Sodium Diet</u>					
	CP		DR		M		CP		DR		M	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
NER	3.76	2.3	3.26	1.9	2.94	1.9	3.52	2.5	3.41	2.7	3.14	2.5
AGR	8.52	3.0	8.17	2.9	8.58	2.8	9.00	3.1	7.91	3.4	8.61	3.5
HAP	7.73	2.9	7.55	2.7	7.76	2.9	7.85	3.3	7.67	2.8	7.38	2.6
TEN	4.24	3.0	3.88	2.6	3.70	2.4	4.35	2.8	4.35	3.3	4.25	3.4
ANX	5.82	3.6	5.05	3.4	4.52	3.3	5.47	3.4	5.79	4.0	4.88	3.9
REL	7.85	3.1	8.97	2.4	8.64	2.8	9.17	2.9	8.55	3.3	8.67	3.6
DIS	3.65	3.1	2.90	1.9	3.06	2.1	3.09	2.7	2.28	1.5	2.81	1.9
ANN	3.70	2.6	3.26	2.1	3.14	2.8	3.61	2.8	4.02	3.3	3.67	2.7
SAD	2.58	1.9	2.64	2.1	2.47	1.9	2.58	2.3	2.26	1.3	2.29	1.4
IRR	3.17	2.3	2.94	2.2	3.00	2.4	4.02	3.4	3.67	3.1	3.94	2.6
ANG	2.67	2.2	2.14	1.1	2.67	2.4	2.20	1.8	2.17	1.3	2.20	1.3
DEP	2.84	2.1	2.65	1.8	2.68	2.2	2.25	1.4	2.59	1.9	2.65	1.9
GUI	2.31	1.3	1.90	1.0	2.12	1.1	2.18	2.0	2.18	1.3	2.31	1.3

Note. NER = Nervous; AGR = Agreeable; HAP = Happy; TEN = Tense;
ANX = Anxious; REL = Relaxed; DIS = Discouraged; ANN = Annoyed;
SAD = Sad; IRR = Irritated; ANG = Angry; DEP = Depressed; GUI = Guilty

various stressor tasks, 2×3 repeated measures ANOVAs were conducted on change scores for each state affect measure of the State Affect Questionnaire. Means and Standard Deviations for state affect measures as a function of diet and stressor task are presented in Table 6. Significant changes (main effects) were found for the following state affect measures as a function of stressor task: *nervous*, $F(1,16) = 3.90, p < .007$, *agreeable*, $F(1,16) = 3.33, p < .025$, and *angry*, $F(1,16) = 6.36, p < .035$. Participants were most nervous on the Math task, least agreeable on the Cold Pressor task, and most angry on the Discrimination Recall task, compared to the other two stressor tasks in each case. A significant change in state affect measure, *sad*, $F(1,16) = 4.73, p < .046$, was found for the regular versus the sodium diet condition, with more sadness in the regular diet condition. No interaction effects were found.

Correlation Analyses of State Affect Measures and Cardiovascular Reactivity Measures. Analyses of the correlations between each state affect measure and each cardiovascular response to stress was conducted for each dietary condition separately. Given that there are 13 state affect measures, eight cardiovascular response measures, three stressor tasks, and two dietary conditions, this resulted in a total of 624 comparisons. Based on a p value of .05, it is expected that less than 31 significant correlations obtained would suggest a possibility of results occurring by chance. In these analyses, a total of 30 significant correlations were found.

In the regular diet condition, nine significant correlations were found for the following: HR was positively correlated with *angry* on the Cold Pressor task, $r(17) = .490, p < .05$, and with *depressed* on the Discrimination Recall task, $r(17) = .545, p < .05$. CO was positively correlated with *guilty* on the Cold Pressor task, $r(17) = .507, p < .05$.

Table 6

Means and Standard Deviations of State Affect Change Scores
as a Function of Stressor Task and Sodium

State Affect	<u>Regular Diet</u>						<u>Sodium Diet</u>					
	CP		DR		M		CP		DR		M	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
NER	-0.11	1.5	1.47	2.9	2.79	3.0	.076	1.4	1.02	4.4	1.70	1.7
AGR	-1.20	3.4	-0.02	1.7	-1.14	1.8	-2.08	2.3	-0.38	2.1	-0.11	3.1
HAP	-0.73	1.6	-1.17	2.4	-1.20	3.4	-1.05	2.5	-1.00	2.3	0.38	2.6
TEN	1.11	3.2	1.67	3.1	3.20	3.9	1.23	3.6	0.91	3.5	0.80	1.8
ANX	0.55	2.8	0.50	4.5	2.55	3.0	0.67	3.2	-0.61	2.0	1.05	3.5
REL	-0.61	3.2	-2.41	3.4	-2.14	3.1	-2.73	2.8	-1.20	2.1	-1.41	4.9
DIS	-0.75	2.1	0.84	2.7	1.75	3.3	-0.56	1.3	1.34	2.2	1.00	3.0
ANN	0.17	1.6	1.58	2.97	2.02	3.8	0.47	2.3	0.76	3.3	0.29	3.7
SAD	0.08	0.6	1.35	2.5	0.55	0.8	-0.61	1.9	1.20	2.6	0.32	1.7
IRR	1.11	2.4	2.20	2.8	2.11	3.0	0.73	2.7	1.41	3.3	0.08	2.9
ANG	0.47	2.2	2.88	3.0	0.05	2.3	0.35	1.5	2.11	3.3	1.05	2.4
DEP	0.31	1.8	1.18	2.1	0.43	1.2	-0.15	0.7	0.75	1.6	0.37	2.1
GUI	0.06	1.8	0.34	0.8	0.09	0.9	0.06	0.4	0.18	1.6	0.09	1.3

Note. NER = Nervous; AGR = Agreeable; HAP = Happy; TEN = Tense;
ANX = Anxious; REL = Relaxed; DIS = Discouraged; ANN = Annoyed;
SAD = Sad; IRR = Irritated; ANG = Angry; DEP = Depressed; GUI = Guilty

PEP was positively correlated with *sad*, $r(17) = .657, p < .01$ on the Math task. LVT was positively correlated with *relaxed* on the Discrimination task, $r(17) = .513, p < .05$, and negatively correlated with *angry* on the Math task, $r(17) = -.527, p < .05$. DBP was positively correlated with *guilty* on the Cold Pressor task, $r(17) = .578, p < .05$, and negatively correlated with *discouraged* on the Math task, $r(16) = -.539, p < .05$. TPR was positively correlated with *happy* on the Math task, $r(17) = .623, p < .001$.

In the sodium diet condition, 21 significant correlations were found for the following: HR was negatively correlated with *angry* on the Discrimination Recall task, $r(16) = -.525, p < .05$. SV was positively correlated with *happy* on the Discrimination Recall task, $r(16) = .576, p < .05$, negatively correlated with *angry*, $r(17) = -.643, p < .001$, and *sad*, $r(17) = -.666, p < .001$ on the Math task, and also positively correlated with *happy*, $r(17) = .496, p < .05$, and *relaxed*, $r(17) = .538, p < .05$ on the Math task. CO was negatively correlated with *annoyed*, $r(16) = -.521, p < .05$, *sad*, $r(16) = -.526, p < .05$, and *angry*, $r(16) = -.583, p < .05$, on the Discrimination Recall task. PEP was positively correlated with *tense*, $r(16) = .527, p < .05$, and negatively correlated with *relaxed*, $r(16) = -.583, p < .05$ on the Cold Pressor task. LVET was positively correlated with *depressed* on the Cold Pressor task, $r(16) = .523, p < .05$, with *nervous*, $r(16) = .610, p < .05$, *happy*, $r(16) = .609, p < .05$, and *tense*, $r(16) = .775, p < .01$, on the Discrimination Recall task, and positively correlated with *happy*, $r(17) = .554, p < .05$, on the Math task. SBP was negatively correlated with *relaxed*, $r(17) = -.644, p < .01$, while DBP was negatively correlated with *happy*, $r(17) = -.489, p < .05$, on the Cold Pressor task. TPR was negatively correlated with *happy*, $r(16) = -.642, p < .01$, and positively

correlated with *sad*, $r(16) = .555, p < .05$, and *angry*, $r(16) = .502, p < .05$, on the Discrimination Recall task.

A few limited patterns emerge from these disparate findings. In the Cold Pressor task, where a total of eight correlations was found, the significant moods reported by participants were all negative moods. These included *angry*, *tense*, *not relaxed*, and *guilty*. In Math task, where a total of nine correlations was found, there were negative associations with the negative moods, *angry* and *sad*, and positive associations with positive moods of *happy*, *relaxed* and *not discouraged*. The most correlations, 13 in total, were found for the Discrimination Recall task and a consistent pattern emerged for the negative mood state, *angry*. For HR and CO there were negative associations with state affect, *angry*, whereas for TPR, there was a positive association with this state affect.

Discussion

The goal of the present study was to examine the relation between sodium, stress, and cardiovascular reactivity as they may moderate hypertension in the Black population. An additional focus was looking at cardiovascular reactivity as mediated by stressor-task characteristics and individual response characteristics linked to the activation of alpha- and/or beta-adrenergic receptors. The hypothesis that Black individuals who are considered alpha-adrenergic responders would have the greatest vascular profile (TPR and DBP responses) to the Cold Pressor task (an alpha-adrenergic stressor) was confirmed, however, the hypothesis that there would be a difference in the vascular profile of reactivity for the Discrimination Recall (a mixed alpha/beta stressor) and the Math task (a beta-adrenergic stressor) was not confirmed. There was no significant difference in the magnitude of TPR and DBP responses for the Discrimination Recall and Math tasks. The hypothesis that individuals would have greater cardiovascular reactivity on tasks in the high sodium dietary condition compared to their reactivity in the regular dietary condition was also not confirmed. There were no differences in cardiovascular reactivity to stressor tasks for the two dietary conditions. The above results suggest that, among Blacks who are generally classified as vascular responders, there is variation in response, with Black individuals showing a greater vascular response to certain stressors compared to others. Furthermore, the non-confirmatory findings suggest that factors other than those considered in this study may be implicated in individual responses to various stressors. In addition, based on the results of this study, the effect of short-term sodium loading on cardiovascular reactivity remains inconclusive.

Although there were no differences in overall cardiovascular reactivity to stress as a function of dietary manipulation, reactivity as a function of stressor task was significantly greater in the Cold Pressor and Discrimination Recall tasks relative to the Math task, as evidenced by a greater increase in DBP in the two former tasks. Participants showed a typical and expected cardiac/beta-adrenergic pattern of response to the strong beta-adrenergic eliciting Math task, characterized by significant increases in HR and CO, and a decrease in TPR. The finding that Blacks were most vascularly reactive (a strong TPR response, with little or no HR or CO response, a typical alpha-adrenergic pattern) to the Cold Pressor task compared to the other tasks is not surprising, given that Blacks are considered alpha-adrenergic/vascular responders and that the Cold Pressor task is the most potent alpha-adrenergic/vascular stimulant of the various stressors used. It is possible that an additive effect between individual response characteristics and stressor task characteristics would produce such a result as seen in the Cold Pressor task. These findings are consistent with previous studies that have demonstrated the same pattern of hemodynamic response to physical stressors, mediated largely through an increase in peripheral vascular resistance, in normotensive Blacks (e.g., Anderson et al., 1989; Calhoun, 1992).

There was no significant difference in the magnitude of DBP for the Cold Pressor and the Discrimination Recall task, however, the hemodynamic profiles of the two responses were vastly different, with the former task showing a predominantly vascular profile and the latter task, an overwhelming cardiac/beta-adrenergic profile (large increases in HR and CO, and a small decrease in TPR), similar to the Math task but without a significant baseline to stress change in TPR. Given that the Discrimination

Recall task is a mixed alpha-/beta-adrenergic stressor task, it was expected that a mixed alpha-/beta-adrenergic response would be elicited (mild to moderate increases in both cardiac and vascular hemodynamic measures). As such, the strong cardiac/beta-adrenergic pattern observed for the Discrimination Recall task was unexpected, given the study's hypotheses. Possible factors contributing to this unexpected finding are discussed below.

The predominant cardiac/beta-adrenergic pattern of response observed in the Discrimination Recall task may be due to certain aspects of this stressor, such as the speech component of this task. Kamark (1992) suggests that the speech component of Anger Recall tasks (similar to the Discrimination Recall task used in this study) is a factor that evokes changes in blood pressure on its own and can add error variance to the task. Rate of speech could not be controlled for in the Discrimination Recall task in the present study and could have been a confounding factor in cardiovascular reactivity. In addition, it is known that the social-evaluative challenge of public speaking results in significant increases in cardiac activation (e.g., Bongard, Absi, & Lovallo, 1998). In the Discrimination Recall task in the present study, the interpersonal nature of the task, including prompts from the experimenter to ensure that the participant talked for three minutes, could have contributed to the enhancement and pattern of cardiovascular reactivity observed for this task.

Another possible reason that the response patterns observed in the Discrimination Recall task deviated from the expected patterns compared to the Cold Pressor and Math tasks, may be the nature of these tasks and their relative relevance to stressors experienced in daily lives of Black individuals. The latter two tasks were very structured,

allowing for less flexibility in responses compared to the Discrimination Recall task, which was more open-ended, given that participants chose the incident they recalled and this choice allowed for great variability in response. All participants voluntarily chose to recall a previous incident of racial discrimination in their daily lives. It is known that experiences of everyday racism provide a potential source of stress, which is part of the daily fabric of life for most African Americans (Jones, 2001). As such, the Discrimination Recall task appears to have good ecological validity as a laboratory stressor, replicating a more relevant stressor in the daily lives of Blacks (compared to the Cold Pressor and Math tasks), which may contribute to their increased risk for the development of hypertension and cardiovascular diseases. Clark, Anderson, Clark, and Williams (1999) suggest a biopsychosocial model, which postulates that personally mediated racism behaves as an environmental stressor triggering exaggerated psychological and physiological responses, producing frequent though transient elevations in blood pressure, and triggering the pathways leading to sustained hypertension. According to Clark and colleagues, the physiological responses after exposure to stress involve neuroendocrine and cardiovascular functioning and the psychological responses include anger, hostility, hopelessness, fear and depression. Anger and hostility in particular, have been shown to influence cardiovascular reactivity (e.g., Bongard et al., 1998; Suarez, Harlan, Peoples, & Williams, 1993).

Suarez and colleagues (1993) showed that hostile individuals are more physiologically reactive than less hostile persons when engaging in an interpersonal task or when asked to recall anger provoking events. It has also been shown that hostility and anger expressiveness (anger-in versus anger-out) interact in their effects on

cardiovascular reactivity, and a mismatch between hostile cognitions and anger expression style leads to a cardiac pattern of response in individuals (Bongard et al., 1998). While hostility traits and anger expressiveness style were not examined in this study and cannot be commented upon in relation to the results obtained, measurement and analyses of state affect, anger, showed that participants were most *angry* on the Discrimination Recall task, the task which elicited the most robust pattern of cardiac response. It is reasonable to speculate that these factors could have potentially contributed to the results obtained in the present study, particularly the unexpected findings of a predominantly cardiac pattern of response obtained for the Discrimination Recall task, a task with a significant anger component. Interestingly, upon examining mood and cardiovascular responses of individuals on the Discrimination Recall task, a positive correlation with anger was only found for TPR, the vascular component of the response (though this response was insignificantly different from baseline), while a negative association was found with anger and the cardiac measures, HR and CO, for this stressor task. It would seem, based on these findings, that the emotion of anger is differentially related to various hemodynamic components of cardiovascular reactivity. Such a relation warrants further exploration in the investigation of risk factors for cardiovascular reactivity and hypertension.

It is also possible that the cardiac reactivity pattern observed in the Discrimination Recall task was a result of efforts at active cognitive coping with the distressing situation/incident being recalled. It is suggested that speech stressor tasks, provide ample opportunities for active coping, allowing for a wide range of appraisals and emotions (Obrist, 1981). Consistent with this, it was observed that participants in the present study

did not only recall a particular racial discrimination incident as it happened, but included retrospective justifications, rationalizations and other cognitive coping strategies in their account of the incident. Such active cognitive coping elicits a predominantly cardiac response pattern, similar to the 'fight or flight response' (Hilton, 1982). Given that anxiety/fear is typically associated with this pattern of response, it is interesting that significant correlations with the state affect *anxious* were not obtained for the Discrimination Recall task, however this could possibly be a result of the lack of power of the analyses for state affect measures in the study.

Despite its possible limitations, the state affect measures analyzed may provide some additional insight into the patterns of cardiovascular reactivity obtained for the various stressor tasks in this study. Participants were most nervous on the Math task. This is consistent with the type of coping that is associated with such a task. As mentioned before it is known that tasks of an active cognitive coping nature generally produce strong cardiac/beta-adrenergic patterns of response (likened to the fight or flight response), characterized by the activation of anxiety/fear in the individual (Hilton, 1982). Thus, it was not surprising to find that participants were significantly nervous on the Math task.

The Cold Pressor task, which involves passive endurance of the stimuli (e.g. Saab et al., 1993), requires relatively lesser active coping than the Math task or the Discrimination Recall task. Given the limited control participants have on exposure to the Cold Pressor task (a physical stressor), as well as the significant psychological pain component of this stimulus (Peckerman et al., 1994), it was not surprising to find that participants were least *agreeable* on this task. Consistent with this, on the Cold Pressor

task, participants reported other significant negative moods including *angry*, *tense*, *not relaxed*, and *guilty* while they reported no significant positive moods. Such negative moods associated with the Cold Presor task may be linked to the strong cardiovascular reactivity observed for this stressor (largest mean increases in SBP and DBP).

The findings of the present study looking at cardiovascular reactivity within the Black population suggest that the common classification of Blacks as vascular/alpha-adrenergic responders based on typical findings of Black/White racial differences in reactivity may be overly simplistic. Many differences exist within Black populations, which may influence patterns of cardiovascular reactivity and which may contribute to the development of hypertension among these individuals. The present study is important in highlighting some factors that may influence this process. By using an ecologically valid stressor in this study, the Discrimination Recall task, replicating a naturally occurring stressor in the lives of Black individuals, it was shown that the pattern of response elicited in this study was not a vascular pattern but a predominantly sympathetic, cardiac, beta-adrenergic pattern. Furthermore, results of this study suggest that such a response is influenced by factors such as mood states, particularly anger. Future studies should further examine these, and other factors including those of gender differences and family history (discussed below) that may mediate patterns of responses of Black individuals exposed to everyday experiences of discrimination, and investigate the links between these factors and the development of hypertension and cardiovascular disease within this population.

Limitations to the present study include factors such as gender differences and family history of hypertension, which were not analyzed, mainly due to the small sample

size. These variables are currently being measured and will be analyzed in the larger study of which this study is a part. The possible influence of these limitations on the present study will be briefly discussed below.

Gender differences likely contributed to the pattern of results obtained in this study. Differences between males and females in cardiovascular reactivity to stressors have been observed in several studies (e.g., Allen & Matthews, 1997; Girdler, Turner Sherwood, & Light, 1990), with males typically showing greater vascular/alpha-adrenergic responses and females showing more cardiac/beta-adrenergic responses. Many researchers maintain that appraisal of a situation is as important as the stressor itself in determining whether a stimulus generates a stress response (e.g., Lazarus & Folkman, 1984; Smith & Anderson, 1986). It is well known that women are socialized to apprehend some situations in different ways than men and such appraisals may magnify or attenuate cardiovascular responses to stress. Particularly, on tasks such as the Discrimination Recall task where appraisals and emotions seem to be instrumental in response patterns to stress, it is possible that gender differences would result in substantial differences in cardiovascular response. Gender differences may particularly influence individual responses on the Discrimination task given that such types of tasks rely in part on "traditionally feminine skills such as good communication skills and willingness to express emotions" (Light, Turner, Hinderliter, & Sherwood, 1993). Such unanalyzed gender differences may have contributed to the pattern of responses observed in the present study.

Another unanalyzed factor in the present study, which has been shown by others to moderate cardiovascular reactivity to stress, is family history of hypertension. There is

considerable evidence that individuals with a family history of hypertension show greater cardiovascular reactivity to stressors (Frederikson & Matthews, 1990; Lovallo & Wilson, 1992; Turner, 1994). Frederikson and Matthews found that relative to normotensives with a negative family history of hypertension, normotensives with a positive family history of hypertension exhibited larger sympathetic responses. Furthermore, psychological traits such as hostility and anger (discussed above) have been shown to interact with family history of hypertension (e.g., Perrini, Muller, & Buhler, 1988) in influencing cardiovascular reactivity. Family history information is currently being collected in the larger study of which this study is a part, but again, because of the sample size, participants were not separated into groups and analyzed based on this factor in the present study.

There were only two significant effects of sodium: participants were more irritated at baseline before beginning stressor tasks in the sodium condition compared to the regular condition, and HR was significantly higher at baseline on stressor tasks in the sodium condition compared to the regular condition. It is possible that the quantity of salt (255 mmol/24 hr) added to participants' diet and/or the length of time for the salt-loading period (10 days) in the present study were insufficient in producing observable changes in participants' blood pressure. Kirkendall and colleagues (1976), who studied eight normotensive individuals at various levels of sodium intakes at 10 mmol, 210 mmol, and 410 mmol, with each diet being given for four weeks, also failed to find increases in blood pressure despite employing a higher level of sodium and a longer duration of sodium-loading than in the present study. These authors further measured the body's potassium level concurrently with salt-loading and found an inverse relationship between

individual's potassium level and sodium level. That is, there were decreases in total body potassium level as evidenced by increases in urinary potassium, with increases in dietary salt. However, there were no changes in the blood level of potassium nor, as mentioned before, were there increases in blood pressure due to increased dietary sodium. These authors suggest that "normal" individuals are able to compensate for large increases in sodium levels with metabolic changes through possible hemodynamic and hormonal compensatory mechanisms. While the generalizability of these findings is somewhat limited with respect to the present study given that these authors used White participants and not Blacks, findings of this study suggest that, in addition to the amount of sodium used, factors such as dietary potassium which were not controlled for in the present study, may have influenced the pattern of results obtained.

Other factors that could potentially have influenced the pattern of results found in the present study include sodium-sensitivity and/or family history of hypertension. Sodium sensitivity, which is generally defined as a change in blood pressure in response to changes in salt and water homeostasis (Svetkey, McKeown, & Wilson, 1996) has been found in 73% of hypertensive and 36% of normotensive Blacks and may be a heritable trait that plays a significant role in hypertension in Blacks (Weinberger, Miller, Luft, Grim, & Fineberg, 1986). In addition, Wilson, Bayer, and Sica (1996) suggest that there may be gender differences in the prevalence of sodium-sensitivity in the Black population. The uncontrolled factor of sodium-sensitivity in the present study may have affected the pattern of results obtained. Furthermore, sodium-sensitivity and family history have been shown to interact with sodium in their influence on blood pressure (Pietinin, Wong, & Altschul, 1979; Textor & Turner, 1991). It is reasonable to speculate

that these factors may have potentially influenced the pattern of results found in the present study. However, this possibility could not be assessed as sodium sensitivity was not measured in this study and family history of hypertension was not analyzed. Given these and other limitations of the present study, the general lack of dietary sodium influences on blood pressure should be viewed with extreme caution.

Overall, the findings in the present study may offer insight into the roles of different hemodynamic response patterns in response to various types of stressors, in the pathogenesis of essential hypertension. The extent to which dietary sodium intake may modulate this phenomenon remains to be clarified. Future studies need to sort out the health implications of the various response patterns to different types of stressors, by relating these to disease endpoints. Determining the causes of hypertension and related cardiovascular diseases is crucial to the design and implementation of improved primary prevention and intervention strategies.

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Appendix A
Screening Health Questionnaire

Subject Health Questionnaire

Name: _____ Phone Number: _____

Present address: _____
Street City Province Postal Code

E-mail address: _____

Date of birth: _____ Age: _____ Gender: _____
Month Day Year

Birthplace: City _____ Province _____ Country _____

If born outside of Canada, please indicate your age when you moved to Canada: _____

Race: Caucasian _____ Black _____ Asian _____ Hispanic _____
Native-American _____ Other (please specify) _____*The following refers to your biological parents:*Race of mother: Caucasian _____ Black _____ Asian _____ Hispanic _____
Native-American _____ Other (please specify) _____

Mother's country of origin: _____

Race of father: Caucasian _____ Black _____ Asian _____ Hispanic _____
Native-American _____ Other (please specify) _____

Father's country of origin: _____

Please answer all of the following questions carefully:

Do you suffer from...

	Yes	No	Specify/Explain
medical or surgical problems (past yr)			
chronic illnesses			
heart trouble			
high blood pressure			
diabetes			
kidney trouble			
epilepsy			
liver trouble			
asthma			
bronchitis			
fainting spells			
psychological or psychiatric disorders			

Please list any medication(s) that you are presently taking and the reason for taking it:

Please give the approximate date of your last medical check-up: _____

Have your parents suffered (or continue to suffer) from...

	Mother	Father	Neither	Don't know
angina or heart pain				
heart attack				
stroke				
high blood pressure				
Diabetes				
Kidney disease				

Do your parents ...

a) have other circulatory problem? _____

If yes, please describe: _____

b) take medication for high blood pressure?

_____ Father _____ Mother _____ Neither _____ Don't know

Signature: _____

Date _____

Appendix B
State Affect Questionnaire

Participant Code: _____

HOW ARE YOU FEELING RIGHT NOW?

Indicate on each of the scales below by starting a **vertical stroke** through the line at the appropriate point.

Not at all Nervous	_____	Very Nervous
Not at all Agreeable	_____	Very Agreeable
Not at all Happy	_____	Very Happy
Not at all Tense	_____	Very Tense
Not at all Anxious	_____	Very Anxious
Not at all Relaxed	_____	Very Relaxed
Not at all Discouraged	_____	Very Discouraged
Not at all Annoyed	_____	Very Annoyed
Not at all Sad	_____	Very Sad
Not at all Irritated	_____	Very Irritated
Not at all Angry	_____	Very Angry
Not at all Depressed	_____	Very Depressed
Not at all Guilty	_____	Very Guilty

Appendix C
Instructions for the Math Task

Instructions for Math Task

- ❖ A series of mathematical subtraction equations will be presented on the computer monitor.
- ❖ You must respond by pressing one of the buttons on the mouse.
- ❖ Press the right button, the one marked “C”, if you think that the answer on the screen is correct.
- ❖ Press the left button, the one marked “I”, if you think that the answer on the screen is incorrect.
- ❖ If you are accurate in your response, the computer will emit a high-pitched tone.
- ❖ If you are inaccurate in your response, the computer will emit a low-pitched tone.
- ❖ You will be presented with 60 equations in total.
- ❖ You will have 3 seconds to respond to each equation.
- ❖ At the end of 2 seconds the colour of the equation on the monitor will change.
- ❖ This indicates that you have 1 second left to respond.
- ❖ At this time, if you do not know the answer, we suggest that you guess and respond by pressing either “C” or “I”.
- ❖ You will score an automatic 0 if no response is made, and no tone will be emitted.

Appendix D
Instructions for the Cold Pressor Task

Instructions for Cold Pressor Task

- ❖ I will place a cold pack on your forehead and hold it in place with a velcro band for 2 minutes.
- ❖ Please keep your arms and legs relaxed at all times.
- ❖ After a period of 2 minutes, I will take the ice pack off.
- ❖ After a break of 1 minute, I will again put the ice pack on your forehead for another 2-minute period.
- ❖ I will remove the ice pack at the end of these two minutes.
- ❖ If at any time you feel that you cannot continue with this task and want to stop the task, please tell me this and I will remove the ice pack at your request.

Appendix E

Instructions for the Discrimination Recall Task

Instructions for Discrimination Recall Task

- ❖ I want you to think about an event in your life when you felt discriminated against.
- ❖ I would like you to imagine that you are back in that situation.
- ❖ Try to re-experience the situation, especially, how you were feeling at that time.
- ❖ I would like you to tell me about that event, describing your feelings to me as best as you can.
- ❖ Talk to me about you experience and your feelings for 3 minutes.
- ❖ I will tell you when to stop.
- ❖ Begin now.

Appendix F
Diet Instructions

Diet Instructions

During the 10 designated special diet days please use the following procedures:

- ❖ Day 1
 - Consume regular diet **plus** one package of Lipton Noodle Soup (provided) and the packet of table salt (provided).
 - You may consume the soup over the course of the day or in one sitting. Please note that the soup requires preparation as per the package instructions and be sure to entirely dissolve the soup base.
 - The salt may be added to one or more portions of your normal dietary intake (e.g. oatmeal cereal, rice, sprinkled on moist vegetables such as sliced tomato, or added to any compatible beverages such as juices or plain water).

- ❖ Days 2-8
 - Please follow the same dietary procedures as on Day 1.

- ❖ Day 9
 - Please follow the same dietary procedures as on Days 1-8.
 - You may not consume coffee, cigarettes, alcohol, or recreational drugs from 6:00 p.m. until after the laboratory procedures on day 11 (see below).

- ❖ Day 10
 - Please follow the same dietary procedures as on Days 1-9.
 - Please continue to refrain from consuming coffee, cigarettes, alcohol, or recreational drugs.
 - Please present yourself at the laboratory (as instructed) to receive your ambulatory blood pressure unit and 12-hour overnight urine collection kit (kit contains necessary instructions).

- ❖ Day 11
 - Please follow the same dietary procedures as on Days 1-10.
 - Please continue to refrain from consuming coffee, cigarettes, alcohol, or recreational drugs.
 - Please present yourself at the laboratory (as instructed) to return your ambulatory blood pressure unit and urine specimen, and to participate in the laboratory segment of the study.

- ❖ General Information
 - It is extremely important that you follow the diet consumption instructions, as we will be analyzing the urine specimen.
 - We will be contacting you on a daily basis in order to ensure protocol compliance.

If you have any questions during any phase of the study, please contact the researchers at:
848-2424 Ext. 2846

Appendix G
Urine Collection Instructions

12-Hour Overnight Urine Collection Instructions

Kit Contents:

Large plastic collection container (brown)
 Urine specimen vial (clear plastic tube with blue cap)
 Pair of latex gloves

- ❖ As this is an overnight 12-hour urine collection it is important that you begin collecting the urine output by 8 p.m. in order to ensure a full 12-hour collection.
- ❖ It is important to remember that you may not consume coffee, cigarettes, alcohol, or recreational drugs during this period.
- ❖ Please indicate in the space provided below the time of the first urine collection (e.g., 8:25 p.m.). Collect the urine in the large brown plastic container.
- ❖ If you urinate again before retiring for the night or if you wake during the night and need to urinate, please collect the entire output in the same container. There is no need to indicate these collection times.
- ❖ When you wake up please collect the entire first morning urine output in the same large brown collection container. If this is the last collection of the 12-hr period, please indicate the time in the space provided below (e.g., 7:53 a.m.). Please note that you will be presenting yourself at the laboratory at 9:00 a.m.
- ❖ After the morning collection, place the container on a flat level surface and verify the quantity of urine in the container. Write the quantity in the space provided below.
- ❖ After you have written the total quantity below, please pour a sufficient quantity of the urine from the brown collection container into the urine specimen vial (please fill to approximately 1 cm below the top of the tube) and place the blue cap firmly on the vial.
- ❖ Please insert the filled vial into the plastic bag (provided) and bring the vial to the scheduled laboratory appointment (same morning).

First (evening) collection time: _____ Last (morning) collection time: _____

Urinary output quantity: _____ ml

Participant # _____

Date: _____

If you have any questions during any phase of the study, please contact the researchers at:
 848-2424 Ext. 2846

Appendix H
Participant Informed Consent Form

INFORMED CONSENT FORM

Hypertension: Physical and Psychological Moderators in the Canadian Black Population

**Research Study Conducted at Concordia University
Department of Psychology on Behalf of Dr. Sydney Miller**

We would like you to participate in a study investigating moderators of risk factors for hypertension. In this study, changes in blood pressure and heart rate during normal daily activities will be recorded with an ambulatory (portable) blood pressure monitor, and during laboratory sessions with similar equipment. These procedures have been widely used in other research, and are completely safe and non-invasive. No needles or medication are involved and you will be asked to consume completely natural dietary sodium supplements. As is consistent with similar research, women who are pregnant will not be tested. Females will undergo a urine based pregnancy screen prior to beginning the test protocol.

Your participation in the study will require you undergo a 30-minute general medical exam in which physical and mental health will be assessed, to come to the laboratory for 3 sessions lasting approximately 30 minutes, and 2 sessions lasting approximately 90 minutes. During the first 30-minute session you will be asked to read and sign this consent form, given instructions and provided a dietary protocol which may include natural sodium supplements. You will also be asked to take with you and complete a package of questionnaires. Included in these questionnaires is one examining your experiences with racism. At the subsequent two 30-minute sessions, you will be fitted with a blood pressure cuff similar to those used in a doctor's office. Two blood pressure readings will be taken and you will then be asked to relax for a 10-minute period. Following the rest period, three more blood pressure readings will be taken. During these 30-minute sessions you will be fitted with an ambulatory blood pressure monitor. This monitor will be programmed to take intermittent blood pressure readings for a 24-hour period while you go about your regular activities (except bathing, swimming, or contact sports). Although you may experience some minor temporary discomfort as blood pressure readings are taken, the procedure is completely harmless. During waking hours you will be required to complete an activity diary immediately after each blood pressure reading is taken. In addition, we ask that you complete a few short questionnaires before retiring for the night. During the first of these last two 30-minute sessions you will be given further instructions and provided a dietary protocol, which may include natural sodium supplements. Prior to each of the two sessions during which you will be fitted with the ambulatory blood pressure monitor you may not consume coffee, cigarettes, alcohol, or recreational drugs beginning the evening (6 p.m.) prior to

presenting at the laboratory, and must continue to abstain until the end of that session's laboratory testing (approximately).

As part of the dietary protocol you will follow a 10-day routine diet and a 10-day high sodium diet (detailed instructions will be provided). On the last day of both the routine and high sodium diet you will participate in the second 30-minute session (described above), be fitted with the ambulatory blood pressure unit and follow a 24-hour blood pressure monitoring (described above) and complete a 12-hour overnight urine collection. After this 24-hour period you will come back the laboratory to return the blood pressure unit and participate in the first 90-minute session. In this 90-minute session physiological changes such as increases in heart rate and blood pressure will occur. These changes will be only temporary, however, returning to normal immediately after the experiment and causing no ill effects. You will be equipped with physiological measurement devices that consist of transducers placed on the skin and are safe, painless, and non-invasive. The measures include blood pressure and heart rate as well as several other heart related measures. You will be asked to sit quietly for 15 minutes and physiological measurement will begin during the last 5 minutes. Following this you will be asked to participate in three tasks.

These will include:

- (i) the placement of a cold gel pack chilled to a temperature of 4° Celsius on your forehead for two 2-minute periods separated by one minute. This procedure can be moderately painful but is harmless and the discomfort is no greater than what you would experience during a cold winter day.
- (ii) a 3-minute interview where you will be asked to recall an event in your past where you felt you were discriminated against,
- (iii) a 3-minute computerized math task.

After the 90-minute session you will begin the second diet period. On the last day of this diet period you will participate in the second 30-minute laboratory session (described above), and complete the final 24-hour ambulatory blood pressure monitoring and 24-hour urine collection. At the end of this 24-hour period you will return the blood pressure equipment to the laboratory and participate in the final 90-minute laboratory session (as described above).

Prior to leaving with the ambulatory blood pressure equipment and other materials, you will be asked to leave an identification card (e.g., social insurance card, student identification card) with the research assistant. Your identification card will be

kept in a secure place at the laboratory until it is returned to you the next morning with the return of the monitoring equipment and completed diary.

Moderators of blood pressure factors may include a family history of high blood pressure, high cholesterol levels, stroke, or other cardiovascular problems. In order to collect and verify this information we need to contact your parents for this information prior to your participation in this study. Please note that no information about your participation in the current study will be transmitted to your parents other than the fact that you have agreed to participate in the research project.

You are free to withdraw from the experiment at any time.

Participating in this study has no direct benefit for the participants or their families.

You will be paid \$100.00 for your participation when you have complied with the dietary protocols, provided the urine samples, returned the properly completed questionnaires and diaries, monitoring equipment, and participated in the final 90-minute laboratory session. Failure to comply with the requirements of the study described above will result in a reduction in the amount of financial compensation you receive.

All information we obtain about you is completely confidential and will not be seen by anyone who is not a member of the research team. Ultimately, all data will be coded using participant numbers rather than names.

Once you have carefully studied and understood this form, you may sign it in indication of your free consent and agreement to participate in the study.

In summary the steps that you will complete if you participate in this research are as follows:

1. Health questionnaire for screening purposes.
2. Provide contact information and consent to contact your parent(s).
3. Participate in a medical examination.
4. Undergo a urine-based pregnancy-screening test (females only).
5. Receive instructions and dietary materials and complete a questionnaire package (at home).
6. Follow a 10-day (high sodium diet) and 10-day (regular diet) dietary protocol.
7. 30-minute laboratory session including resting blood pressure readings and instrumentation with a portable blood pressure unit for 24-hour monitoring.
8. 24-hour monitoring including activity log.
9. 12-hour overnight urine collection.

10. 90-minute laboratory stress testing session that includes the two 2-minute cold pressor tests, a 3-minute discrimination-recall interview & a 3-minute computerized math task.
11. Complete several questionnaires.
12. Follow the second dietary protocol (regular or high sodium diet).
13. 30-minute laboratory session including resting blood pressure readings and instrumentation with a portable blood pressure unit for 24-hour monitoring.
14. 24-hour monitoring including activity log.
15. 12-hour overnight urine collection.
16. 90-minute laboratory stress testing session as described in step 8 with similar questionnaires.
17. Receive \$100.00 remuneration as stipulated above.

Parent Information:

Mother's Name	_____	Father's Name	_____
Telephone #	_____	Telephone #	_____
Address	_____	Address	_____
	_____		_____
E-mail	_____	E-mail	_____

Research Contacts:	Laboratory	SP-252.00
		848-2424 Ext. 2846
	Regarding your rights as a subject:	
	Concordia University Ombudsman	848-2424 Ext. 4964
	Researcher:	
	Sydney Miller Ph.D.	848-2424 Ext. 2183

NAME (PLEASE PRINT) _____

SIGNATURE _____

DATE _____

INVESTIGATOR'S SIGNATURE _____

Appendix I

Physician Physical Examination Form

PHYSICAL EXAMINATION

For participation in research study:

Hypertension: Physical and Psychological Moderators in the Canadian Black Population

Name: _____

Sex: F M

DOB: _____

Day Month Year

Height: _____

Weight: _____

Blood Pressure: _____

Pulse: _____

Respiration: _____

HEENT _____

Thyroid: _____

Lymph: _____

Respiration: _____

Cardiovascular: _____

GI: _____

GU: _____

Central Nervous System:

Skin: _____

Musculo Skeletal:

_____Pregnancy: Yes: _____ No: _____ L.M.P: _____
Day Month Year

HPI:

Allergies:

Previous Medical History:

Family History:

Mother:

Father:

Sibling(s):

Functional Inquiry: (Positives Only)

I see no medical contraindication to his/her participation in your sodium and hypertension stress study.

Signature: _____

Date: _____

Day Month Year