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I am submitting herewith a thesis written by Jenelle S. Krishnamoorthy entitled "Psychophysiological Study of Genetic Predisposition to Essential Hypertension." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Arts, with a major in Psychology.

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We have read this thesis and recommend its acceptance:

Accepted for the Council:

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PSYCHOPHYSIOLOGICAL STUDY OF GENETIC PREDISPOSITION TO ESSENTIAL HYPERTENSION

A Thesis
Presented for the
Master of Arts
Degree
The University of Tennessee, Knoxville

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August 1997

DEDICATION

This thesis is dedicated to my parents, Kris and Irene Krishnamoorthy, who provided me with unconditional love and support and inspired me to reach high for my dreams. They taught me to work hard and they gave me access to an educational experience that would not have been possible without them.

ACKNOWLEDGMENTS

I owe a great deal of thanks to a number of individuals who have been of invaluable assistance in the completion of this master's thesis. Although words are inadequate to express fully my gratitude, thanks are extended first to the members of my committee: my committee chairperson, Dr. Kathleen Lawler, who supported and encouraged me through the development of this research proposal, who gave endless hours reviewing various drafts of this manuscript, and always pushed me to reach my highest potential; and committee members, Dr. James Lawler, who provided invaluable assistance with methodological considerations, and Dr. Debora Baldwin, for her many suggestions and help through the thesis phase of the degree program. These individuals have been the backbone of my education here at the University of Tennessee, and I thank them accordingly.

Special thanks goes to Allison Bonner, Danelle Dimitrov, Christina Harper, Shen-Fen Ho, Beth Overbay, Rachel King, and Amy Scott for assisting in physiological recording and entering data. I would also like to thank Ingrid Edgemon, who provided me with much-needed breaks by overseeing the project at times and assisting in running the subjects. I would never have finished this thesis on time had it not been for the help of these individuals.

I would also like to thank my brother, Kris Krishnamoorthy, for checking in on me at the office and at home to make sure all was going smoothly. His sense of humor

and words of encouragement kept me smiling throughout the process. He definitely made this experience more enjoyable and pleasant.

Finally, I would like to thank Jimmy Mathews for putting up with me during this entire process--the long drives, high phone bills, and the weekends he spent watching me studying. I cannot express my appreciation for his words of encouragement, laughter, and his mere belief that I could do it, which all helped me accomplish this goal. As James Mathews, Sr. would say when times got tough, "hope springs eternal"; these are words to live by.

ABSTRACT

Genetic differences in family history status predict the subsequent development of hypertension. Individuals with at least one first-degree relative are more likely to develop hypertension. Three physiological response mechanisms by which this risk may be conferred are elevated baseline blood pressure, enhanced stress-induced cardiovascular reactivity, and delayed recovery from stress. An positive family history of hypertension may lead to essential hypertension through any or all of these mechanisms. Rarely have studies examined all three of these mechanisms, used males and females, had a large subject pool and verified their family history status. The present study represents a methodological improvement over prior studies by addressing all of these points.

Cognitive, affective, or behavioral personality predispositions have been linked to cardiac heart disease (Scheier and Bridges, 1995). Evidence has also suggested that a positive family history of hypertension may be associated with psychological attributes; one of the personality variables that may be implicated in the development of coronary heart disease is emotional suppression. By investigating both the biological and psychological predictors of hypertension, the present study has helped to further our understanding of the development of essential hypertension.

The results suggest that family history has significant effects on individuals' resting blood pressure, task blood pressure levels, and recovery blood pressure levels. However, family history groups did not differ in cardiovascular reactivity to stressors

independently of blood pressure levels. Further, the results indicated that positive family history subjects did not express their emotions differently than negative family history subjects. Exploratory analyses within the positive family history group revealed higher blood pressure levels associated with the suppression of positive and intimate emotions and with the expression of negative emotions.

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CHAPTER 1

INTRODUCTION

Hypertension is defined as persistently elevated arterial pressure that can eventually lead to the development of coronary heart disease, stroke, congestive heart failure, renal insufficiency, and peripheral vascular disease (NIH,1993). The American Heart Association estimates that about 50 million people in the United States suffer from hypertension (American Heart Association, 1996). It has been defined by the Heart Association as a resting blood pressure (BP) reading of 160/90 mm Hg or above on two different assessments taken on different days. The origins of 90% of all hypertension cases are unknown, referred to as essential hypertension. Researchers have speculated that there are probably a number of different causative mechanisms involved in essential hypertension. It seems highly unlikely that any one mechanism is involved in all cases of essential hypertension, but rather that it is a heterogeneous group of syndromes.

Coronary heart disease may result from the stress placed on the arterial vessels in hypertension. The extreme forces on the system under high pressure produce small lesions in the walls of the lumen of the vessels. As these lesions heal, scar tissue and lipid tissue can be deposited on the lumen wall which serves to decrease its diameter, leading to a vicious circle of increased BP due to an impediment of flow (Guyton, 1976). This kind of build-up in the coronary arteries can lead to coronary heart disease. Hypertension also has detrimental effects in that the heart is required to pump the blood against a higher pressure gradient which then increases its workload.

Despite varying opinions concerning the etiology of essential hypertension most investigators agree on the importance of genetic factors (Miall, 1971). A genetic influence on BP may operate through a number of mechanisms that alter BP levels (Julius, Pascual, & London, 1971). Research has found that offspring of hypertensives develop hypertension with greater frequency than offspring of normotensive parents (Feinleib, 1979; Pickering, 1968). Therefore, by studying these individuals one might further understand the potential pathology that predates the development of hypertension (Muldoon, Terrell, Bunker, Manuck, 1993).

There has also been evidence linking personality predispositions and acute psychological states to coronary heart disease (Scheier & Bridges, 1995). Personality predispositions include cognitive, affective, or behavioral tendencies on the part of an individual that are relatively stable across time and context (Scheier & Bridges, 1995). Expression of emotion is a personality variable that seems to be implicated in the cardiac heart disease outcome. Moreover, family history of hypertension (FH) has been thought to be associated with some psychological correlates. The interaction between FH and expression of emotion will be further examined in a future chapter.

Both cardiac heart disease and hypertension are of great interest to psychophysiological researchers, because of the belief by many that psychological stress may play an important role in their etiology. I have chosen to examine an area where individual differences, psychological stress, and cardiovascular responses may interact with the development of essential hypertension. I begin by discussing research seeking to tie FH to cardiovascular responses during stress. Second, the discussion examines expression of emotion, and its relationship to coronary heart disease. A review of the FH and the expression of emotion literature will follow in order to fully understand both of these factors and their interactions as predictor variables for essential hypertension.

CHAPTER 2

FAMILY HISTORY OF HYPERTENSION

Offspring of hypertensives develop hypertension with greater frequency than offspring of normotensive parents (Jamerson & Julius, 1991; Friedman, Selby, Quesenberry, Armstrong, Klatsky, 1988; Watt, Foy, & Hart, 1983). Jamerson and Julius (1991) compared the BP of 471 subjects at age 22 with their parents' BP, when they were age 22. They found that 30% of subjects who had a positive family history of hypertension (FH+) had higher BP readings (in the 80th percentile) compared to 18% of the subjects who did not have a family history of hypertension (FH-). Friedman, Selby, Quesenberry, Armstrong, and Klatsky (1988) compared medical charts of 1031 diagnosed hypertensive patients with 1031 normotensive patients after matching for demographic variables. Using the Kaiser Permanente multiphasic health checkup questionnaire, which reported the FH status of the parents, they found that having an FH+ was predictive of essential hypertension. They also found the relationship was stronger when the hypertensive parent was the mother or when both parents were hypertensive than solely the father being hypertensive. Watt and colleagues (1983) classified parents, who had participated in a previously conducted study in which they had already had their BP measured, as high/high if they both belonged to the top third of the distribution of BP or low/low if they both were in the bottom third. They tested the BP of 116 English offspring (ages 10-43) of these high/high or low/low groups. They found that offspring of the high/high group had significantly higher SBP than offspring of the low/low group. There are data to indicate that a greater percentage of college-aged subjects with FH (1 or more parents with diagnosed hypertension) reported already having hypertension (10.8%) than those with no family history of hypertension (FH-) (1.6%) (Jorgensen & Houston, 1981).

By, studying individuals "at risk" as a result of FH, one may examine potential pathophysiologic factors that predate the development of hypertension (Muldoon, Terrell, Bunker, & Manuck, 1983). Researchers, therefore, can either include these subjects who already have some degree of hypertension, or exclude them so that only currently normotensive individuals with and without a FH participate. Both kinds of studies have been reported in looking at physiological responsivity in individuals differing in FH.

Three measures that have been examined by researchers, in order to get a better understanding of the development of hypertension: resting BP, the cardiovascular response to a stressor, and recovery rate back to baseline BP, following a stressor. Many investigators have found inconsistent results with these three measures. Some have reported FH+ subjects displaying one or a combination of an elevated resting BP, exaggerated cardiovascular response to a stressor, and a slower recovery rate to baseline BP following a stressor, all which may indicate an increased likelihood of developing hypertension later in life (Jorgensen & Housten, 1981,1986; Hastrup, Light, & Obrist, 1982; Manuck, Proietti, Rader, & Polefrone, 1985). In order to understand these physiological measures involved, short explanations will be given of each. Then an extensive review of these three physiological responses in FH+ and FH- individuals will follow to determine whether there are any differences between the two groups.

Casual, or resting BP is the strongest single predictor of subsequent hypertension. Normotensive individuals with an FH+ have displayed an elevated resting BP compared to

FH- individuals (Shapiro, Goldstein, & Jamner 1995; Lamensdorf & Linden, 1992; Lawler, Lacy, Armstead, & Lawler, 1991; Ravogli, et al., 1990). Researchers have found that an elevated resting BP and having an FH+ are both risk factors for the future development of hypertension (Shapiro, Goldstein, & Jamner 1995; Lamensdorf & Linden, 1992; Ravogli, et al., 1990). By already having a higher baseline BP, it is more likely that these levels will increase with age, which will eventually put these individuals in the high BP range (Julius, 1977).

Another possible mechanism that may put individuals at risk for the development of hypertension is an exaggerated cardiovascular response to a stressor. Cardiovascular reactivity has been defined as an acute increase in BP in response to psychological, physical, or interpersonal challenges compared to a baseline or resting level. Two major hypotheses have been proposed for the role of hyperreactivity as a mechanism in the development of essential hypertension. One hypothesis suggests that hyperreactive BP peaks damage the intimal layer of arteries, resulting in arteriosclerosis and subsequent essential hypertension. An alternative hypothesis suggests that hyperreactive BP peaks cause greater release of mitogens, which result in hypertrophy of smooth muscles. This leads to increases in total peripheral resistance and subsequent essential hypertension (Borghi, Costa, Boschi, Mussi, & Ambrosioni, 1986; Fredrikson and Matthews, 1990). The reactivity hypothesis was developed with hypertensives and then studied in normotensive individuals who possessed one or more risk factors. Studies will be reviewed that examine FH and elevated resting BP and exaggerated cardiovascular response.

The recovery rate of BP and heart rate back to baseline levels, following a stressor, has been introduced as another mechanism by which FH may increase one's risk for hypertension. Few investigators have examined recovery rates as a risk factor; however, preliminary research has shown that individuals who have an FH+ have a slower recovery rate back to their baseline values following a stressor (Gerin & Pickering, 1995). The mechanism underlying delayed recovery in FH+ individuals remain unexplained. The reasons could be physiological or psychological or a combination of both. Either way, the sustained BP levels following a stressor may be placing that individual more at risk for the later development of hypertension.

Elevated Resting Blood Pressure

Ravogli and colleagues (1990) investigated BP elevation in normotensive subjects with and without an FH. There were three groups comprised of 15 subjects whose parents did not have hypertension, 15 subjects who had one hypertensive parent, and 15 subjects whose parents were both hypertensive (10 women and 5 men in each group). Verification of group classification was established by measurement of parents' BP.

The subjects were monitored during a 30-minute baseline period and four laboratory tasks (mental arithmetic, mirror tracing, hand grip, cold pressor). Each stressor was administered twice. The tasks were separated by 5-minute rest periods, where BP and HR were continued to be measured. In addition, an ambulatory BP monitor was attached to the subject to record BP and HR for the next 24 hours.

The results of the study found that subjects with an FH+ (with either 1 or 2 hypertensive parents) had significantly higher resting BP (recorded both in the laboratory and during the ambulatory monitoring). However, the FH+ group did not show an exaggerated cardiovascular response to the four different stressful tasks. The authors conclude that this elevation in resting BP may be important because BP is related to cardiovascular disease even within the normotensive range (Kannel, 1974).

Elevated Resting Blood Pressure and Cardiovascular Reactivity

Shapiro, Goldstein, and Jamner (1995) examined the effects of having a FH on BP with 209 normotensive college students. One hundred and two of the subjects were classified in the FH+ group and 107 subjects were in the FH-. Family history classification was verified by letter from the parent. At least one parent had to be confirmed as hypertensive to be classified in the FH+ group.

Following an initial screening, the subjects came to the laboratory and completed health and personality questionnaires. After a 5-minute baseline resting period to assess BP, the subjects were given a difficult mental arithmetic task to perform for 3-minutes, a hand grip task at 20% maximum, and a 1-minute cold pressor task. These tasks were all counterbalanced and had a 5-minute recovery period between each. Blood pressure was determined using a beat-to-beat tracking-cuff system (Shapiro, Greenstadt, Lane, & Rubinstein, 1981) which measured SBP in the right arm and DBP in the left arm.

For baseline values of BP, the FH+ group displayed significantly higher SBP and DBP levels than the FH- group. During the mental arithmetic task the FH+ group also showed significant increases in DBP reactivity compared to the FH- group. Shapiro and his colleagues concluded that having a FH appears to be a magnifier of reactivity and is also related to higher resting baseline BP levels.

Lamensdorf and Linden (1992) further examined the effects of FH on BP with a total of 60 college students, divided into 2 groups. The two groups consisted of normotensive subjects with either one or more parents with hypertension, or no history of hypertension. Confirmation of FH status was secured through the mail from the parents.

During the initial 15-minute baseline rest period, BP and HR were assessed. A Dinamap machine was used to obtain BP and HR readings. The subjects then engaged in either describing an emotionally distressing time, saying what season the slides shown were taken in, or mental arithmetic for 5 minutes each. Upon completion of each task, the subject had a 5-minute resting period where BP and HR continued to be measured. The final minute of each rest period acted as the baseline value to the next task.

Baseline DBP levels were significantly higher for FH+ compared to the FH- group; however, there were no differences between the groups during the baseline period for SBP or HR. Throughout the tasks there was a significant main effect for family history on DBP. This indicated that there was more DBP reactivity amongst the FH+ group compared to the FH- group.

Another study conducted by Lawler, Lacy, Armstead, and Lawler(1991), examined the role of FH (37 FH+, 73 FH-) on the cardiovascular response to a challenging task. Subjects were classified in the FH+ group if they reported that one of their parents was hypertensive. The investigator was blind to the FH classification of each subject until the end of the experiment. Blood pressure was measured with the Roche Arteriosonde monitor with the cuff being placed on a subject's nondominant arm.

Following attachment of the equipment, subjects were instructed to rest for a 15-minute baseline/rest period. The subjects were then administered the mental arithmetic and visual IQ tasks with a 5-minute rest period given between each. Upon completion of the last task a 10-minute recovery/rest period was given.

The results indicated an interaction between sex and FH group. Positive family history males displayed higher SBP during rests and tasks compared to FH- males. The authors concluded that FH may have different effects on the males and females. An FH+ was associated with higher BP levels during rest and tasks for males, but not for females. These effects were best demonstrated by the significant interactions of FH with gender for SBP. There was no significant effect of FH on DBP. Overall, there were no significant main effects of FH.

In contrast to the above findings, many other studies have not found any FH group differences in resting baseline BP levels (Sausen, Lovallo, Wilson, 1991; Manuck, Proietti, Rader, Polefrone, 1985; Semenchuk & Larkin, 1993; Falkner Onesti, Angelakos, Fernandes, & Langman, 1979; Gerin & Pickering, 1995). These results provide evidence that there are inconsistencies that surround this measure and its association to FH. A discussion of factors potentially underlying these inconsistencies is included at the end of this chapter.

Increased Cardiovascular Reactivity Alone

Other investigators have examined the relationship of FH in undergraduates (17 FH+, 77 FH-) to cardiovascular reactivity to a stressful cognitive task (Sausen, Lovallo, Wilson, 1991). Parental history classification was verified through surveys sent home to the parents. An initial screening consisted of the administration of health questionnaires, while a second session involved the measurement of BP while engaging in the cognitive tasks (serial subtraction and repeating numbers backwards). Blood pressure baseline values were approximately the same for the FH+ and FH- groups. The FH+ group exhibited significantly greater SBP and DBP reactivity to all of the tasks. The FH+ group also displayed significantly larger rate pressure product (HRXSBP, a measure of demand on the heart) during the tasks compared to the FH- group. There were no group differences on HR during the tasks. This study found the FH factor predictive of the cardiovascular response to the challenging tasks.

Manuck, Proietti, Rader, and Polefrone (1985) also investigated the cardiovascular response to a cognitive task in undergraduate men (22 FH+, 22 FH-). Following a brief adaptation period, baseline assessment of BP was recorded over a 3-minute interval, during which the subject sat still. Subjects were then engaged in a 5-minute mental arithmetic task. The FH+ group displayed a greater DBP reactivity, despite equivalent task performance by both groups. There were no group differences on SBP reactivity during the experimental task, but the average HR reactivity was greater for the FH+ group than the FH- group. The study's findings support the hypothesis that normotensive individuals who have an FH+ display a larger cardiovascular response to behavioral stimuli compared to FH- individuals.

Another recent study also found evidence to support the reactivity hypothesis with 40 normotensive (20 FH+, 20 FH-) undergraduate males (Semenchuk & Larkin, 1993). After an initial screening session to fill out family health history questionnaires, subjects were scheduled for a 1-hour testing session. After a 16-minute adaptation/baseline period, a 3-minute interpersonal challenge was given. After a 6-minute recovery period, the subjects were engaged in a second 3-minute interpersonal challenge, followed by another 6-minute recovery period. During the baseline periods, HR was significantly higher for FH+ individuals than FH- individuals. Throughout the two interpersonal challenges, the FH+ group exhibited significantly greater SBP reactivity compared to the FH- group.

Widgren, Wikstrand, Berglund, and Andersson (1992) investigated whether individuals with an FH+ displayed significantly elevated BP responses to both a physical and a mental challenge. Thirteen male subjects with an FH+ and 13 males subjects with an FH- at age 31 participated in the study. The criterion for being classified in the FH+ group was that the fathers had hypertension or SBP readings above 175 mm Hg or DBP readings above 115 mm Hg or the mothers had either suffered a stroke or been treated for hypertension before the age of 65. Verification of group classification was conducted through a telephone interview with a parent.

Subjects were asked to rest in a supine position for 45 minutes. Three baseline recordings were taken during the last 15 minutes of this period at 5-minute intervals. These measurements were then averaged to yield baseline BP values. There were no group differences during the baseline period. The tasks (isometric hand grip & Stroop task) were then administered with BP being assessed throughout. During the initial assessment, absolute BP levels were significantly higher only during the isometric handgrip task, just before exhaustion, in FH+ subjects.

At a 5 year follow-up the same procedures were followed. At this time, both the absolute DBP and SBP levels and the diastolic reactivity were found to be significantly increased during the handgrip task in FH+ subjects, compared to the FH- subjects. The DBP response of FH+ subjects was also significantly higher at the follow-up than at initial assessment, while the FH- subjects displayed a lower SBP at follow-up than at initial assessment. During the Stroop task, the DBP reactivity was significantly greater for FH+ subjects than FH- subjects. Diastolic BP remained significantly higher for the FH+ group compared to the FH- group throughout the Stroop task. These authors conclude that normotensive FH+ males were characterized by increased BP reactivity under both physical and mental stress compared to FH- male subjects.

Increased Cardiovascular Reactivity and Delayed Recovery

Falkner, Onesti, Angelakos, Fernandes, and Langman (1979) examined the hemodynamic response to a mental arithmetic task of 75 males and females (mean age= 15 years). One group was the control group and consisted of subjects who were FH- for at least 3 generations. The genetic group involved individuals who had at least one parent with diagnosed hypertension. The third group included subjects who had a DBP greater than the

95th percentile (labile hypertensives), with periods of normotension. These individuals also had to have an FH+ to be included in this group.

Following explanation of the study and signing the consent form, subjects were given a 30 minute resting period. After recording baseline values for BP, the subjects were then engaged in a difficult mental arithmetic task for 10 minutes. Blood pressure was determined every minute during the task.

During the mental arithmetic task the control group's DBP increased slightly at the beginning of the task, but quickly recovered to baseline and beyond before the end of the 10-minute task. The genetic and labile groups showed a significantly greater increase in DBP compared to the control group. This increased DBP in both groups remained high throughout the task and through the recovery period and never returned to their baseline values. The labile and genetic group also displayed a rapid increase in HR which was sustained throughout the mental arithmetic task. This difference in the sustained HR change was significantly different from the control group. This study found that the control group had an increase in response to the stressor, but quickly returned to baseline levels with the stressor still continuing. In comparison, the subjects in the labile group displayed a higher stress response pattern of sustained increase in DBP throughout the stressor and into the recovery period. Throughout the study the genetic group displayed a similar pattern to the labile group, adding evidence of the genetic factor underlying hypertension.

In contrast to the previous studies which have found FH group differences in the cardiovascular response to a stressor, negative results have also been reported in several well-designed studies (Muldoon, Terrell, Bunker, & Manuck, 1993). The large number of negative studies in this area raises questions about the strength of the relationship between reactivity and FH. Amongst the studies reviewed here, Gerin and Pickering (1995) and Lawler, Lacy, Armstead, and Lawler (1991) found no FH group differences in cardiovascular reactivity following a stressor. This adds evidence that more studies need to be conducted with more subjects, stricter guidelines for group classification, confirmation of FH groups, and controlling for body mass index.

Delayed Recovery Rate

Gerin and Pickering (1995) examined the recovery rate of BP following a mental stress task with FH+ and FH- individuals. A total of 537 normotensive college students records were examined by combining existing data. Classification of FH was determined through a self report questionnaire. After a 10 or 15 minute baseline period, the subject was given a serial subtraction task, followed by a 10 minute recovery period. This study found no group differences in cardiovascular reactivity during the task. For recovery rate, a significant effect was found for FH+ individuals on SBP and a marginal effect on DBP. Further analyses revealed that FH+ subjects with two hypertensive parents remained elevated at a significantly higher level than either subjects with one or no hypertensive parents. The authors concluded that FH may affect the recovery rate of BP in response to a stressful task more than the degree of the response itself.

Recovery to baseline BP following a stressor is not a commonly examined measure when investigating FH. Shapiro, Goldstein, Jamner (1995), Lamensdorf and Linden (1992), Sausen, Lovallo, and Wilson (1991), and Semenchuk and Larkin (1993) have not investigated the association of FH with the recovery measure during their studies. The preliminary evidence that has been reviewed suggests that the delayed return of BP to baseline level, may be related to the impairment of the depressor mechanism (Hines & Brown, 1932).

Analysis

As shown in Table 2-1 the available literature on the relationship between FH and resting BP, cardiovascular reactivity to a stressor, and recovery to baseline BP, has yielded inconsistent results. The research reviewed here found that FH+ individuals exhibited a variety of responses, either individually or in some combination. While FH+ often display higher resting BP, exaggerated cardiovascular reactivity to a stressor, and a slower recovery to baseline BP, the many inconsistencies that exist among studies raise serious concerns regarding the strength and replicability of these associations (Muldoon, Terrell, Bunker, & Manuck, 1993).

There are many reasons that may explain the different results among these studies. Many studies have used a small number of subjects to examine the differences between the two groups, thus increasing the size of the difference needed to achieve statistical significance. Other studies with large samples tend to have unequal groups, with more subjects in the FH- than the FH+ group. In addition, the FH- subjects are not screened for other risk factors for hypertension, such as smoking, obesity, or oral contraceptives, that may be confounded with FH classification. Furthermore, guidelines for classification of FH+ and FH- differ from study to study. For example, some investigators only classify the subject as FH+ if both of their parents are hypertensive, while other investigators merely require one parent diagnosed with hypertension. Family history classification is sometimes verified with parents or doctors and sometimes assessed through self-report questionnaires. Through examining the studies, I noticed that many of them did not control for body mass index. This factor alone can skew the results, as weight is highly correlated with BP, and therefore true group differences may be obscured. Finally, the protocols of the studies reviewed did not examine all three of the measures described here: resting levels, reactivity and recovery. With the bias toward emphasizing significant differences, it is unclear which measures would consistently show differences or no differences, if routinely reported.

CHAPTER 3

EXPRESSION OF EMOTION

Recent evidence has linked personality predispositions and acute psychological states to coronary heart disease (Scheier and Bridges, 1995). These "person variables" are personality traits that characterize cognitive, affective, or behavioral tendencies that are used to distinguish one individual from others. One of the personality variables that seems to be implicated in coronary heart disease outcome is emotional suppression. This section will focus on the effects of suppression of emotion and its implications for the development of coronary heart disease.

Research has found that the degree to which individuals suppress their emotions may influence the etiology of coronary heart disease (Temoshok, 1985; Grossarth-Maticek, & Eysenck). Haynes, Feinleib, and Kannel (1980) investigated the relationship of behavioral responses to anger and the report of coronary heart disease over an eight-year period. In this study, there were 1674 men and women (ages 45-77) who were free of heart disease and considered healthy. Participants were administered a battery of questionnaires that assessed their manner of expressing anger. These measures, in particular, examined whether the participants kept their anger in, expressed it by taking it out on others (anger-out), or talked with a friend or relative (anger-discuss).

In an eight-year follow-up session, women (aged 45-64) who developed coronary heart disease scored significantly higher on the Framingham Type A behavior, suppressed hostility (not showing or discussing anger), tension, and anxiety symptoms scales than women remaining free of coronary heart disease. In a further analysis, Framingham Type A behavior and not discussing anger were independent predictors of coronary heart disease incidence when controlling for the standard coronary risk factors and other psychosocial scales. It was also discovered that working women below the age of 65, who developed coronary heart disease, also scored significantly lower on the anger-out scale, compared to disease-free women.

Men exhibiting Framingham Type A behavior, suppressed hostility (not showing anger), and work overload were at increased risk of developing coronary heart disease (especially between the ages of 55 and 64 years). However, when the data were adjusted for other pre-existing risk factors for coronary heart disease (cholesterol, smoking, BP), the association between styles of expression of anger and heart disease was no longer significant. Thus, Haynes et al. (1980) concluded that anger suppression appears to influence the development of coronary heart disease only in women. However, to the extent that anger suppression is associated with other risk factors (smoking, high fat diet), it may still exert an indirect effect on subsequent hypertension.

Genetic predispositions to essential hypertension has also been thought to have some psychological correlates. We have established that normotensive FH+ individuals are genetically more at risk for the later development of hypertension than FH- individuals. Other researchers are not just studying the genetic effects of having a FH+, but also the psychological factors in the family during childhood. The psychological correlates that have been thought to be associated with a FH+ are also being viewed as a precursor for adult hypertension. Baer, Vincent, Williams, Bourianoff, and Bartlett (1980) investigated behavioral differences between families with a hypertensive father (n=16) and a normotensive father (n=15). The three-member families consisted of a father, mother, and a boy or girl who completed the Revealed Differences Test questionnaire, had to unanimously agree on a solution on a Revealed Differences Test episode given to them (conflict resolution task), and participated in a Family Role Playing skit. Their blood pressures were assessed before and after each task. The results of the study found families with hypertensive fathers exhibited significantly more negative nonverbal behavior, higher frequencies of negative behavior combining both nonverbal and verbal components, and less frequency of positive verbal behavior than normotensive families. Further analysis revealed FH+ male children exhibited less positive verbal behavior than FH- male children. This difference did not occur for female children. There were also group differences in how the families responded to instructions to either express or suppress their emotions while they interacted during a conflict resolution task. The FH+ families expressed more negative verbal behavior, and less positive behavior, when instructed to express their feelings. In response to suppressing their emotions, the FH+ families exhibited less negative verbal behavior and more positive verbal behavior. The response to the latter instructions is consistent with other studies finding that hypertensive adults tend to suppress expression of hostile emotion. The study also found that the greater the frequency of parental negative nonverbal behavior, the more elevated the child's SBP following the Family Role Playing skit.

Children growing up in families that have a hypertensive father may be learning not to express their negative emotions directly, but express them indirectly through nonverbal behaviors. The fact that these children already exhibit elevated SBP following conflict, and express negative emotions indirectly, supports the view that these individuals are already at increased risk for the development of coronary heart disease. The results of this study illustrate the link between hypertension and suppression of emotion and how it may be transmitted from a hypertensive adult to his/her child through the interaction of genetics and environment.

Studies have found that FH+ normotensives exhibit greater sympathetically driven cardiovascular reactivity to stressors than FH- normotensives (Falkner, et al., 1979; Widgren, Wikstrand, Berglund, & Andersson, 1992; Semenchuk & Larkin, 1993; Sausen, Lovallo, Wilson, 1991). As discussed in Chapter II, exaggerated cardiovascular response following a stressor may place individuals at greater risk for the development of coronary heart disease. Researchers have proposed that personality characteristics, in combination with heredity, may also contribute to the this exaggerated reactivity that may effect the pathogenesis of some types of essential hypertension.

Jorgensen and Houston (1986) investigated the possibility that a certain personality pattern possessed by FH+ individuals may be accompanied by exaggerated cardiovascular reactivity. The study included 57 FH+ (31 males, 26 females) and 57 FH- (28 males, 29 females) subjects. The first session consisted of completing personality measures and setting up an appointment for the laboratory testing. During the lab testing, subjects were given a 10-minute baseline period and then administered two tasks (mental arithmetic and shock avoidance mental arithmetic). State anxiety and anger measures assessed feelings during the task; both tasks were followed by 4-minute recovery periods.

A subgroup of the FH+ group, characterized by denial and unwillingness to admit neurotic feelings or aggressiveness, displayed exaggerated blood pressure reactivity to the tasks. Moreover, in relation to their level of heightened physiological arousal, subjects in this subgroup reported little negative affect in response to the tasks, which suggests that they deny or suppress their feelings. This personality pattern of these cardiovascularly reactive FH+ individuals is similar among individuals with essential hypertension.

Gross and Levenson (1993) also investigated the effects of suppression of emotion by having some participants inhibit their facial expression to an external emotion elicitor and others behave normally. The participants were asked to view three different films (a neutral film, a medical procedure of a burn victim, and an amputation) and complete questionnaires to assess their emotional response to what they had just viewed. Participants who suppressed their emotions experienced increased skin conductance, decreased finger pulse amplitude and more pronounced shortening of pulse transmission times to the finger, all signs of increased activity of the sympathetic nervous system. These findings support the hypothesis that suppression of emotion leads to increased arousal, which may place individuals at greater risk for the later development of coronary heart disease (Pennebacker, 1985).

Another study examined the associations between various psychosocial factors and BP with 444 subjects who participated in the Michigan Statewide Blood Pressure Survey. Individuals were classified into groups based on their DBP levels (normotensive, borderline hypertensive, hypertensive). Following completion of personality measures, the subjects' BP was taken. Results of the study found that for men and women, suppressed emotion and internalized aggressive impulses were positively associated with higher DBP levels. This study lends further evidence that suppression of emotion increases an individual's BP even in normotensive subjects (Gentry, Chesney, Gary, Hall, & Harburg,1982).

The data from these studies add support to the hypothesis that the lack of emotional expression (internalizing) leads to greater physiological responses to emotion-eliciting stimuli than outward expression (externalization) (Jones, 1950; Notarius & Levenson, 1979). Past research has mainly focused on the expression/suppression of hostility or anger. This study will examine the expression of positive, negative, and intimate emotions. Scheier and Bridges (1995) concluded, after reviewing articles in this area, that to get a better understanding of the effects of suppression of emotion there needs to be more research with the "biobehavioral model". This model combines biological and psychological components in only to understand the development of disease. Through investigation of the three physiological responses (resting BP, cardiovascular reactivity, recovery) by which FH may lead to essential hypertension, and studying the expression of emotions with participants that are FH+ and FH-, this study will try to clarify further the mechanisms by which genetic and psychological factors may lead to the development of cardiac heart disease.

CHAPTER 4

STATEMENT OF RATIONALE AND PURPOSE

Genetic differences in family history status predict the subsequent development of hypertension. Individuals with at least one first-degree relative are more likely to develop hypertension. Three physiological response mechanisms by which this risk may be conferred are elevated baseline BP, enhanced stress-induced cardiovascular reactivity, and delayed recovery from stress. An FH+ may lead to essential hypertension through any or all of these mechanisms. Rarely have these studies examined all three of these mechanisms, used males and females, had a large subject pool and verified FH status. The present study represents a methodological improvement over prior studies by addressing all of these points.

Cognitive, affective, or behavioral personality predispositions have been linked to cardiac heart disease (Scheier and Bridges, 1995). Evidence has also suggested that an FH+ may be associated with psychological attributes. One of the personality variables that may be implicated in the development of cardiac heart disease is emotional suppression. By investigating both the biological and psychological predictors of hypertension, the present study may be able to clarify previous inconsistencies in the literature and further our understanding of the development of essential hypertension. The principal aims of the present research were to: 1) gather data on a large pool of male and female subjects, 2) examine the resting BP, stress-induced cardiovascular reactivity, and the BP recovery from stress in FH+ and FH- individuals; and 3) gather information on the expression of emotion in FH+ and FH- individuals.

In order to meet these aims, a variety of measurements and tasks were used. The measurements of BP were taken during two challenges: a mental arithmetic task and a mirror tracing task. The reason for choosing these tasks is that they are mental stressors that have been used in the cardiovascular reactivity literature, and they reliably increase BP. Some specific questions I would like to address in this study include the following:

1) Do FH+ individuals exhibit a higher resting BP level compared to FH- individuals?

2) Do FH+ individuals display greater cardiovascular reactivity to the tasks than FH- individuals?

3) Do the different FH groups differ in their recovery rates back to baseline?

4) Do FH+ subjects differ in the way they express their emotions from FH- subjects?

CHAPTER 5

METHODS

Subjects

The study protocol was approved by the University of Tennessee, Knoxville Institutional Review Board. Written informed consent was obtained prior to participation. All subjects were undergraduates at The University of Tennessee, and received extra credit in their psychology class for participation. Subjects were recruited by posting a sign-up sheet on a bulletin board advertising psychology experiments and going to classes and discussing the experiment. Participants were asked not to drink anything containing caffeine, eat, or smoke 2 hours prior to the study. One-hundred and thirty-eight participants completed the study. Thirty-eight of the subjects' data were not included because of smoking more than 10 cigarettes a day or medications that could affect BP, such as oral contraceptives. There were a total of 50 FH+ subjects and 50 FH- subjects in the study. The subjects ranged in age from 17 to 43, with an average age of 22 and a mean ($\pm$ standard deviation) of 5.07 years. Of the 100 subjects who were used in the study, 10 were African-American and 4 were Asian. The remaining subjects were Caucasians.

Groups

Subjects were given a family history/health questionnaire to complete. In this survey it specifically asked whether either of the subjects parent's had been diagnosed with hypertension and if they were taking medication for it. A postcard was then sent to the subjects' parents to receive confirmation of their hypertension status. If the parent' and subject's report differed, the parents' information was used for group classification. If the parents did not return the postcard, the subject's report was used for their group classification. If the parent had died from coronary heart disease, the subjects' report was also used for classification. The subjects were classified as in the FH+ group if one or more parents were diagnosed with hypertension and they were being treated with medication. Those reporting having no parents with hypertension were then classified in the negative family history group.

Apparatus

The experimental procedure was conducted in the health psychology laboratory. The laboratory contained 4 small rooms, 2 of which were used for the experiment. In the experiment room there was a recliner chair, television, VCR, intercom system and table. Next to the experiment room was the equipment room which contained the measuring equipment and the intercom.

Physiological Recording

The equipment room contained an IBS Sd-700A Blood Pressure and Pulse Rate Monitor, an intercom system, and a BoMed NCCOM-e Cardiovascular Monitor (BoMed Manufacturing Limited, Irvine, CA).

Systolic BP and DBP were assessed with the BP and Pulse Rate Monitor. A cuff was attached to the subject's upper left arm, with microphone of the cuff was placed over the brachial artery. Blood pressure measurements were initiated from the experimenter room throughout the study. A matching of HR measurement from the BoMed Cardiovascular Monitor and the BP and Pulse Rate Monitor verified the HR values.

Cardiac impedance data were collected by using the BoMed Cardiovascular Monitor. Eight electrodes were attached to the neck and sides of the subjects. Thoracic fluid index, ventricular ejection time, ejection velocity index, stroke volume, HR, and cardiac output were the 6 parameters assessed with averages of every 12 heart beats recorded.

Procedure

Upon entering the lab, the subject was given the consent form and asked to read and sign it. They were then administered a personal and family history medical questionnaire. After completion of these forms the subject was either instructed to finish completing the battery of psychological questionnaires or come into the experimental room.

Each subject was tested individually. After entering the testing room, he or she was asked to remove his/her shoes in order to obtain accurate height and weight measurements. The subject remained standing while the electrodes were being applied, and then sat in the recliner. The BP cuff was placed on his left arm. The subject was then asked to relax for a moment while the assistant went into the equipment room to test whether the equipment was applied properly.

After assessing the equipment hook-up, the research assistant re-entered the experiment room and asked the subject to continue to relax while watching a video entitled, "Coral Sea Dreaming...an evolving balance" (Coral Sea Imagery & Natural Symphonies, 1993) for the next 15 minutes. The experimenter then left the room and returned to the equipment room. Following the baseline period the tasks were administered. The order of the tasks was counterbalanced. During the mental arithmetic task the experimenter re-entered the room and read the instructions for the task. The subject was then asked to subtract by 7's from 1250 for 4-minutes. If the subjects made a mistake they were given their last correct answer and asked to continue. If they made a mistake again they were then given the right answer and asked to continue. Upon completion of the task, the subjects were given a 4-question perspective questionnaire. This assessed whether they were using active or passive coping skills during the task. Once completing the questionnaire, they were then asked to relax and watch the same video for the next 8-minutes; the experimenter left the room. The experimenter then returned to the experimental room and had the subject sit up in the recliner and provided a pillow for extra back support. The assistant then placed a writing table across the subject's lap for the mirror tracing task. Subjects were then read the instructions and asked if they had any questions. They had to trace around the star between the lines as many times as possible and verbalize the star points while they traced for the 4-minute time period. Once the task was completed, the assistant administered the same perspective questionnaire. The experimenter then had the subject recline the chair back, removed the support pillow, and asked him to relax and watch the video for 8-minutes. After removal of the physiological monitoring equipment the subjects were either asked to complete the battery of psychological questionnaires or be debriefed. The subjects were then asked not to discuss the experiment with other subjects.

Variables

Blood pressure. Baseline BP was assessed during the first 15 minutes of the experiment. This period consisted of readings taken at minutes 5, 10, 12, and 14. Task readings were taken during the 4 minute stress-induced tasks at 15 seconds, 1:15, 2:15, and 3:15. In addition, BP was taken for 8 minutes following completion of the stressful task, at 30 seconds, 2:30, 4:30, and 6:30. Calculation of MAP from SBP and DBP will be completed for the same 4 minutes recorded during the tasks and baseline BP.

Heart rate and cardiac impedance variables. Heart rate, thoracic fluid index, ventricular ejection time, stroke volume, and cardiac output were displayed with 12-heart beat averages. These measurements were computed throughout the experiment, and stored in a computer script file. Subsequent analysis led to means for each minute of tasks and rest periods. For the purpose of this experiment, only heart rate will be analyzed with minute by minute means. Rate product pressure will be calculated from SBP and HR for each minute.

Expression of emotion. The Emotional Expressiveness Questionnaire (King & Emmons, 1990) assessed the expression of negative, positive, and intimate emotions. An example of a statement assessing negative emotions would state; when I am angry, people around me usually know. A positive emotion statement would ask if when watching television or reading a book it could make you laugh out loud. Expression of an intimate emotion would ask if you often told people that you loved them. High scores on the Emotional Expressiveness Questionnaire indicated a tendency to express the emotion. King and

Emmons (1990) reported the internal consistency of this instrument as satisfactory (Cronbach's alpha= 0.78), with similar reliability coefficients for the expression of positive emotion (Cronbach's apha=0.74), negative emotion (Cronbach's alpha=0.67), and intimate emotion (Cronbach's alpha=0.63). The mean interitem correlation on the 16 item questionnaire was 0.18.

Data Analysis

Participants' demographic variables will be analyzed using either Chi Square (for categorical data) or t-tests (for interval data). These analysis will determine whether there are any significant group differences (FH+ vs. FH-) for the age, height, and weight variables.

(1) Do FH+ individuals exhibit a higher resting BP level compared to those FH- individuals? A 2 (FH) x 2 (sex) x 4 (repeated measures: baseline rest 5 min, 10 min, 12 min, 14 min.) analysis of covariance (ANCOVA) with BMI as the covariate. Completed for SBP, DBP, HR, MAP and RPP.

(2) Do FH+ individuals display greater cardiovascular reactivity to the tasks than FH- individuals? A 2 (FH) x 2 (sex) x 2 (repeated measures: 4 minute MA, 4 minute MT) with baseline and BMI covariated. Completed for SBP, DBP, HR, MAP and RPP.

(3) Do the different groups of subjects differ in their recovery rates to baseline? A 2 (FH) x 2 (sex) x 4 (minutes) one for MA and one for MT with BMI covaried. Completed for SBP, DBP, HR, MAP and RPP.

(4) Do FH+ subjects differ in the way they express their emotions from FH- subjects? Are there gender differences? A 2 (FH) x 2 (sex) ANOVA for Expression of Emotion and subscales.

CHAPTER 6

RESULTS

Family Health History

We received confirmation of FH status on both parents for 60 of the subjects. There was a 90% FH status agreement, found between parents and subjects by dividing 54 (subjects whose FH status agreed with their parents) by 60 (the total number of subjects whose parents sent their cards back). When there was a disagreement on FH status between parent and child, the parental report was used. An additional 40 subjects were classified through self-report; 12 of these subjects had one parent confirmation and 28 subjects were randomly selected that had no parent confirmation. There was 100% FH status agreement between the 12 subjects and their one parent who responded. These 40 subjects were included in the analysis to achieve greater statistical strength. In addition, these, subjects' SBP and DBP were examined to ensure they were not outliers within their FH groups. An additional 22 subjects who also had no parent confirmation on FH status were eliminated from the study because we had already filled each family history cell. We eliminated 7 subjects from the study because they were taking medications that could alter their BP. We also eliminated 8 subjects who had only 1 parent respond and differed in their FH status from what their child reported. These subjects were eliminated from the study because we did not feel confident in their FH classification. We ran 137 subjects for the study. We used a total of 100 subjects with 25 in each FH cell.

The mean age for the subjects (N=100) was 22.0 years, with a range of 17 to 43 years. There were no age differences between FH groups. The female subjects had a mean weight of 142.87 pounds with a range of 110-288 pounds. The male subjects had an average weight of 173.41 pounds with a range of 118-276 pounds. There were no significant weight differences between FH groups. As indicated in the preceding chapter, 10 of the subjects were African-American and 4 were Asian; the minority subjects were evenly divided between the two FH groups.

Cardiovascular Responses

Blood pressure and HR were recorded at baseline rest, task periods, and recovery following the tasks. Mean arterial pressure and RPP were also calculated to provide a better understanding of the demand placed on the heart at rest and during tasks. Table 5-1* includes the descriptive statistics for means, averaged from 4 assessments throughout each period of the experiment (baseline rest, tasks, and recovery), and classified by gender and FH status.

In order to examine FH, gender differences, and their interactions, repeated measures ANCOVAs were performed. All of the physiological variables were assessed four times during initial rest (5, 10, 12, 14), both tasks (15 sec, 1:15, 2:15, 3:15), and both recovery rests (30 sec, 2:30, 4:30, 6:30). We assessed these physiological variables several times both to improve reliability and to determine whether there was a pattern that differed by FH status or gender. When assessing differences in resting BP and task BP levels, BMI was entered as a covariate. When examining group differences in task reactivity, resting BP was entered as the

* All tables and figures may be found in the Appendices.

covariate. Finally, to examine recovery rates and BP levels following the tasks, the last minute of the previous task was covaried. The figures are not corrected for the effects of BMI; thus, differences may appear significant in the graphs which are not supported by the ANCOVA.

Systolic blood pressure. Figure 5-1 shows the four, minute means during initial rest, tasks, and recovery following the tasks by FH status and gender. To assess whether there were any FH or gender differences or interactions during the initial 15 minute rest, a repeated measures analysis of variance 2 (FH) X 2 (Sex) X 4 (min5, min10, min12, min14) was conducted, using BMI as a covariate. The covariate was highly significant [$F(1,95) = 29.73$, $p < 0.0001$], indicating that BMI is a major contributor to SBP values. The main effects of FH [$F(1,95) = 5.09$, $p < 0.02$], and sex [$F(1,95) = 13.82$, $p < 0.0004$] were also significant. Positive FH subjects had higher SBP levels than FH- subjects, and females had lower levels of SBP than males. These means are shown in the first four points of the graph in Figure 5-1. There was no interaction between sex and FH. The graph illustrates the FH+ groups and the males having the higher SBP during the initial rest period. The pattern of change across the four minutes appears to differ for the females, with FH+ females increasing SBP while the FH- females show a marked decrease over time during the rest period. However, the interaction of gender, FH, and repeated measures was not significant
($p< 0.11$). Refer to Table 5-1 for the group means during this period.

There were no significant effects during either task when examining SBP reactivity differences. Figure 5-1 illustrates that all of the groups showed similar SBP increase while engaging in the tasks. Examining Figure 5-1, there appear to be significant sex and FH differences in the SBP levels achieved during the math task. There was a main effect of sex [$F(1,95) = 13.65$, $p < 0.0004$], with males having a higher SBP than females. There was no significant FH effect [$F(1,95) = 2.52$, $p<0.12$], although the means, illustrated in table 5-1, suggest that FH+ individuals tended to have higher SBP levels. There was also no interaction between FH and sex during the math task ($p<0.13$). In addition, there were main effects of FH [$F(1,95) = 4.40$, $p < 0.04$] and sex [$F(1,95) = 16.51$, $p < 0.0001$] during the mirror tracing task. Positive family history individuals and males had higher SBP levels during the mirror tracing task. Figure 5-1 further illustrates that during math, the males displayed a similar pattern throughout the 4 minutes assessed. During the mirror tracing task there is not a clear pattern established between any of the 4 groups. The only similarity is found during minute 4 with the FH+ groups and the FH- males displaying their highest SBP levels during this task. The FH- females exhibit a progressive decline across the four minutes. Table 5-1 gives the mean SBP levels for the groups during the two tasks.

After finding that these groups achieved different levels during the tasks, it was of interest to understand the relationship of group classification to SBP recovery following the tasks. There was a significant main effect of FH [$F(1,95) = 9.90$, $p < 0.002$], with FH- subjects recovering to a significantly lower level following the mental arithmetic task than the FH+ subjects. There were also significant main effects of sex following the mental arithmetic [$F(1,95) = 6.47$, $p < 0.01$] and mirror tracing tasks [$F(1,95) = 3.85$, $p < 0.05$], with males exhibiting a higher SBP level than females. Figure 5-1 displays all of the groups recovering quickly (in the first minute of rest) back to their baseline levels following both of the stressors. There were no significant interactions found between time and FH status or sex during either of the tasks. Thus, there were no significant differences in the rate of SBP recovery back to baseline between the groups following the tasks. Observing baseline SBP, with math and mirror tracing recovery in Table 5-1, it is apparent that they are all relatively comparable.

Diastolic blood pressure. Figure 5-2 portrays the DBP values by FH status and gender, with initial rest shown in the first four points. For resting levels, there was a significant main effect for FH [$F(1,95) = 7.05$, $p < 0.009$], but no sex effect. Positive FH men and women had higher DBP levels than FH- subjects. By examining Figure 5-2 it suggests that the females had higher DBP values than the males.

An analysis of covariance was conducted to examine whether there were any DBP reactivity group differences during the two tasks. It was found that all of the groups increased DBP similarly while engaging in the tasks. Examination of Figure 5-2 suggests that there may be differences in the DBP levels achieved during the tasks. Analyses revealed a significant main effect of FH [$F(1,95) = 3.91$, $p < 0.05$], with FH+ subjects having higher DBP levels during the mental arithmetic task than FH- subjects. A main effect of FH also approached significance during mirror tracing[$F(1,95) = 3.50$, $p<0.06$], with FH+ groups displaying higher DBP levels. Figure 5-2 illustrates the FH+ groups having higher DBP levels during the mental arithmetic task and all through the mirror tracing task except during minute 4. In addition, the FH+ females' DBP begins to recover during minutes

3 and 4 while engaging in the mirror tracing task. This may explain why the FH main effect did not achieve significance during this task.

To assess whether there were any differences in recovery rate back to baseline following engagement in the tasks, analyses of covariance were performed, with prior task level as the covariate. There was a significant main effect for FH during the mental arithmetic [$F(1,95) = 6.68$, $p < 0.01$] and the mirror tracing tasks [$F(1,95) = 9.17$, $p < 0.003$], with FH- subjects recovering back to a lower DBP level than FH+ subjects. This is clearly seen in Figure 5-2 with the FH+ subjects sustaining higher DBP levels throughout the 4 minute recovery period following both tasks than the FH- subjects. Table 5-1 further confirms this with the FH+ DBP recovery means, following both of the tasks, being higher than the FH- subjects. A main effect of sex approached significance [$F(1,95) = 3.13$, $p<0.08$], with females displaying higher DBP levels during recovery following the mirror tracing task. Figure 5-2 also illustrates the initial DBP recovery rate, following both of the tasks as being relatively the same. This was verified with no interactions found between time and FH status or sex, thus finding no differences in DBP recovery rates following the tasks.

Mean arterial pressure. The calculation of this measure [DBP+((SBP-DBP)/3)] offers another way to evaluate the demand on the heart. As shown in Figure 5-3 and Table 5-1, there was a main effect for FH [$F(1,95) = 8.98$, $p< 0.004$) during initial rest; FH+ men and women had higher resting MAP than FH- subjects. There were no gender differences in MAP, which seems contrary to what appears in Figure 5-3. However, the figures are not corrected for

BMI, which is highly correlated with BP, and may underlie the apparent gender effect [$F(1,95) = 0.65$, $p<0.42$].

As shown in Figure 5-3, analysis of covariance found no reactivity differences between FH or sex groups. All of the subjects responded to the tasks with relatively the same amount of MAP increase. Further analyses were performed to determine whether there were significant MAP level differences between groups. Figure 5-3 and Table 5-1 illustrate the significant main effects of FH during mental arithmetic [$F(1,95) = 4.63$, $p < 0.03$], and mirror tracing [$F(1,95) = 5.27$, $p <0.02$], with FH+ subjects exhibiting higher MAP levels than FH- subjects. A main effect of sex approached significance during mirror tracing [$F(1,95) = 3.04$, $p<0.08$], with males tending to have higher MAP levels than females. Figure 5-3 illustrates this by the females beginning to recover following the third minute of the mirror tracing task, while males maintain their pressor responses throughout the task.

An analysis of covariance, with the last task minute as the covariate, was employed to examine MAP during post-task recovery. There were significant main effects of FH during mental arithmetic [$F(1,95) = 6.00$, $p < 0.02$] and mirror tracing [$F(1,95) = 6.11$, $p < 0.02$], with FH- subjects recovering to a lower MAP level than FH+ subjects. There were no interactions found between time and FH or sex. Thus, there were no significant group differences in recovery rates back to baseline following either of the task. As shown in Figure 5-3 and Table 5-1, all of the groups have a marked MAP decrease within the first 30 seconds of completing the task.

Heart rate. Figure 5-4 shows the minute by minute means during initial rest, tasks, and recovery by FH status and gender. For initial rest, there was a significant main effect for sex [$F(1,95) = 6.39$, $p < 0.01$]; Figure 5-4 and Table 5-1 show the females having a higher heart rate compared to the males during the resting period. Figure 5-4 also illustrates the FH+ groups having a higher heart rate consistently through the 4 minute rest than the FH- groups, however the ANCOVA found this group difference not to be significant [$F(1,95) = 0.33$, $p<0.57$).

There were no heart rate reactivity group differences found with either of the tasks. Figure 5-4 and Table 5-1 show heart rate for all of the groups increasing in a similar pattern during task onset. For females, FH+ subjects seemed to be somewhat more reactive; however, this was not true for males and there was no Sex x FH interaction during math ($p<0.29$) or mirror tracing ($p<0.48$). An analysis of covariance on HR levels revealed significant main effects of sex during both math [$F(1,95) = 6.79$, $p < 0.01$] and mirror tracing [$F(1,95) = 8.25$, $p< 0.005$]. Figure 5-4 illustrates that, for both tasks, females achieved higher heart rate levels than males.

Heart rate recovery levels following task completion were similar for all of the groups. Figure 5-4 shows the FH+ groups having higher heart rate levels; however, these were not shown to be significant with the ANCOVA. There was a significant main effect of sex [$F(1,95) = 4.00$, $p < 0.05$], with males recovering to a lower heart rate level than females following the mirror tracing task. Males also recovered back to a lower heart rate level following the mental arithmetic task; however, this was not verified to be significantly different with the ANCOVA ($p<0.30$).

Rate pressure product. The measure of SBP*HR is used as a measure of oxygen demand on the heart and offers another way to examine FH and sex differences. Figure 5-5 shows the minute by minute means during initial rest, tasks, and recovery by FH status and gender. As shown in the first four points of Figure 5-5, FH+ groups had consistently higher RPP throughout the rest period compared to FH- groups. However, the ANCOVA found neither FH main effect [$F(1,95) = 1.93$, $p<0.17$] nor sex effect [$F(1,95) = 0.11$, $p<0.75$], indicating that there were no significant FH or gender RPP differences during the resting period.

As shown in Figure 5-5, all of the groups increased RPP during the first 15 seconds of engaging in the tasks; however, there were no significant differences in RPP reactivity among the groups. In addition, there were neither significant FH main effects [$F(1,95) = 0.48$, $p<0.49$] nor sex differences [$F(1,95) = 0.04$, $p<0.84$] in the RPP levels achieved while engaging in the tasks. This is also portrayed in the standard error bar overlap in Figure 5-5. Table 5-1 further illustrates the similarity of the RPP levels among groups.

The analysis of covariance on recovery levels revealed a significant main effect of FH following the mental arithmetic task [$F(1,95) = 8.56$, $p < 0.004$], with FH- subjects recovering to a lower RPP level than FH+ subjects. After the mirror tracing task, a main effect of FH approached significance[$F(1,95) = 3.32$, $p<0.07$], with FH-groups tending to recover to a lower RPP level than the FH+ subjects. There were no interactions between time and FH group or sex, which suggests that there were no group differences in recovery rate back to baseline following completion of the tasks. Figure 5-5 further verifies this finding with all of the groups appearing to recover at the same rate following both of the tasks.

Expression of Emotion and Family History Differences

A 2 (FH) X 2 (Sex) analyses of variance was performed to examine whether there were any group differences in self-reports of emotional expression for intimate, positive, and negative emotions. Table 5-2 shows the mean score for each emotion category, by FH group and gender. The highest score that can achieved for positive expression is 49, negative expression 35, and intimate expression 28. As shown in Table 5-2, females expressed their positive [FH (F=0.58), Sex (F=2.74), FH x Sex (F=1.60)], negative [FH (F=0.13), Sex (F=1.61), FH x Sex (F=0.01)], and intimate [FH (F=0.08), Sex (F=1.26), FH x Sex (F=0.11)] emotions slightly more than males; however, the ANOVA found no significant main effects of FH or gender nor interactions among the groups.

A correlational analysis was then performed, within the FH+ groups, to see whether there were any relationships between emotional expression and BP, separately for men and women. Since these analysis were exploratory, we used $p<0.10$ as an indicator of significance. Table 5-3 includes the correlation coefficients for the positive, negative, and intimate emotions with SBP, DBP, and HR for FH+ males (n=25). There were negative correlations between expression of positive emotions and BP. When FH+ males suppressed their positive emotions, it was associated with an increased baseline heart rate, heart rate during math, and SBP during math and mirror tracing. Table 5-4 illustrates the correlation coefficients for the expression of positive, negative, and intimate emotions with SBP, DBP, and HR for FH+ females (n=25). There were negative correlations for FH+ females between expression of positive and intimate emotions and BP. These results indicate that when FH+ females suppress their intimate and positive emotions, their BP increases. Also, there were significant positive correlations for FH+ females between negative emotion expression and BP. When FH+ females expressed their negative emotions, they exhibited higher blood pressures.

CHAPTER 7

DISCUSSION

The primary purpose of this study was to investigate the relationship of family history of hypertension to cardiovascular responses at rest, during laboratory stressors, and recovery following the stressors. Rarely have past studies examined all three of these measures, used males and females, had a large subject pool, and verified FH status. The present study represents a methodological improvement over prior studies by addressing all of these points. Secondly, the study was concerned with the influence of FH on the expression and suppression of emotions. Past studies have suggested that possessing a FH+ may be associated with psychological attributes. Suppression of emotion is a personality variable that may be implicated in the development of coronary heart disease. By investigating both the biological and psychological predictors of hypertension, this study has helped to understand further the development of essential hypertension.

These results suggest that family history has significant effects on individuals' resting BP, task BP levels, and recovery BP levels. However, FH groups did not differ in cardiovascular reactivity to stressors independent of BP levels. Further, the results of this study indicated that FH+ individuals do not express their emotions differently than FH- subjects. Scores on the expression of positive, negative, and intimate emotions were similar for FH+ and FH- men and women. However, exploratory analyses on FH+ individuals revealed significant correlations between the expression of positive, negative, and/or intimate emotions and cardiovascular responses.

Baseline resting BP has been identified as the strongest single predictor of subsequent hypertension. Positive FH subjects displayed higher levels of SBP, DBP, and MAP during the baseline rest period. That FH+ subjects display an elevated resting BP is consistent with past research (Shapiro, et al., 1995; Ravogli, et al., 1990; Lamensdorf, et al., 1992; Lawler, et al., 1991). These normotensive 22 year olds with a positive FH are already displaying an elevated baseline BP; it is more than likely that these levels will increase with age, which may eventually place these individuals in the high BP range (Julius, 1977).

The relationship between FH and exaggerated cardiovascular reactivity remains controversial (Muldoon, et al., 1993; Gerin & Pickering, 1995; Lawler, et al., 1991). In the present study there were no significant differences in cardiovascular reactivity to either the mental arithmetic or mirror tracing tasks. However, differences were found in the BP levels achieved during the tasks. Positive family history of hypertension subjects displayed higher SBP, DBP, and MAP levels than FH- subjects during both tasks. In addition, males responded to the mental arithmetic task with higher SBP levels than the females, while females exhibited higher heart rate levels during the mental arithmetic task and in response to the mirror tracing task.

The results of this study and others (Ravogli, et al., 1990; Lawler, et al.,1991; Gerin & Pickering., 1995) have found FH status not manifested in terms of reactivity, but associated with elevated resting BP levels, task BP levels, and recovery BP levels. Thus, it may be that these measures are more reliably associated with FH and perhaps more important in examining the effects of FH than reactivity changes during stressors.

Preliminary research has suggested a delayed recovery rate back to baseline levels, following a stressor, as another mechanism by which FH may increase risk for hypertension (Gerin & Pickering, 1995). The results of this study found the recovery rates following the tasks similar among all of the groups. There may have been recovery group differences that were missed by the minute means. Future studies should measure the subjects BP following the stressor more frequently and with less time lapse between completion of the task and the first BP assessment. Gerin and Pickering (1995) found no group differences in recovery time with subjects that only had one parent with hypertension. In this study the FH+ group was defined by having at least one parent with hypertension. This may be another reason why there were no group differences found in recovery time. There were however, marked group differences in the BP levels to which each group recovered upon task completion. The FH+ groups recovered to a significantly higher SBP, DBP, MAP, and RPP level following the mental arithmetic task than the FH- subjects. Following the mirror tracing task, the FH+ subjects also recovered to higher DBP, MAP, and RPP levels than the FH- subjects. In addition, males recovered to higher SBP levels than females following the math and mirror tracing tasks, females displayed higher DBP and HR levels following the mirror tracing task. This elevated BP level among FH+ men and women during rest, while engaging in the tasks, and following a stressor may be what is placing them at greater risk for the later development of hypertension.

As mentioned earlier, past studies have suggested that an FH+ may be associated with psychological attributes. We were interested in examining the expression or suppression of emotion as a personality variable within these FH groups: FH+ individuals expressed or suppressed their emotions the same as FH- individuals. However, with further exploratory analysis performed, there were relationships within the FH+ groups between the expression of positive, negative, and intimate emotions and BP. For FH+ females, a negative relationship was found between suppression of positive and intimate emotions and increases in BP. In addition, a positive relationship between negative emotions and BP was observed. The FH+ males had a negative relationship between positive emotions and BP; in this group, suppression of positive emotions was associated with higher BP. These associations found between the expression/suppression of emotions suggest that FH+ females would reduce the stress on their heart if they expressed their positive and intimate emotions and controlled their negative emotions. This finding supports societies stereotype on females. Society frowns upon females that express their negative emotions. These data suggest that when females goes against societies stereotype they then experience an increase in blood pressure. The relationships found between emotions and BP suggest that FH+ males would benefit from expressing their positive emotions instead of holding in these feelings.

There are limitations concerning this study which must be addressed. Sixty of the 100 subjects had FH status verification from both parents. Even though there was a 90% FH status agreement between parents and subjects, there is still a possibility that some of the additional 40 subjects may have been misclassified. It would have been most beneficial to measure the parents BP, since FH may exert its effects before an actual hypertension diagnosis. Also the study would have been improved by the comparison of subjects with 2 hypertensive parents, 1 hypertensive parent, and no FH. Subjects with 2 hypertensive parents are clearly more at risk for developing hypertension as they get older. However, individuals with only 1 hypertensive parent may or may not inherit the "at risk" gene and therefore, may be essentially an FH- individual. If these subjects are then classified in the FH+ group their data may skew the results of the FH+ effect on BP. By examining all three groups it would give a more definitive picture of the effects of having a positive FH.

We measured the expression of emotion from a questionnaire given to the subjects prior to participating in the study. It would also have been informative to assess their expressiveness through a role play task. By examining the expression of emotion in a role play situation, it would allow the researcher to collect physiological data simultaneously while the subject engaged in a real life scenario. The validity of the FH self-report information was 90%. Thus, by assessing the expression of emotion through role play it would increase the validity of the assessment by not depending on a self-report measure.

Finally, a longitudinal investigation would give researchers a more comprehensive understanding of the effects of elevated resting BP levels, tasks levels, recovery levels, and the FH risk factor. Ambulatory studies would assess BP in the lab and in the subjects own environment and would add ecological validity to these findings. The methodology of future studies needs to strengthened so that they are examining only the effects of the independent variable. They need to verify their subjects classification into the different FH groups. These subjects also need to be free from smoking, medications that effect BP, and other risk factors so that the FH effects are solely being studied. It is also important that these studies covary for BMI seeing that weight is highly correlated with SBP.

This study adds to the hypertension literature by confirming that FH+ individuals are displaying an elevated baseline resting BP compared to FH- individuals. Our data also raise additional questions about the reactivity hypothesis and bring to light the importance of examining BP levels. This study examined 2 tasks, which employed different mechanisms of raising BP. However, there was no direct anger-relevant task, which could account for there being no family history differences in cardiovascular reactivity. The exploratory analysis revealed that there is a relationship between expression or suppression of emotion and its physiological response amongst FH+ individuals. Future studies should explore the reliability and validity of these findings.

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APPENDICES

APPENDIX A

Tables and Figures

Table 2-1: Summary of FH article's results.

Articles	Elevated Resting Blood Pressure	Exaggerated Cardiovascular Reactivity	Delayed Recovery	Subjects	Group Classification	Tasks
Sharpio, Goldstein, & Jamner (1995)	SBP and DBP	DBP		209 college students (103 females, 106 males) (17-33 years)	FH+ = 1 hypertensive parent verified by letter from parent	Mental arithmetic, handgrip, and cold pressor tasks
Lamensdorf & Linden (1992)	DBP	DBP		46 college students (16 females, 30 males)	FH+=1 hypertensive parent verified by mail or telephone	Mental arithmetic, a low affect task, and interpersonal task (high affect).
Ravogli, et al., (1990)	SBP and DBP			45 high school or college students (10 women, 5 men in grp) (age=22)	FH+=verified by assessing at least one parents' blood pressure	Mental arithmetic, mirror tracing, handgrip, and cold pressor tasks.

Articles	Elevated Resting Blood Pressure	Exaggerated Cardiovascular Reactivity	Delayed Recovery	Subjects	Group Classification	Tasks
Lawler, Lacy, Armstead, Lawler (1991)	SBP			122 college students (66 females, 56 males)	FH+=students report at least one parent have both high BP and on meds.	Reaction time and Ravens progressive matrices tasks
Sausen, Lovallo, & Wilson (1991)		SBP, DBP, & RPP		99 male college students	FH+=verified through the mail At least 1 hypertensive parent	Serial-subtraction and digits backward tasks
Semenchuk & Larkin (1993)	HR	SBP		40 male college students (mean age=20 years)	FH+= verified through telephone At least 1 hypertensive parent	2 interpersonal challenges
Manuck, Proietti, Rader, & Polefrone (1985)		DBP and HR		44 male college students (mean age=19.6 & 18.4)	FH+=verified through telephone. At least 1 hypertensive parent	Mental arithmetic task

Articles	Elevated Resting BP	Exaggerated Cardiovascular Reactivity	Delayed Recovery	Subjects	Group Classification	Tasks
Widgren, Wikstrand, Berglund, & Andersson (1992) Time 1 Time 2		Time 1=SBP and DBP during hand grip. 5 years later=SBP and DBP during handgrip and DBP during Stroop task		26 male subjects (age=31 years)	FH+=measured fathers' BP and verified by phone moms' BP condition. Had to have 2 generations of hypertension.	Isometric handgrip and Stroop stress tasks
Gerin & Pickering (1995)			SBP	537 college students (420 female, 117 male) 17 to 23 years	Classified in FH+ or FH- groups through self report	Serial-subtraction task

Articles	Elevated Resting Blood Pressure	Exaggerated Cardiovascular Reactivity	Delayed Recovery	Subjects	Group Classification	Tasks
Falkner, Onesti, Angelakos, Fernandes, Langman (1979)		DBP and HR	DBP	75 adolescents (mean age=15 years) (38 female, 37 male)	Genetic group=had one parent with hypertension Labile group=had DBP greater than the 95th% and had a parent with hypertension FH-= subjects who were FH- for 3 generations	Serial-subtraction task

Table 5-1. Descriptive statistics for physiological variables at rest, during tasks, and recovery from tasks.

	FH+/Males	FH-/Males	FH+/Females	FH-/Females
Baseline				
SBP	119.78	116.12	112.34	103.42
DBP	72.63	66.74	71.94	67.39
HR	68.68	66.63	74.96	71.02
MAP	88.32	83.52	85.46	79.00
RPP	8497.61	7808.03	8536.52	7659.76
Math Task				
SBP	133.93	131.39	125.05	115.59
DBP	81.25	76.31	80.88	76.71
HR	77.49	79.43	87.25	83.59
MAP	98.81	94.67	95.60	89.67
RPP	10898.46	11475.81	11161.10	9868.76
Mirror Tracing				
SBP	134.85	79.23	81.91	77.87
DBP	84.63	79.23	81.91	77.87
HR	77.37	76.82	83.81	80.94
MAP	101.37	95.93	96.06	90.58
RPP	10483.36	9991.43	10362.59	9399.61
Math Recovery				
SBP	121.93	118.39	114.85	103.72
DBP	73.07	67.77	73.81	68.59
HR	69.35	66.68	75.73	72.20
MAP	89.19	84.65	87.49	80.30
RPP	8519.08	7926.93	8622.95	7498.00
Mirror Tracing Recovery				
SBP	121.54	117.15	114.06	103.89
DBP	73.82	67.64	73.66	69.21
HR	70.33	66.24	77.73	72.89
MAP	89.73	84.14	87.13	80.77
RPP	8625.00	7793.44	8768.81	7584.49

Table 5-2. Group mean scores for positive, negative, and intimate emotions.

Emotions	FH+/Males	FH+/Females	FH-/Males	FH-/Females
Positive	33.52	36.52	34.04	34.44
Negative	17.36	18.36	17.64	18.64
Intimate	22.00	22.56	21.56	22.60

Table 5-3. Expression of emotion correlational results for FH+ males.

	Positive	Negative	Intimate
Baseline			
SBP	-0.08	-0.09	0.04
DBP	-0.18	-0.22	0.12
HR	-0.38*	-0.11	0.27
MAP	-0.16	-0.19	0.63
Math Task			
SBP	-0.35*	-0.19	0.06
DBP	-0.11	-0.09	0.01
HR	-0.47**	-0.04	0.16
MAP	-0.22	-0.15	0.04
Math Recovery			
SBP	-0.25	-0.11	-0.01
DBP	0.03	-0.12	-0.15
HR	-0.16	-0.10	-0.16
MAP	-0.08	-0.13	-0.08
Mirror Tracing			
SBP	-0.38**	-0.21	0.09
DBP	-0.12	-0.03	-0.14
HR	-0.33	-0.04	0.25
MAP	-0.24	-0.11	-0.07
Mirror Tracing Recovery			
SBP	-0.14	-0.03	-0.06
DBP	-0.01	-0.18	0.13
HR	-0.21	-0.10	0.28
MAP	-0.07	-0.14	0.07

*$p<0.10$
**$p<0.05$

Positive emotions SD=4.76
Negative emotions SD=4.02
Intimate emotions SD=3.50

Table 5-4. Expression of emotion correlational results for FH+ females.

	Positive	Negative	Intimate
Baseline			
SBP	-0.02	0.25	-0.39**
DBP	-0.14	0.37*	-0.37*
HR	-0.35*	0.32	0.11
MAP	-0.11	0.39**	-0.46**
Math Task			
SBP	-0.08	0.12	-0.41**
DBP	-0.18	0.23	-0.29
HR	-0.21	0.10	0.13
MAP	-0.15	0.20	-0.38*
Math Recovery			
SBP	-0.08	0.17	-0.39**
DBP	-0.04	0.26	-0.57**
HR	-0.15	0.01	0.13
MAP	-0.07	0.27	-0.61***
Mirror Tracing			
SBP	-0.06	0.20	-0.36*
DBP	-0.13	0.44	-0.30
HR	-0.41**	0.29	0.04
MAP	-0.12	0.39	-0.36*
Mirror Tracing Recovery			
SBP	-0.10	0.14	-0.45**
DBP	-0.13	0.40**	-0.45**
HR	-0.14	0.01	0.19
MAP	-0.14	0.38*	-0.56**

*p<0.10
**p<0.05
***p<0.001

Positive emotions SD=5.58
Negative emotions SD=3.98
Intimate emotions SD=3.22

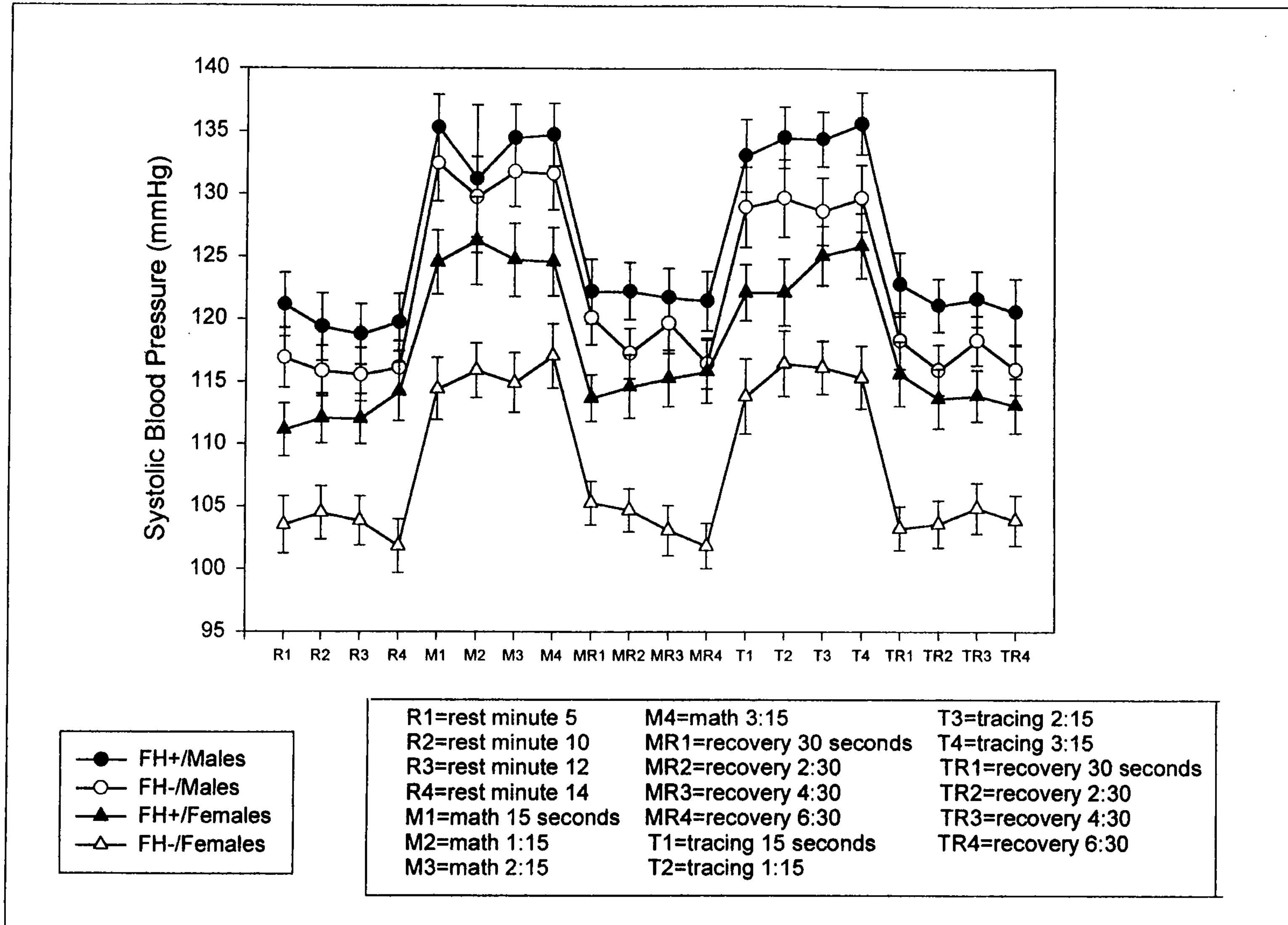

Figure 5-1: Mean (± SEM) SBP during rest, tasks, and recovery.

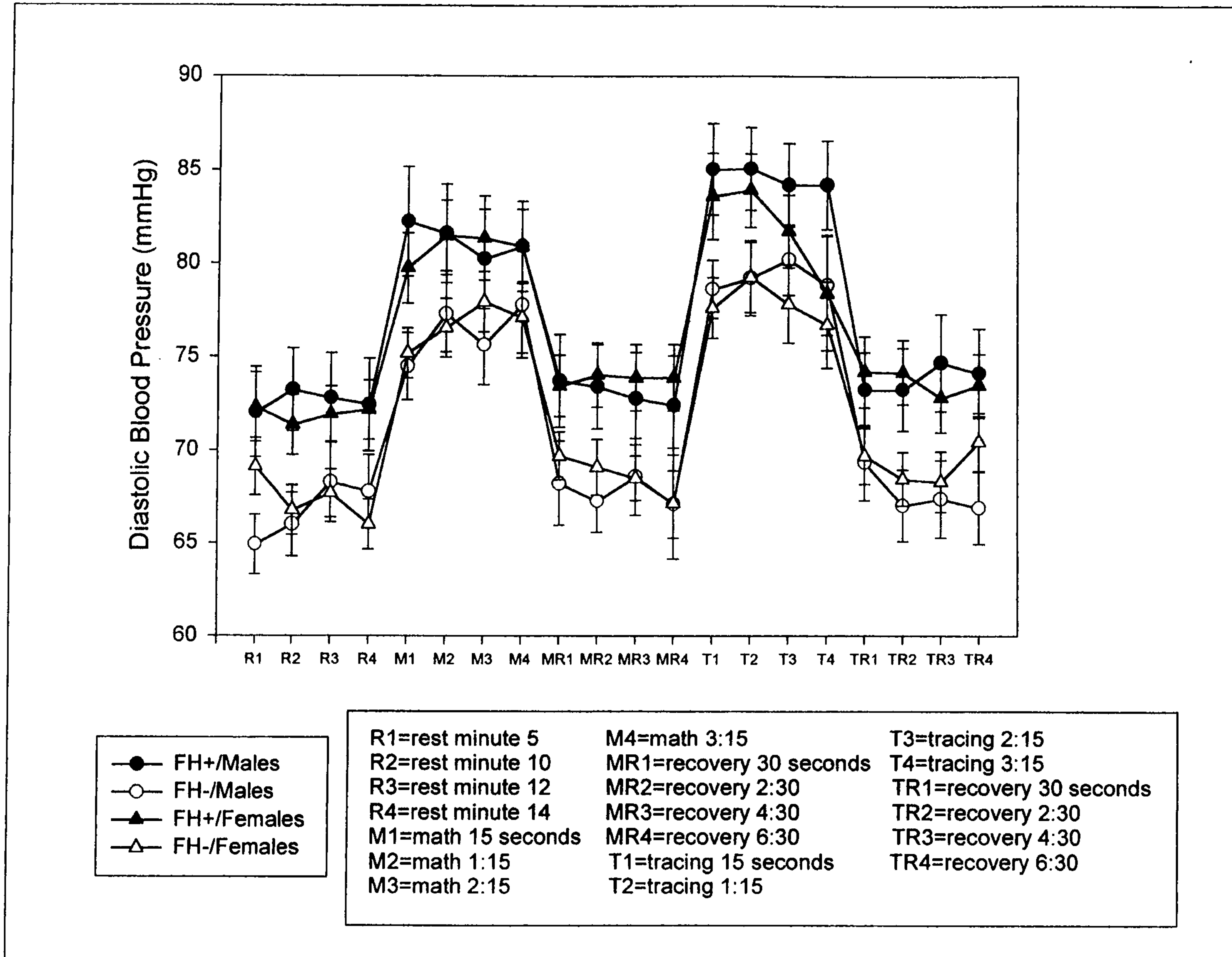

Figure 5-2: Mean (±SEM) DBP during rest, tasks, and recovery.

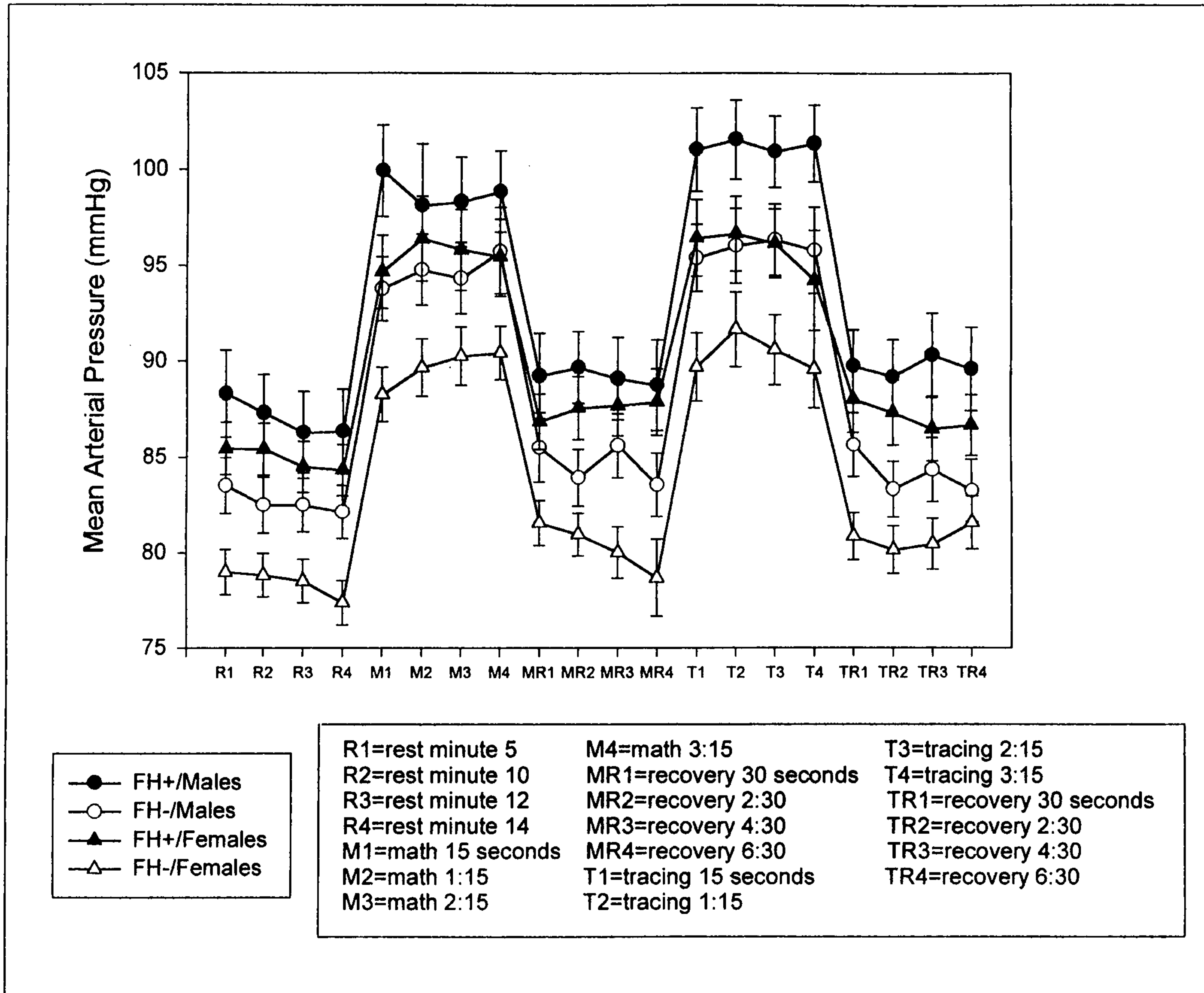

Figure 5-3: Mean (±SEM) MAP during rest, tasks, and recovery.

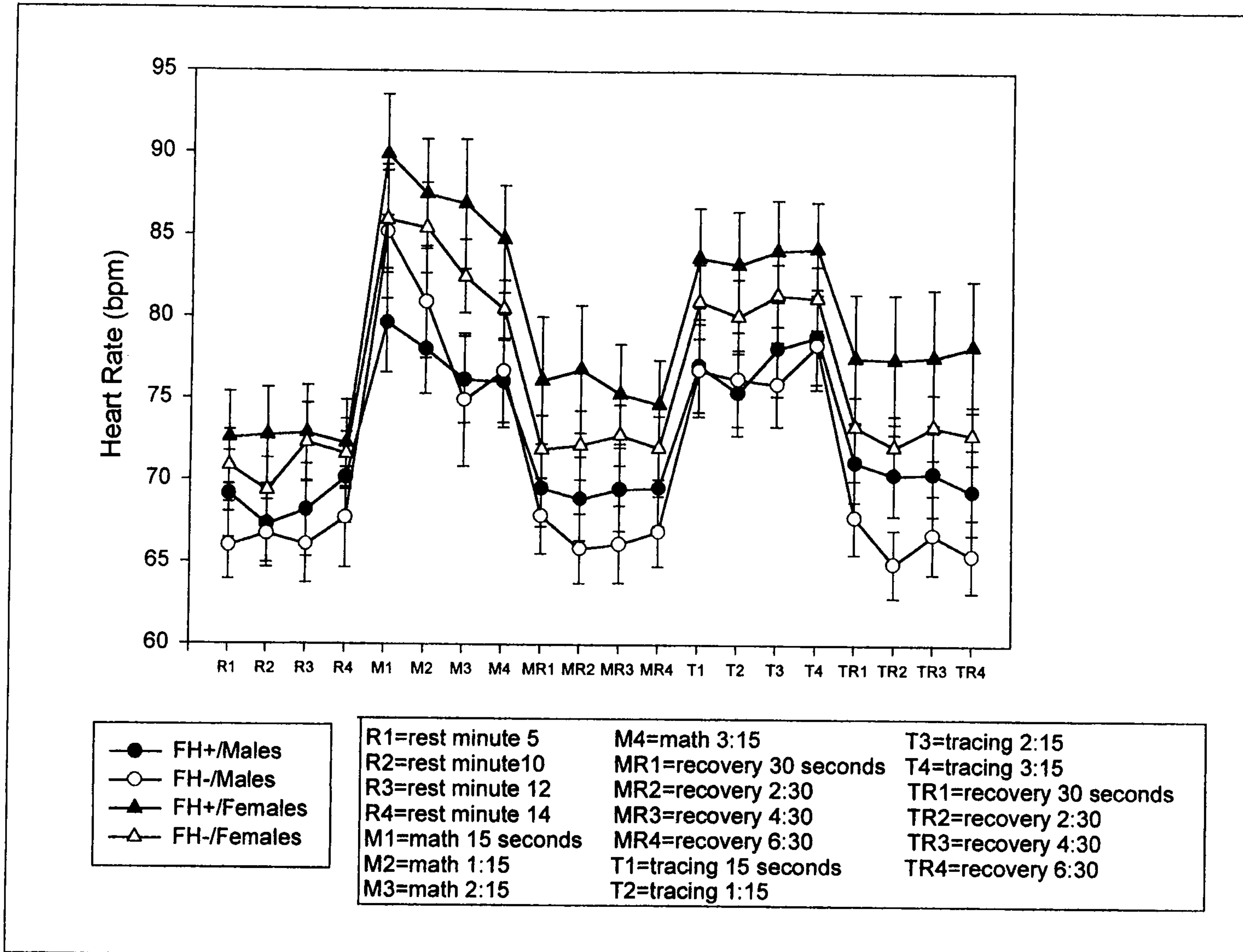

Figure 5-4: Mean (±SEM) HR during rest, tasks, and recovery.

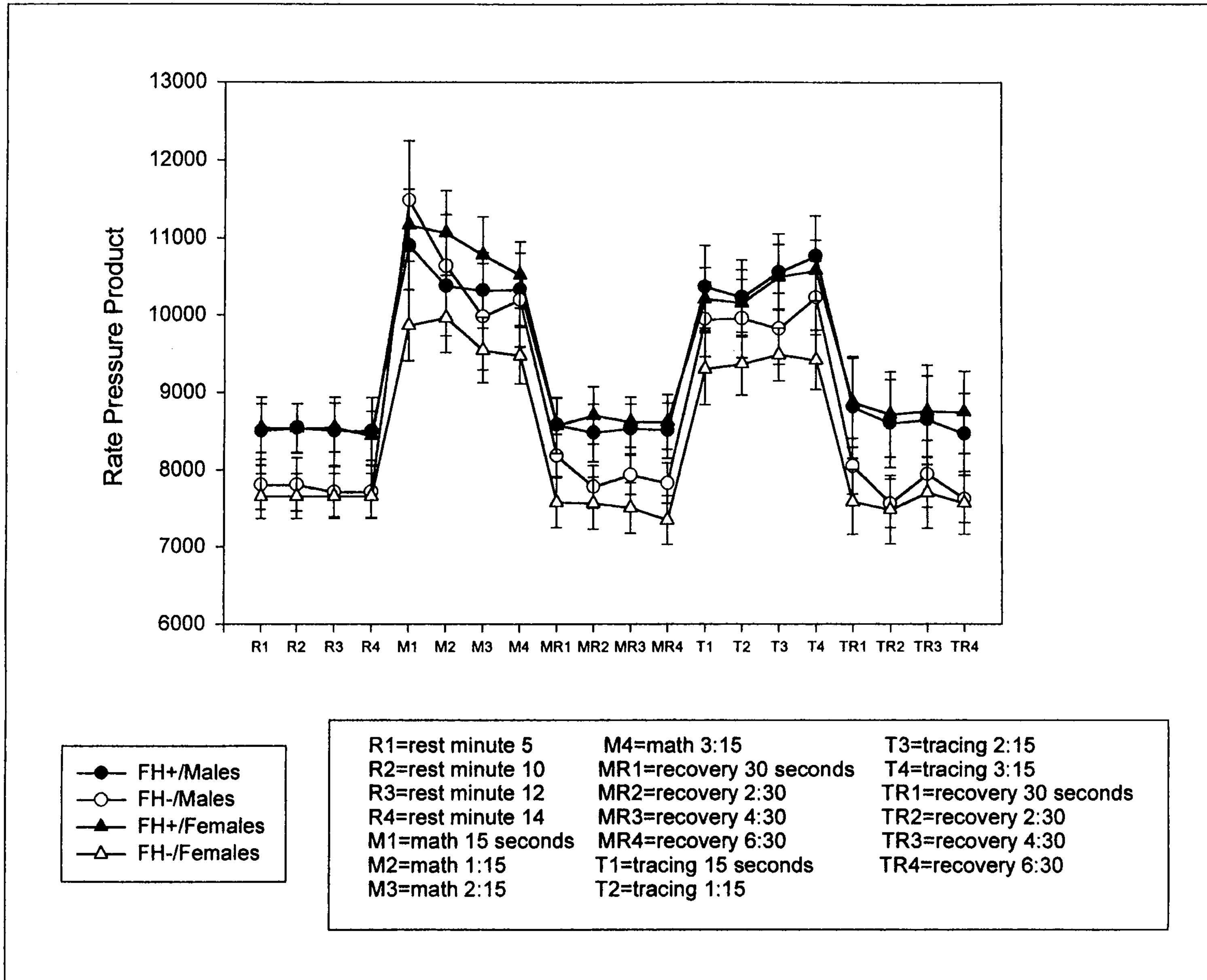

Figure 5-5: Mean (±SEM) RPP during rest, tasks, and recovery.

APPENDIX B

Informed Consent and Family Health History/
Demographic Information

Informed Consent

Project: Psychophysiological study of genetic predispositon to essential hypertension

Researcher: Kathleen A. Lawler, Ph.D., Department of Psychology, AP409, 974-8458.

This research project focuses on the cardiovascular responses people manifest when they rest and work on tasks requiring mental effort. We are particularly interested in whether these responses are the same or different depending on your family history of high blood pressure.

This research involves two parts, both of which will occur in one session. For some individuals, Part 1 will occur first, while for others, Part 2 will be first. In Part 1, we will be measuring your heart rate and blood pressure. This will be accomplished by attacking surface electrodes to monitor heart rate, and an automatically-inflating blood pressure cuff. While these responses are being monitored, there will be rest periods and two tasks: 4 minutes of mental arithmetic and 4 minutes of a mirror tracing task. The physiological record will be identified only by subject number. This part will last approximately 50 minutes.

In Part 2, we will ask you to fill out 8 questionnaires. One of these asks about your own health status and the cardiovascular health of your parents. The others are standard personality inventories. They will ask you to rate yourself on characteristic behaviors, attitudes and emotions. They will be identified only by your experiment number. This part will take approximately 70 minutes.

Data from both parts of this research will be placed in a folder and stored in a file drawer in AP Room 409. Consent forms will be kept in a separate drawer for 3 years and then discarded. Actual physiological and questionnaire data will be kept for 5 years after the research is written up, which will take approximately 2 years.

Your participation in this research is purely voluntary and you may withdraw from the project at any time by request. No risks of personal injury are possible. From your participation you will gain an accurate reading of your resting blood pressure and receive extra credit in Introductory Psychology. This credit is given to students when leaving the laboratory. If you withdraw from the project, you will be given credit for the time of participation.

Please feel free to ask any questions about the study. Should you have any questions after the session, you may contact Dr. Kathleen A. Lawler, at the address above.

I volunteer to participate in the investigation conducted by Dr. Kathleen A. Lawler, Department of Psychology. I have read the description, I have had all my questions answered, and I agree to participate in this experiment. I also realize that I may terminate the experimental session at any time by request without penalty or loss of benefits.

Date______________________________

Signature______________________________

Printed name______________________________

Researcher's signature______________________________

RESEARCH PARTICIPANT INFORMATION SHEET

Subject Number: ______________________

Name and permanent address: This is optional; please fill out if you would like a copy of the final published report.

____

____

____

Height: ______________ Race: ______________

Weight: ______________ Age: ______________

Are you taking any medications at the present time? ______________

If yes, please describe: ______________________

____

Have you had any major illnesses or surgery in your life: ______________

If yes, please describe: ______________________

____

Do you smoke cigarettes? ______________ If yes, how many per day? ________

Have you ever had high blood pressure? ______________

If yes, when? ______________

Are you taking medication for it, or did you in the past? ______________

Has either your mother or father had: high blood pressure ______________
heart attack ______________
atherosclerosis ______________
stroke ______________

If yes, please indicate which individual and whether they have medications for it.

Are you employed? ______________

If yes, please describe position and hours per week: ______________

____

____

APPENDIX C

Consent to Contact Parents, Letters to Parents, and
Family History Postcard

Subject Number ____________

This form is to provide us with information that will allow us to contact your biological parents. We would like to ask them questions similar to those on the FAMILY HEALTH HISTORY questionnaire that you just completed in order to verify your family history status. By signing this page and the following page(s), you do or do not give us permission to contact your parents. Extra credit will be provided for each parental reply.

I give permission to contact my parents: ______________________________
(student's signature)

I do NOT give permission to contact my parents: ______________________________
(student's signature)

Mother's name and address:

Name: ______________________________

Street Address: ______________________________

City: ____________________ State: ____________

Zip Code: ____________________ Telephone: ____________

Father's name and address:

Name: ______________________________

Street Address: ______________________________

City: ____________________ State: ____________

Zip Code: ____________________ Telephone: ____________

THE UNIVERSITY OF TENNESSEE
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http://funnelweb.utcc.utk.edu/-jlawler

Dear Parent:

Your child has recently participated in a psychology experiment at the University of Tennessee. During the first phase of this project, we examined how cardiovascular function (such as blood pressure and heart rate) changes during times of rest and stress. For the second phase of the project, we are interested in investigating the role of family history in these factors.

Your child provided us with your name, address, and permission to contact you during the first phase of the project. For the second phase, we would like for you to complete the enclosed card relating to your personal history. Your participation will be confidential in that we will identify your card by a code number in the upper left-hand corner. Please do not state your name on the card. Simply return the stamped, self-addressed card to us, upon completion.

Thank you for your time and consideration.

Sincerely,

Kathleen A. Lawler

Kathleen A. Lawler, Ph.D.
Professor

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University of Tennessee
Psychology Department
307 Austin Peay
Knoxville, TN 37916-9989

Code # _____

Your date of birth: ______________ Sex: M F

Race: ____________________________

Height: _______ Feet _______ Inches

Weight: ________ pounds

Blood pressure, if known, at time of last measurement:

_______ systolic ________ diastolic

Are you currently taking any medication for high blood pressure and/or heart disease? Yes No

Please circle any disorder that you have now or have had in the past:

a. chest pains (angina)
b. diabetes (high blood sugar)
c. high blood pressure (hypertension)
d. heart attack
e. coronary artery disease
f. kidney disease (other than kidney stones)
g. irregular heart beat
h. hardening of the arteries (arteriosclerosis)
i. migraine headaches
j. stroke

APPENDIX D

Mental Arithmetic Task

Subject Number______

Mental Arithmetic Task

Instructions: This is a mental arithmetic task that lasts for four minutes. Your task is to count backwards by 7s, from a starting number that we give to you. For example, if we asked you to count backwards from 1000 by 7s, you would reply "993, 986, 979, 972, 965, etc." Please respond as quickly and accurately as possible, as your performance will be compared against other individuals in the experiment. If you make a mistake, I will repeat the last correct subtraction and ask you to try again. Do you have any questions?

Please count backwards by 7s from 1250.

1250	1110	970	830
1243	1103	963	823
1236	1096	956	816
1229	1089	949	809
1222	1082	942	802
1215	1075	935	795
1208	1068	928	788
1201	1061	921	781
1194	1054	914	774
1187	1047	907	767
1180	1040	900	760
1173	1033	893	753
1166	1026	886	746
1159	1019	879	739
1152	1012	872	732
1145	1005	865	725
1138	998	858	718
1131	991	851	711
1124	984	844	704
1117	977	837	697

Students: draw a line under the number the subject reaches at mins 1, 2, 3, and 4.

Keep a tally of number of errors:_____

Comments:

calm, poised______

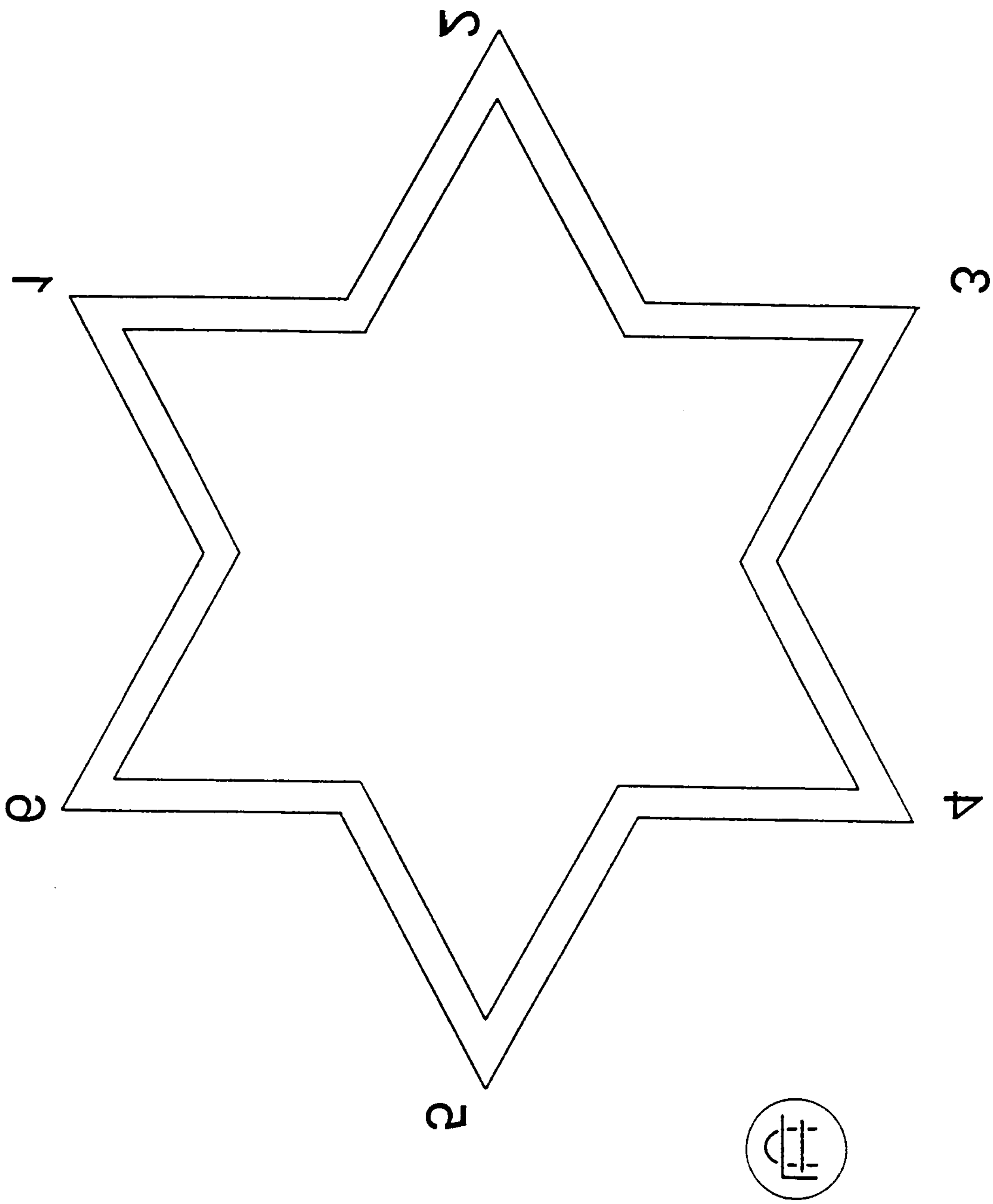
mildly tense_______

very anxious_______

other:

APPENDIX E

Mirror Tacing Task


1
2
3
4
5
6

VITA

Jenelle S. Krishnamoorthy was born in Chicago, Illinois on January 26, 1972. She was raised in Des Moines, Iowa and Lynchburg, Virginia, and graduated from Brookville High School in June, 1990. The following fall, she entered Randolph-Macon College, in Ashland, Virginia, where she majored in Psychology with a minor in Biology. She received her Bachelor of Science degree from Randolph-Macon College in May, 1994. She worked at the Medical College of Virginia for a year as a research assistant working on a hypertension study while applying to graduate schools. She entered The University of Tennessee, Knoxville in August, 1995, and completed the requirements for her Master of Arts degree in Psychology in August, 1997.

The author is presently continuing to pursue her Doctor of Philosophy degree in Clinical Psychology at Virginia Commonwealth University. Her research will involve further investigation of essential hypertension and the relationship between psychological and physiological well being.

Jenelle is the daughter of Irene and Kris Krishnamoorthy of Lynchburg, Virginia. She has one younger brother Kris Krishnamoorthy of Knoxville, Tennessee.