METHODOLOGICAL AND PSYCHOLOGICAL PREDICTORS OF THE WHITE COAT EFFECT

by

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Abstract

The purpose of the study was to examine psychological and methodological factors which would predict the white coat effect (WCE). The WCE is defined as the difference (mm Hg) between ambulatory and office measured blood pressure (BP). Sixty three community volunteers participated in this study. Participants were divided into 3 Response style groups: (1) Office responders had ambulatory BP values which were lower than office BP, (2) Non responders showed a minimal difference between office and ambulatory BP, and (3) Home responders had significantly higher ambulatory BP compared to office BP. Participants were asked to have a series of BP readings taken by a physician, nurse and by themselves and participate in 24 hour ambulatory monitoring. State and trait self-report psychological measures were completed.

Self measured BP was the most representative of ambulatory BP for the sample as a whole, and in particular for the Home responders. State anxiety, previously dismissed as mediating factor in the expression of the white coat effect, proved to discriminate between the groups. Office responders had significantly higher levels of state anxiety, directly related to BP measurements, compared to Home and Non responders. Habituation to the experience of having BP measured by a physician, and habituation of the anxiety prior to the BP measurement, was different among the three groups. Trait psychological variables did not distinguish group membership. Self measured systolic BP, state anxiety prior to self measured BP, habituation to physician measured BP and the anxiety preceding it, were entered as predictors variables in a discriminant function analyses. These variables were able to correctly classify group membership for 63% of the sample.

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I. INTRODUCTION

The presumed arousing effect of having blood pressure measured by a physician is known as the "white coat effect" (e.g., Prattichizzo & Galetta, 1996), and has been offered as an explanation for the frequently observed discrepancy between office and ambulatory or home blood pressure (BP) measurements. The white coat effect can produce an elevation in BP that persists throughout the office visit, and may result in a diagnosis of hypertension. The literature indicates that between 15% and 20% of individuals who are clinically diagnosed as hypertensive are actually normotensive -- an estimate which is likely conservative (Pickering et al, 1988). These patients, who present with a persistent white coat effect, have been labelled as "white coat hypertensives". As a result of their clinical classification as hypertensives, they are at risk for unwarranted pharmacological intervention.

Another interesting group of patients, who have received much less attention in the research literature, demonstrate a measurement effect which is opposite to that seen in the classically defined white coat hypertensives (Gerardi, Blanchard, Andrasik & McCoy, 1985). These individuals present at the medical setting with *normal* blood pressure values, while ambulatory or home BP values fall within the *hypertensive* range. They were originally labelled as "home responders" (Gerardi et al, 1985), and more recently have been called "white coat normotensives" (Prattichizzo & Galetta, 1996). Estimates of the prevalence of the white coat normotensives have not often been reported. In a sample of borderline hypertensives, 14% demonstrated the white coat normotensive pattern (Enstrom, Thulin & Lindholm, 1991). This group of home responders, least likely to be detected, is at particular risk for developing the complications of untreated hypertension.

The white coat effect is responsible for many office-based false positives (the white coat hypertensives), as well as false negatives (the white coat normotensives),

suggesting that the office BP measurement and the resulting diagnosis are highly unreliable and that improved protocols are urgently needed. Identification of groups "at risk" for misdiagnosis typically occurs by retrospective comparison between ambulatory monitor BP readings and office BP readings. The ambulatory monitoring procedure is, however, expensive and time-consuming for both physician and patient (Pierdomenico et al, 1995; Prisant, 1995). Research attempts to distinguish white coat hypertensives from their normotensive counterparts, using both physiological and psychological factors, have been largely unsuccessful.

A. Terminology

In the preceding pages a number of different terms have been used to describe the various phenomena associated with BP measurements. The definition of these descriptive labels is discussed throughout the text, however, a brief review of these terms is warranted at this point. The term "white coat hypertension" has typically been used to describe the phenomena in which an individual has high BP within the medical setting yet normal BP when measured outside of the medical setting. These individuals have been referred to as "white coat hypertensives".

The term "white coat effect" is used to describe the difference (in mm HG) between office BP and either ambulatory or home BP values. The original use of this term was used to describe the discrepancy between high office BP and low home or ambulatory BP as seen in white coat hypertensives (e.g. the "white coat effect"). Currently, however, the use of the term is problematic for the following reasons. First, it is rare for an individual to have identical ambulatory or office BP values. Therefore, the white coat effect is not only a common occurrence but an anticipated phenomenom especially since different BP measurement techniques and recording devices are used for office, home, and ambulatory BP measurement. Although this term appears meaningless because it simply describes the differences between BP values measured within and

outiside of the medical setting, it has typically been used to describe differences which are clinically significant (e.g. as a result of BP differences individuals receive different diagnostic labels when the magnitude of the white coat effect is large). Second, the term "white coat effect" has been primarily used to describe a unidirectional difference in BP which has resulted in the diagnosis of "white coat hypertension" (e.g. substantially larger BP values obtained in an office setting compared to those BP values obtained at home or during ambulatory monitoring). As discussed above, however, there are a group of individuals who show a large "white coat effect" in the opposite direction such that their home or ambulatory BP values are much higher than office BP values, and these individuals have been labelled "white coat normotensives".

In summary, the white coat effect is common and expected. The term "effect" typically refers to an increase or decrease in BP when measured by a health care professional compared to ambulatory or home BP values. Therefore, the larger the white coat effect, the higher the risk of misdiagnosis. The above discussion was written to acknowledge some of the ambiguities associated with using the term "white coat effect"; however, abandoning use of this term for the purposes of this discussion is, in itself, problematic for reasons of communication to reasearchers in the field who understand the context in which the term is typically used.

Measurement of BP within the medical setting has been described as "office BP" or "clinic BP", and these terms are interchangeable. Throughout the following discussion, BP measurement within the medical setting will be called "office BP". Blood pressure measured by a physician will be referred to as "physician BP", and BP measured by a nurse will be referred to as "nurse BP".

Blood pressure measurement outside of the medical office has been described as "ambulatory BP" or "home BP", and these terms are not interchangeable. The term "home BP" indicates that BP measurements are taken by an individual at home, either

manually (after they have been trained in the procedure), or with a automated BP measurement device which is designed for stationary BP measurement. Home BP is typically measured during times which have been designated by a physician or research investigator that coincide with an individual's schedule. In contrast, ambulatory BP measurement provides BP data obtained during the course of a typical day (e.g. work, home, and other activities). The BP monitoring device is portable, typically automated, and BP readings are taken during a variety of activities. The number of BP measurements taken during ambulatory monitoring is between 2 and 4 per hour, providing a much higher number of readings compared to home BP measurement procedures.

Finally, the terms which were applied to the groups under investigation in this study are based upon "response style". The term "Non responder" refers to a group of individuals who show a minimal white coat effect. "Home responders" refers to individuals who show a large white coat effect characterized by higher BP outside of the medical office (e.g. during ambulatory monitoring) compared to lower BP obtained during the office visit. The group called "Office responders" refers to individuals who have office BP which is higher than BP measured outside of the medical office. This group of "Office responders" encompasses the majority of individuals who would traditionally have been classified as "white coat hypertensives".

B. The White Coat Effect

Ayman and Goldshine (1940) first observed that in-home BP measurements were consistently lower than those taken by a physician within the clinical setting. Working on the assumption that individuals have an initial alarm reaction to having their BP measured by a physician, Mancia and colleagues designed studies specifically to quantify this white-coat effect (Mancia et al, 1983; Mancia et al, 1987). Parameters of the white-coat effect were provided by comparison between intra-arterial BP values and BP

measurements taken by a physician using a standard mercury sphygmomanometer during routine hospital examinations. The intra-arterial BP measured in both normotensive and hypertensive patients increased an average of 27/25 mm Hg (systolic/diastolic) above pre-physician visit values. This peak occurred within 1-4 minutes of the physician's arrival at the patient's bedside, indicating that the mere presence of a physician, prior to actual BP measurements, could induce a potent pressor response.

The specificity of this white coat response is clearly demonstrated by the comparison between physician BP and BP measurements obtained by a nurse or technician. Mancia et al. (1987) reported that intra-arterial nurse BP levels were 47% lower than when measured by a physician in the majority of their patients. The same systematic discrepancy between physician/nurse and physician/technician BP values, although less dramatic, has been replicated by others (Pickering & James, 1989; Porchet, Bussien, Waeber, Nussberger & Brunner, 1986). Although nurse BP corresponds more closely with ambulatory monitoring values, the number of inaccurate diagnoses made by nurse BP is such that identifying white coat hypertensives within the office is not an acceptable substitute for ambulatory monitoring (Veerman & van Montfrans, 1993).

It is important to note that the transient rise in BP in response to the presence of a physician (the white coat effect) is not unique to a specific group of patients. Regardless of BP diagnostic status, BP values obtained by physicians are transiently elevated to a larger degree relative to BP values obtained by other health care professionals. The white coat effect becomes clinically significant when, instead of being a transient phenomenon, it persists within and between clinic visits, and is of sufficient magnitude such that misdiagnoses is likely. The protracted presence of elevated BP within the clinic, despite markedly lower BP values outside of the clinic, poses an undoubtedly significant threat to accurate clinical diagnosis of BP status.

C. White Coat Hypertensives

An increase in BP is a typical reaction to having one's BP measured. Habituation to the clinic setting, and/or to the actual procedures involved in BP measurement, helps to reduce an individual's risk of being misclassified as hypertensive. For example, in one study 11% of participants who had been originally classified as hypertensive on their initial screening visit were subsequently re-classified as normotensive based on BP values obtained during repeated clinic visits (Carey et al, 1976). Systolic BP values can drop considerably during a single clinic visit, thereby substantially reducing the number of individuals who would otherwise have been identified as hypertensive (Van Loo, Peer & Thien, 1986). Thus, repeated BP measurements taken over an appropriate time interval during a single visit, or measured over repeated clinic visits, can reduce the number of false positive diagnoses.

In contrast to individuals whose initial elevation in BP decreases with subsequent visits or repeated measures, white-coat hypertensives do not exhibit substantial habituation within or between office visits. This situational yet stable elevation in BP is well documented and is key to the risk of misclassification.

The stability of the white coat effect both within and over repeated office visits is demonstrated by a number of investigations. For example, as many as 56% of individuals who had office BP values exceeding 140/89 mm Hg measured on at least three different occasions, produced ambulatory values of less than 140/89 mm Hg (Waeber et al, 1984). Despite an average of nine BP measurements assessed on three separate occasions, ambulatory BP was significantly lower than office BP and resulted in 24% of a sample population being classified as white coat hypertensive (Siegel, Blumenthal & Divine, 1990). This finding is representative of other investigations where between 14%and 21% of individuals who had presented with persistently elevated office

BP had ambulatory BP values which would be considered normal (Laughlin, Sherrard & Fisher, 1980; Padfield, Lindsay, McLaren, Pirie & Rademaker, 1987).

As a result of ambulatory monitoring, a significant proportion of therapy-resistant hypertensives (39%) were identified as having daily BP values which fall within the normotensive range (Lerman et al, 1989; Touyz, Milne & Reinach, 1990). This suggests that the so-called "resistance" is a measurement artifact, and these patients may have received unnecessary treatment. These findings are particularly remarkable when one considers that these patients were monitored regularly within the clinic over a five year period.

Given estimates of as low as 14% and as high as 56% of patients who presented with a marked discrepancy between office and ambulatory or home BP, some investigators have excluded the first series of BP readings from their calculation of office BP in order to compensate for the habituation effect. This methodological procedure has the potential to provide a more conservative estimate of office BP and potentially reduce the discrepancy between office and ambulatory BP values. However, even when initial BP values are eliminated from the calculation of office BP, there continues to remain a group of individuals whose office BPs remain greater than 140/90 mm Hg while ambulatory BP readings are less than 130/80 mm Hg (White, Schulman, McCabe & Dey, 1989). Pickering et al. (1988) estimated that 21% of study participants whose initial BP values were excluded from the calculation of office BP, still had office diastolic BP greater than 90 mm Hg despite having normal range BP values measured outside of the office setting.

The white coat hypertensive's persistent and stable office BP elevation, both between and within clinic visits, poses a unique problem in terms of identification. The inability of the white coat hypertensives to habituate to the office setting or to the experience of BP measurement puts them at risk for misclassification and unnecessary

intervention. Furthermore, the staggering estimate that approximately 25% of hypertensive patients are refractory to treatment must be re-evaluated in light of this persistent white coat response (Lerman et al, 1989; Touyz et al, 1990). This is particularly relevant when one considers the potential risks associated with increasing dosages or prescribing new drugs to a patient who is hypertensive exclusively within the office setting.

Regardless of patient's BP status, the experience of having one's BP measured produces a typical pattern of BP change. Relatively high BP is seen upon initial evaluation, with a subsequent decline and stabilization of BP values. This pattern of decreasing BP over repeated measurements is attributed to the process of habituation. Even when the effect of habituation is accounted for, individuals who respond with persistently elevated BP are not discernible from true hypertensives unless ambulatory monitoring is used.

D. Identification of White Coat hypertensives using Ambulatory Monitoring

Guidelines outlined by the World Health Organization and the International Society of Hypertension (Memorandum from the WHO/ISH, 1993) suggest that individuals who present with mild hypertension (initial diastolic pressure >90 mm Hg) should have at least two further measurements during a four week period before considering anti-hypertensive medication. They further recommend that office BP should be based on the average of the fourth and fifth BP readings.

Adherence to these guidelines may be useful for detection of borderline hypertensives or essential hypertensives; however, as indicated above, those who suffer from white coat hypertension may not be detected, as evidenced by their persistent and stable office BP values.

At present, the method for identification of white coat hypertension is retrospective in nature. White coat hypertension can only be diagnosed after comparison of home or ambulatory BP with office BP. Both ambulatory and home BP have become widely accepted practices to provide more representative BP measurements (Duggan, 1994; Pickering, Harshfield, Devereux, & Laragh, 1985). A number of studies have shown that ambulatory monitoring is a more sensitive index of the cardiovascular consequences of hypertension (e.g. increase in left ventricular mass) than standard office BP measures (Pickering & Devereux, 1987; Omboni, Ravogli, Parati, Zanchetti & Mancia, 1991).

Ambulatory BP monitoring has eliminated some of the unreliability inherent in measuring and recording BP values within the office setting. It has been repeatedly shown that office BP values are not fully predictive of ambulatory BP values. Correlations between office BP and the average BP obtained by 24- hour monitoring have been found to be approximately .60, indicating that office BP can account for 36% of the variance of the average BP obtained through 24 hour monitoring (Harshfield, Pickering, Kleinert, Blank and Laragh, 1982). The relationship between mean office systolic values and awake or day time ambulatory monitoring systolic BP ranges from $r=.34$ to $r=.75$ for hypertensive patients, and from $r=.69$ to $r=.79$ for normotensive patients (Pearce et al, 1992).

E. Ambulatory Monitoring.

A large number of variables exist which have the potential to affect BP levels within the medical setting. These include the patient-physician interaction, the status and gender of the physician, observer bias and digit preference (an observer error leading to an excess of BP measurements ending in the number "zero"), and measurement anxiety (Pickering et al, 1985, 1989; Prisant 1995). Ambulatory monitoring procedures are also subject to a number of variables as it is carried out in an uncontrolled environment.

Nonetheless, BP values measured by these non-invasive devices are more reproducible (James et al, 1988), and demonstrate less variability than office BP measurements (Prisant, 1996). The stability of ambulatory BP readings indicates that it is a valid and reliable measure of BP which can control for factors that may artificially elevate BP within the office setting.

F. White Coat Hypertensives versus the White Coat Effect

The term "white coat hypertensive" is a diagnostic label, and often considered a categorical variable. However, the criterion used to decide normal ambulatory BP versus high office BP varies between studies. The "white coat effect" can be considered a continuous variable, use to describe (in mm Hg) the difference between office and ambulatory BP (Verdecchia et al, 1995). This variable can range from negative to positive values depending upon the ambulatory-office BP differences. Most recently, the magnitude and direction of the white coat effect have been examined in relationship to cardiovascular risk factors (Verdecchia, Schillaci, Borgioni, Ciucci & Porcellatie, 1997) and psychosocial stress (Donner-Banzhoff, Chan, Szalai & Hilditch, 1997).

The magnitude and direction of the white coat effect was used as a grouping variable instead of employing the traditional BP diagnostic cut off categories (hypertensives, normotensive and white coat hypertensives) for the following reasons: (1) There is no currently agreed upon BP criterion cut off which is used to determine the presence of white coat hypertension (Verdecchia, Schillaci, Boldrini, Zampi & Porcellati, 1992); and (2) absolute classification lends itself more readily to clinic samples, previously screened for the presence of borderline or hypertension in contrast to population-derived samples (Pickering, 1992). Further, the term "white coat hypertensive" is restrictive in its assumption that the "white coat effect" is unidirectional in producing only an elevation of BP in the presence of a health care professional. As mentioned above, a seldomly reported group of individuals, the "white coat

normotensives", present with office BP values which are significantly lower than their ambulatory BP values.

It is acknowledged that categorically grouping individuals based upon a continuous variable reduces the sensitivity of statistical approach which would otherwise be seen in a correlational design. However, the primary goals of this study were to examine psychological and methodological variables in individuals who represent the more extreme ends of the distribution. Further, this strategy of group definition allows comparison with other groups in the literature without limiting the data obtained from individuals that cannot be adequately described by typical diagnostic categories.

G. Methodological Factors and the White Coat Effect: Summary & Investigative Goals

(1) Summary

Blood pressure measurements taken by a physician, and to a lesser degree by a nurse or technician, are susceptible to the white coat effect and therefore result in transient elevations of BP. The persistent and stable white coat effect seen in individuals who are otherwise normotensive poses significant difficulties in accurate diagnosis and presents the risk of unnecessary intervention.

If one of the primary contributing factors to the white coat effect is the presence of a health care professional in the office BP measurement situation, the possibility exists that BP measurements taken by the patients themselves, in the office, may be more representative of their day-to-day BP values.

Typical comparisons between ambulatory and office BP are based upon different measurement techniques which may introduce the possibility of measurement artifact. Control for instrumentation may reduce the sensitivity of detecting discrepant BP values obtained by different methods (e.g. ambulatory monitoring versus mercury sphygmomanometry) since it is not clear how much of the difference between office and

home BP values are a result of this measurement artifact. In this study I have standardized the methodology of BP measurement across situations, to minimize methodological confounds and provide true BP comparisons.

(2) Investigative Goals

(i) The first objective of this study was an attempt to replicate reports in which a differential white coat effect was found between physician BP and nurse BP values. Critical to this research design was the addition of a new methodological procedure which provided a control for the presence of a health care professional. This was accomplished by asking participants to take their own BP measurements while at the office. The goal was to determine if, in the absence of a health care professional, the white coat effect was minimized such that self measured office BP was more representative of ambulatory monitoring BP values than nurse or physician BP.

(ii) In an attempt to be more inclusive, the study sample was not screened for hypertension prior to participation, and the full range of the white coat effect and its predictors was examined. Participants were grouped according to the magnitude of the white coat effect they displayed in the presence of a physician. Three groups were considered: (1) Office responders (those participants whose office BP was higher than ambulatory BP); (2) Non responders (individuals who showed little difference between office and ambulatory BP values); and, (3) Home responders (participants who had lower office BP compared to relatively higher ambulatory values). The BP criteria used to define these groups are in the Methods section.

It was predicted that for both the Office and Home responders (those who demonstrated the largest white coat effect based upon physician versus ambulatory BP), self BP would be more representative of awake ambulatory BP values. Specifically, it was anticipated that Office responders would have lower self BP compared to physician or nurse BP. In contrast, it was predicted that Home responders will have self BP which

is significantly higher than physician or nurse BP. Finally, it was predicted that Non responders would demonstrate relatively stable systolic and diastolic BP values across all three office BP measurement situations (physician, nurse and self). This stability would be represented by equivalent levels of the white coat effect across all three measurement situations.

(iii) The primary investigative goals and hypotheses were based upon individuals grouped according to BP response styles. However, for comparative purposes, some results were reported and discussed in terms of BP diagnostic groups. These groups were: hypertensives, white coat hypertensives, normotensives and white coat normotensives.

H. Physiological Reactivity and the White Coat Effect

The white coat effect is characterized as a form of excessive reactivity associated with BP measurements taken within the office setting. Given this heightened response to a stressful situation, investigators have hypothesized that the exaggerated BP response may generalize to other stressful situations (Cardillo, De Felice, Campia & Follie, 1993). Labile sympathetic activity has been proposed as the mechanism underlying this transient BP increase (Pickering et al, 1982). The reactivity and lability of BP to stressful physical and mental laboratory tasks is well documented (for a review, see Melamed, 1987). As a result, this BP reactivity to stressors has been developed into laboratory paradigms used to investigate the BP responsiveness of white coat hypertensives to stressors other than office BP measurement itself. Cardillo et al (1996) examined BP reactivity in response to tasks of mental arithmetic, isometric hand grip and cycle ergometry. White coat hypertensives did not differ from either persistent hypertensives or normotensives in terms of BP reactivity to these specific laboratory stressors. This finding is consistent with earlier reports (Julius, Jamerson, Gudbrandsson & Schork, 1992; Pickering et al, 1982; Siegel et al, 1990). The only exception is a study in which

white coat responders demonstrated a significant increase in systolic BP in response to a mental arithmetic test when compared to non responders (Gerardi et al, 1985).

The fact that an office visit may be perceived as stressful has fostered the idea that office BP values are representative of a patient's response to daily stress. A number of studies have confirmed that BP measures taken at work are consistently higher than BP values recorded at home (Enstrom & Pennert, 1996; Kleinert et al, 1984; Pickering et al, 1982). It is reasonable to expect that elevated BP values at work reflect a higher level of stress relative to stress experienced within the home setting. Consistent with this argument, is the suggestion that white coat hypertensives respond with an exaggerated response to stress. This response would be reflected in a relatively larger difference between work and home BP values. This predicted effect, however, is not observed: the work/home BP differences seen in white coat hypertensives, hypertensives and normotensives are proportionately equal (Pickering et al, 1982).

It has been suggested that inherent labile or heightened sympathetic activity may underlie generalized BP variability, which is then responsible, in part, for the persistent white coat effect (Pickering et al, 1982). The standard deviation values of mean blood pressure measurements have been used as an index of labile sympathetic activity. It has been consistently demonstrated, however, that across a wide range of situations, white coat responders do not differ in terms of BP variability from their non responder counterparts (Lerman et al, 1989; Pickering et al, 1982, 1988; Siegel et al, 1990; White et al, 1989). This lack of BP variability is also seen in the white coat normotensives when compared to true normotensives (Prattichizzo & Galetta, 1996). The lack of variability strongly argues against the hypothesis that white coat hypertension is mediated by an underlying pattern of labile sympathetic activity which reflects a generalized response pattern to the stress generated by day-to-day living or laboratory tasks. On the other hand, it is clear, by nature of the definition of white coat hypertensives, that these

individuals are experiencing subjective stress. In conclusion, the exact determinants and nature of this stress response remains to be explained.

I. Situational Factors and the White Coat Effect

(1) Patient - Health Care Professional Interactions

By definition, the white coat effect is observed in the presence of a physician or health care professional. Since typical office BP is usually accomplished by an interpersonal interaction between the patient and a health care professional, this situation may directly elicit or otherwise stimulate a pressor response that is not necessarily indicative of a response to other stressors (Weber, Smith, Neutel & Cheung, 1991).

It has been found that an interpersonal interaction per se can produce a significant elevation of diastolic BP to the extent that the BP of normotensive participants was elevated to the hypertensive range (Williams, Kimball & Williard, 1972). Similarly, a number of studies show that both hypertensive and normotensive individuals demonstrate a rapid and large increase in both systolic and diastolic pressure at the onset of talking (Linden, 1987; Lynch, Long, Thomas, Malinow & Katcher, 1981). These increases in BP were not sustained during the post-conversation period and, in fact, returned to pre-conversation levels. In all of these studies, the magnitude of increased BP during the interaction did not differ between the normotensive and hypertensive individuals.

It is possible that interpersonal interactions occurring during the course of BP measurements contribute to the relative elevation of BP within the office compared to ambulatory or in-home monitoring. This, however, does not explain the discrepancy in BP measurements taken by a physician versus a nurse (Mancia et al, 1987, 1983, Porchet et al, 1986) or between a physician and a technician (Pickering et al, 1988). This suggests that, independent of the setting and interpersonal interaction, the reaction must be, at least in part, specific to the interaction between physicians and patients, with gender, status, and authority as potential factors to be considered.

Mancia et al (1987) have suggested that BP taken by a physician may be emotionally laden as it may be associated with immediate diagnostic and/or therapeutic decisions. They propose that diagnosis and treatment strategies are typically not discussed with a nurse, and therefore, BP readings taken by a nurse are not affected. However, in the studies conducted by Mancia et al (1983, 1987), the physician was male and the nurse was female. This information led some researchers to speculate that the perception of a male authority figure may significantly contribute to the white coat effect. In support of this speculation, Pickering et al (1988) cited an earlier study in which army recruits had significantly higher BP values when measured by a captain in contrast to lower BP values measured by a private (Reiser, Reeves, & Arrington, 1955). However, close examination of this study revealed that the differential BP values were accounted for by a significant decrease in mean BP when the private was providing an explanation of the experimental proceedings, whereas individuals seen by a physician did not show a decrease in BP values. These results are not entirely inconsistent with the argument that authority per se contributes to the white coat effect. The evidence suggests that the nature of the interpersonal interaction may play an important role in the effect.

Pickering et al (1988) extend this argument of perceived authority to place into context their findings that women comprise the majority of whitecoat hypertensives. They speculated that women show an exaggerated pressor response in the presence of a male physician because of the possible stereotyped view of the physician as a male authority figure. In contrast, they suggest that women may perceive a female nurse or technician as representing a more empathetic figure. This suggestion was used to explain the disproportionate number of female versus male white coat hypertensives observed by Pickering et al (1988); however, it provides no insight into the reasons for "male" white coat hypertension. A more convincing argument could be made if female white coat hypertensives displayed a relatively larger white coat effect than men. Without

exception, however, the reported data indicate that there is no difference between males and females with respect to the magnitude of the white coat effect.

The gender of health care professionals, regardless of their perceived status or authority, may moderate the white coat effect. In a recent study using automated BP procedures to examine the effects of gender on BP, it was found that females had significantly higher systolic BP upon first reading when the measurement procedure was conducted by a male "non-physician" versus female "non-physician" (McCubbin et al, 1991). However, this gender discordant effect diminished over 4 measurements occurring at one minute intervals. Since the status of these two "experimenters" was equivalent, the results do not support the male authority figure explanation but instead suggest a differential response between men and women based upon the gender of the experimenter.

In summary, the notion that the differential status/authority contributes to the white coat effect needs to be examined further. In part, this is necessary because the conclusions which have been drawn about patient's perception of health care professionals, are inferred on the part of the researchers. An ideal design would allow manipulation of both gender and status of the health care professional.

(2) State Psychological Indices

The circumstances of a patient-physician interaction can, by nature, provoke anxiety about health treatments, a feeling of powerlessness, reluctantance to communicate, and difficulty discussing fear provoking topics (Shreve, Harrigan, Kues, Kaga, 1988).. Based on previous laboratory findings, anxiety has been consistently associated with an increase in BP (James et al, 1986); and this fact has led to investigations which examined the role of anxiety as a moderating factor in the expression of the white coat effect.

In one of such studies, the expression of state anxiety and anger was investigated in a group of borderline hypertensives, classified as either "normal" (home BP _ 130/83 mm Hg) or "high" (home BP > 130/83 mm Hg) (Schneider et al, 1986). The authors found no difference between groups on either state anxiety or anger, and concluded that "anxiety is a weak predictor of acute office BP elevation" (Schneider et al, p. 247). Julius et al. (1992) drew the same conclusion as Schneider and his group when they found no difference between hypertensive and white coat hypertensive patients on Spielberger's measure of state anxiety, anger and curiosity. This lack of difference concerning state anxiety and anger (typically measured by Spielberger's STAI scales) has been confirmed by others (Gerardi et al, 1985; Jamner, Shapiro, Hui, Oakley & Lovett, 1993; Siegel et al, 1990). However, the conclusion that state anxiety and anger do not discriminate white coat hypertensives from either normotensives of hypertensives has to be qualified by an important fact -- in all of the above studies the state measures were not given at the time of BP measurement. As such, they were not reflecting context-specific anxiety, i.e. the distress related to the BP measurement procedure. These "state" measures should be interpreted, instead, as an index of "trait anxiety" given the non-specificity of the circumstances of administration.

The notion that state anxiety does not play a role in the precipitation of the white coat effect clearly appears to be based on a conceptual error. If state anxiety (and anger) are based on a transient emotional state, with accompanying subjective feelings, it is only natural that white coat hypertensives may not be particularly anxious in a setting that does not produce the situational anxiety (e.g. not in a BP measurement situation).

A study by McGrady and Higgins (1990) approximated the relationship between state anxiety and BP measurements. Participants were asked to complete Spielberger's state anxiety inventory approximately 30 minutes before BP measurement. The authors found a relationship between state anxiety in a group they described as "unstable"

hypertensives (individuals who displayed greater than 5 mm Hg difference in mean arterial pressure between an initial office visit and the mean arterial pressure calculated after the sixth week of a home BP recording period). Specifically, this "unstable" group produced a correlation of .64 between state anxiety scores obtained prior baseline BP measurements and the change in BP between baseline, and the end of the six week period. McGrady and Higgins (1990) attempted to reconcile their results with Pickering's (1988) conclusion that anxiety is not a mediating factor in the white coat effect. They proposed the existence of two separate phenomena. Specifically, they suggested that: (1) there is an increased office and home BP response which is related to anxiety, and that decreases with repeated monitoring (e.g. the process of habituation) ; and, (2) an increased office BP response in contrast to normal ambulatory BP, which does not decrease with repeated measures, and is unrelated to anxiety (e.g. the white coat response). These two phenomena imply a similar conclusion: that the persistent acute elevation in office BP, seen in white coat hypertensives, is unrelated to anxiety. It is clear, that without sufficient evidence pertaining to state anxiety, as it is directly associated with BP measurements, the conclusion that anxiety is not a mediating factor in the white coat effect is premature.

(3) Classical Conditioning

It has been suggested that the anxiety generated by having one's BP taken may precipitate a classically conditioned response (Pickering et al, 1990). These authors speculate that an initial orienting or defensive response, which usually habituates with repeated exposure, becomes a classically conditioned response in white coat hypertensives. The authors suggest that patients who are informed that they have elevated BP during their initial visit may experience an increased level of sympathetic arousal on subsequent visits, thus maintaining the elevated office BP and reinforcing the phenomenon. They cite, as evidence, a study which examined the effects of receiving

two types of information on subsequent office BP values (Rostrup, Kheldsen, Amundsen, & Eide, 1988). In this study, men who had been assessed as having mildly elevated BP on an initial office visit were sent a letter which either stated that their blood pressure was too high, or a neutral letter simply informing them of their next visit. The individuals who received explicit feedback about their hypertensive status had significantly elevated office BP during a return visit, compared to those who received the neutral message. In contrast, physician office and laboratory studies have found that false feedback provided immediately after BP measurement had no effect on subsequent BP levels measured three minutes afterwards (Linden, Herbert, Jenkins and Raffle, 1989).

The explanation of classical conditioning put forward by Pickering et al (1990) is interesting yet incomplete. While this phenomenon may exist, the authors have failed to address the following issue: Why do others, who undoubtedly have been told they have elevated pressures on an initial visit, habituate to this orienting or defense response? This would suggest that responders and non responders may still differ in their cognitive appraisal of the situation and in the coping strategies which they employ.

(4) The Role of Cognitions

Given that to date no study has truly measured BP related anxiety in the context of the white coat effect, it was hypothesized that distorted cognitions may play a role in precipitating the pressor response. As a result of informal conversations with individuals who would be considered white coat hypertensives, it was discovered that these individuals state that they become very anxious just seeing the cuff which is used to monitor BP. More importantly, they describe cognitions associated with the physical sensations they experience during inflation of the cuff. For example, when the cuff begins to expand and exert pressure on the arm, they feel as if their "veins will burst" or that their "heart is being damaged" by the back-load of pressure placed on it by the inflated cuff. As a result, they become anxious, and tense their muscles, such that they

experience even more pressure from the cuff. This vicious cycle continues until the BP measurement is complete, with the cuff deflated and removed.

Currently, there are no reports in the literature which have examined participant's cognitions associated with the physical experience of having one's BP measured. There is, however, a cognitive model of panic put forward by David Clarke (1989), which has in common many of the features described above. Clarke suggests that when individuals experience anxiety, their key cognitions are related to perceived physical or psychological danger. Further, it is not the actual event which is responsible for the production of negative emotions such as anxiety, rather it is an individual's interpretation and expectations which are responsible for the anxiety. In summary, the sequence of events in Clarke's (1989) model are as follows: 1) a trigger stimulus; 2) perceived threat; 3) apprehension; 4) body sensations; and 5) catastrophic interpretations of body sensations. It becomes obvious that if catastrophic interpretations of body sensations occur, the cycle will continue and the individual may ultimately suffer a panic attack.

The experience of having one's BP taken is relatively short-lived. Therefore, if a sequence of events occurs which are similar to Clarke's model, it may not result in a full-blown panic attack. However, catastrophic cognitions are quite likely to result in a transient increase in BP. This cognitive model of panic may serve well to explain the elevated office BP, at least in selected groups of individuals. The theory falls short, however, when one considers the significant decrease in BP seen with ambulatory monitoring, where inflation of the cuff occurs a number of times throughout the day. If this cognitive model can, in part, account for the white coat response, it may be that distorted cognitions are attenuated outside of the office setting.

If patients misinterpret body sensations in a catastrophic fashion to the point where they feel they are in physical danger, their anxiety should be tempered by the fact that they are within a medical setting where any perceived physical danger would receive

immediate medical attention. Thus, it seems counter-intuitive that these individuals would display an exaggerated pressor response within the office setting. On the other hand, what differentiates ambulatory readings from readings taken by a physician or nurse could be the amount of control perceived by the patient. Perhaps during ambulatory monitoring the participants know that they could either remove the cuff or stop the monitor manually, whereas in a office setting they may feel inhibited from requesting a health care professional to discontinue taking a BP measurement. Thus, it could be that the perceived lack of control during BP measurements within the office overrides any safety signal offered by being in a medical setting.

(5) Attentional Focus and Desensitization

It has been argued that since trait levels of anxiety do not differentiate white coat responders from non responders, these individuals have a situation specific anxiety. This situational specificity could be interpreted in the context of attentional focus. This hypothesis easily accounts for the different BP response during ambulatory monitoring, since individuals cannot afford to constantly focus their attention on the experience of having their BP measured when repeated BP measurements take place (typically 40 to 50 readings during a 24 hour sampling period). To my knowledge, the effect of wearing an ambulatory blood pressure monitor on subsequent BP measurements has never been investigated. The possibility exists that during ambulatory monitoring desensitization to the actual process of having repeated measures may occur, in contrast to the office situation during which the patient's primary focus of attention is the experiences of having their BP measured. This attentional focus may precipitate distorted cognitions and heightened arousal.

J. Trait factors and the White Coat Effect

The literature indicates that, despite the white coat hypertensive's observable reaction to having office BP measured, they apparently do not endorse any situation

specific anxiety or anger. I have argued, however, that a conceptual error has occurred and have set out to correct this error in the present study. However, the largely negative findings which indicate that situational factors do not mediate the white coat effect, leave the possiblity that underlying trait or personality characteristics may, at least in part, contribute this phenomenon.

(1) Generalized Stress and Psychosocial Dysfunction

Recently, generalized psychological distress was assessed in association with the observed differences between office and home BP in patients not previously screened for hypertension (Donner-Banzhoff et al, 1997). This group used a psychometrically sound assessment tool, the General Health Questionnaire, which is comprised of five distinct factors: anxiety, feelings of incompetence, depression, difficulty in coping and social dysfunction. They concluded, in agreement with Pickering et al. (1988), that the pressor response is idiosyncratic to the setting and is not a result of underlying generalized psychological distress, since they found no association between the degree of the white coat effect and psychological distress in the large community sample they studied. Fark (1993) investigated the relationship between the white coat hypertension and the presence of numerous psychosocial disorders, including generalized anxiety and panic disorder. He concluded that the white coat hypertensives may warrant a dissociation from other psychosocial disorders. The only statistically significant association with "labile BP" observed between office visits was that of men with alcohol hepatitis. Finally, underlying depression has been ruled out as a mediating factor in white coat hypertensives, as self-report measures have been consistently unable to discriminate this group from either hypertensives or normotensives (Gerardi et al, 1985; Jamner et al, 1993; Siegel et al, 1990).

(2) Trait Anxiety and Anger

Maladaptive expression of anger, such as outward aggression or suppression has been proposed as a risk factor for hypertension (Lamensdorf & Linden, 1992). It has been hypothesized that since angry persons show exaggerated cardiovascular reactivity to interpersonal and evaluative stressors, white coat hypertensives may indeed present with this trait. It has been suggested that the purported white coat hypertension-anger relationship may contribute disproportionately to the reported anger-hypertension relationship seen in hypertensive individuals (Suls, Wan & Costa, 1995). This group has summarized the few available studies in which the relationship between expression and experience of anger in white coat hypertensives was examined. The results indicated that white coat hypertensives typically reported significantly lower levels of the expression and experience of trait anger (Gerardi et al, 1985; Lerman et al, 1990; Schneider et al, 1986). However, other studies have reported no significant difference in self reports of trait anger in white coat hypertensives compared to hypertensives (Siegel et al, 1990) or normotensives (Julius et al, 1992). It is difficult to draw a definitive conclusion concerning the relationship between trait anger and white coat hypertensives, since the criteria employed to define white coat hypertensives varied among the studies cited. Jamner et al (1993) made a comprehenisve attempt to understand anger and hostility in the context of BP differences across measurement situations. The authors analyzed BP data in terms of relative versus absolute BP difference across measurement situations (home, office and ambulatory) in order to resolve the disparity of white coat BP diagnostic criteria. They concluded that individuals who had lower self measured home BP (systolic and diastolic) compared to either office or ambulatory BP values, also had lower total scores on the Buss-Durkee inventory compared to individuals who would have been considered hypertensive regardless of the measurement situation. Although not conclusive, it is possible that the white coat hypertensives may indeed present with

lower levels of trait anger, and at present, it is the single most distinguishing feature of this group.

The consistent reports which indicate that white coat hypertensives do not endorse elevated levels of state anxiety compared to normotensive or hypertensive patients, not surprisingly, reflects the status of trait anxiety as a moderator variable in similar comparisons. Without exception, all investigations to date have reported that white coat hypertensives do not endorse trait anxiety to a higher degree than controls (Gerardi et al, 1985; Julius et al, 1992; Lerman et al, 1990; Siegel et al, 1990).

(3) Personality Structure and Coping Style

(i) Impression Management

Essential hypertension has been linked with the suppression of negative emotions and some have suggested this suppression may elevate BP (Suls et al, 1995). Within the context of examining patient-physician interactions, hypertensives and normotensives were compared on the basis of self report measures of distress versus physician observations of distress (Roter & Ewart, 1992). The results of this study indicated that physicians, and independent observers, rated hypertensives as being in better emotional health and less distressed than normotensives. This observation was in conflict with the self reports of hypertensives who endorsed high levels of distress equivalent to that endorsed by the normotensives. Moreover, the content of the patient-physician interaction was much more emotionally laden for normotensives compared to the hypertensives whose interaction was characterized by discussion of biomedical issues. The authors concluded that hypertensives have a style of presentation which is characterized by difficulty in communicating emotions, particularly negative emotions.

The hypothesis that borderline hypertensives have a preference not to disclose worries and concerns in an appropriate manner has been examined (Cumes-Ray & Price, 1990). These authors found that in a disclosure situation, where there were peer

observers, borderline hypertensives showed a larger pressor response compared to normotensives. Further, Melamed (1996) concluded that individuals who tend to be emotionally reactive and endorse a repressive coping style, have corresponding elevated clinic BP values. The possibility exists that individuals who show a large white coat effect (e.g. the Office responders or white coat hypertensives) may employ differential coping mechanisms such as impression management or self deception. It may also be that the impression management, which has often been observed in hypertensives, may actually represent a more pervasive characterological trait such as alexithymia.

(ii) Alexithymia

To date, and to my knowledge, there has been no theoretical rationale for proposing, or investigating a personality/coping style which may underlie the white coat effect and resultant classification as a white coat hypertensive. Psychophysiological data suggest that white coat hypertensives do not display a generalized "hyper"-response to stress or, labile sympathetic activity except in the medical office at the time of BP measurement. Psychological data indicate that no situational or state factor can identify the white coat hypertensives. The findings which suggest that white coat hypertensives report lower levels of expression and experience of trait anger are currently being debated, however, it is the only trait psychological signature of this group. I posit therefore, that the construct of alexithymia may underlie manifestation of the white coat effect; and, in particular, result in the diagnosis of white coat hypertension.

Historically, the conceptualization and subsequent study of alexithymia have been rooted in its association with the manifestation of psychosomatic illness, including hypertension. There is a consensus within the literature when describing the clinical features of alexithymia. Sifneos (1973) first coined the term alexithymia (a=lack; lexis=word; thymos=emotion), which describes the core feature of the condition - the inability to express emotion. More specifically, individuals who can be considered to be

alexithymic are characterized as having: 1) difficulty in identifying and describing feelings; 2) difficulty in distinguishing between feelings and the bodily sensations of emotional arousal; 3) constricted imaginative processes, as evidenced by a paucity of fantasies; and, 4) an externally oriented cognitive style (Taylor, Bagby, & Parker, 1991). Alexithymia has found to be independent of age, gender, educational level, socioeconomic status, intelligence (Parker, Taylor & Bagby, 1989), social desirability, trait anxiety (Martin & Phil, 1986) and depression (Wise, Jani, Kass, Sonnenschien & Mann, 1988).

This observable discrepancy between subjective and physiological arousal apparently seen in white coat hypertensives is consistent with the hypothesis that alexithymic individuals are unable to differentiate and elaborate affect, with a resultant rise in physiological arousal (Friedlander, Lumley, Farchione & Doyal, 1997). Further, these individuals have been observed to have a tendency to amplify and misinterpret bodily sensations which accompany emotional arousal (Taylor et al, 1991). This latter observation was confirmed by a study which examined the relationship between alexithymic traits and anxiety sensitivity in individuals diagnosed with either panic attacks or obsessive compulsive disorder (Zeitlin & McNally, 1993). These authors found that both alexithymic traits and anxiety sensitivity (defined as a fear of physical signs of anxiety because of their perceived threat to an individual's health) were more prevalent in the individuals diagnosed with panic disorder. They concluded that, since one of the defining features of alexithymia is restricted emotional affect, individuals with panic disorder may constrict emotional experiences to avoid experiences of threatening physical sensations. This conclusion is similar to the earlier discussion (see Role of Cognitions) in which it was hypothesized that the white coat effect may be mediated by distorted cognitions of the kind which are similar to those measured by the Anxiety Sensitivity Index used in Zeitlin and McNally's (1993) study.

Another line of research suggests that alexithymia may serve as a moderating variable in the expression of white coat effect. The discrepancy between the readily observed physiological reactivity in the presence of a health care professional, and the apparent lack of subjective distress (e.g. anxiety) has been observed in individuals considered high in alexithymic traits (Papciak, Feurerstein & Spiegel, 1985). Alexithymic individuals reported decreased levels of subjective stress in the absence of corresponding physiological data (Papciak et al, 1985). This physiological de-coupling occurred during a post-stressor recovery period and the authors suggested that this decoupling may reflect an inadequate ability to manage stress due to misperception of the event itself. Martin and Phil (1985) have proposed a stress-alexithymia hypothesis in which they suggest that the lack of emotional awareness, in combination with a diminished expression of emotion, seen in alexithymic individuals, may intensify physiological responses to stress.

In summary the relationship between physiological and psychological responses to stress seen in alexithymic individuals parallels the apparent BP response seen in white coat hypertensives. The relationship between these two phenomena has not yet been investigated.

K. Psychological Factors and the White Coat Effect: Summary & Investigative Goals

(1) Summary

Psychological factors have, to date, been unable to discriminate white coat hypertensives from their normotensive or hypertensive counterparts. State and trait anxiety apparently do not play a role in the manifestation of the white coat effect as white coat hypertensives do not appear, nor report, increased levels of anxiety compared to others who do not demonstrate a significant white coat effect. The only evidence that the Office responders experience an increased state of arousal, is their transient rise in BP

within the office which is a stable effect across office visits. I speculated that the Office responders may indeed be more anxious than Non responders and that the appropriate timing of the measurement of state anxiety may reveal this. The nature of the anxiety these individuals experience may be precipitated by distorted cognitions which, as in panic attacks, may contribute to heighten their pressor response. If indeed, anxiety plays a role in the white coat effect, desensitization to the experience of having one's BP measurements taken, may result in minimizing the white coat effect.

With the exception of lowered levels of expression and experience of trait anger, the Office responders do not present with any other distinguishing psychological features. Issues related to perception of control over one's own health and, interactions with health care professionals (specifically physicians) have not yet been explored in the context of white coat hypertension. It may be that Office responders come to the office with a different set of attitudes about their health and control over their health compared to Non responders, and impression management may moderate the "non-anxious" presentation of the white coat hypertensives which is frequently observed and reported. Finally, alexithymia was proposed as a moderating factor in the expression of white coat hypertension, given the apparent discrepancy between psychological and physiological arousal, and its known association with hypertension.

(2) Investigative Goals

(i) The amount of BP change between office visits was determined to allow investigation of the degree of BP habituation between office visits, and between pre- and post-ambulatory monitoring. Comparison of pre- and post-ambulatory monitoring was done to provide some insight into the role of desensitization to the experience of having BP measurements. It was predicted that the Office responders will show a differential decrease in office measured BP values between those BP measurements taken prior to

ambulatory monitoring and those taken immediately after completion of the 24 hour monitoring period.

(ii) The role of distorted cognitions and the experience of physical sensations associated with BP measurement was explored to further understand the impact, if any, of these factors on the white coat effect. It was predicted that the Office responders would endorse a heightened level of disturbing physical symptoms and distorted cognitions either before, during, or after BP measurements compared to the Non responders and Home responders.

(iii) State anxiety was assessed in *direct* relationship to the experience of having one's BP measured. Specifically, participants were asked to self report state anxiety as they experienced it directly related to the BP measurement situation, immediately prior to BP measurement. It was predicted that the Office responders would endorse higher levels of state anxiety related to BP measurement than either the Non or the Home responders.

(iv) Trait anxiety was also investigated in order to replicate the previous research findings, but more importantly, to demonstrate that state anxiety, in the absence of trait anxiety, could still moderate BP responsiveness in the presence of a health care professional. Furthermore, an attempt was made to determine whether individuals cope with anxiety in a differential manner, i.e., cognitively or somatically. It has been previously reported that response style groups do not differ with respect to BP reactivity to psychological and physical stressors. Given these data, it was anticipated that the Office responders would express anxiety more in terms of cognitions and, in particular, distorted or catastrophic cognitions, when compared to Non responders and Home responders.

(v) Individuals' perception of control in terms of their general health, and specific to their interaction with their primary care physician, was evaluated. It was

hypothesized that the Office responders woul endorse more negative perceptions related to the interaction with the physician who is typically responsible for measuring office BP. In addition, it was predicted that they would view themselves as having less internal control over their general health and well-being in contrast to the Non responders and Home responders.

(vi) Trait anger was also investigated. Levels of trait anger between Response styles was compared in order to clarify some of the conflicting findings in the literature. It was hypothesized that the Office responders would endorse lower levels of trait anger compared to their Non and Home responder counterparts.

(vii) Coping styles were examined as possible moderating factors in the expression of the white coat effect. In particular, impression management and self-deception were investigated, as well as the construct of alexithymia. Hypertensive individuals have been found typically to express their distress in a less overt fashion compared to normotensives, and studies which reported this did not evaluate whether or not a proportion of these hypertensive individuals were actually white coat hypertensive. Impression management and self deception were evaluated in the context of Response style to determine if the Office responders also use impression management and/or self deception to a greater degree than Non responders or Home responders. Since Office responders purportedly do not endorse a heightened level of subjective anxiety in the presence of physiological arousal, the presence of alexithymic traits was examined. The proposed "de coupling mechanism" between subjective emotional experience and physiological status (such as elevated BP), seen in alexithymic individuals suggested that individuals high in alexithymia traits would also show the largest degree of the white coat effect. This same prediction was made, if indeed the Office responders did report an increase in subjective anxiety in the context of BP measurements, given that some researchers have found a significant positive relationship between anxiety and

alexithymia. In summary it was predicted that individuals high in alexithymia traits would also present with the largest white coat effect. As a secondary goal, clarification of the relationship between subjective anxiety and physiological reactivity was examined along a continuum of alexithymia traits.

(viii) Finally, an additional goal was to provide information relevant to the psychological "profile" of individuals who were classified as hypertensives, white coat hypertensives, normotensives and white coat normotensives.

L. Review of Investigation Objectives

In summary, this investigation was designed to closely approximate the procedures that individuals would experience during a typical medical visit during which their BP was measured. Although additional factors (such as participating in a reasearh project, completing self report questionnaires and using the ambulatory monitor within the office setting) preclude exact replication of a typical office visit, the design allows for some generalizability to a medical office visit during which BP is measured. Control for measurement artifact, by using only data generated from the ambulatory monitor, was done to correct previous methodological inconsistencies and allow for true BP comparisons. Removal the purported source of the "white coat effect" (e.g. the health care professional), and asking participants to measure their own BP in the office setting was critical to determine if self measured BP would reduce the WCE and therefore be more predictive of ambulatory monitoring BP values.

The investigation design was an attempt to examine to role of anxiety as it directly related to BP the measurement situation. Participants were asked to endorse the level of subjective anxiety they experienced immediately prior to BP measurements. This design corrects for the fact that all previous studies investigated state anxiety outside the BP measurement context, yet concluded that state anxiety was not related to BP measurement. Finally, inclusion of several trait psychological measures allowed for

comparison between the previous research findings and the current data, as well as an opportunity to explore variables thought to be theoretically related to the WCE.

II. Method

A. Participants

Community volunteers served as participants in this study. A total of 63 individuals participated, 31 men and 32 women, ranging in age from 20 to 81 years old with an average age of 53.3 years. Table 1 provides a summary of the participant's demographic data.

Recruitment was carried out through media advertising and through referral from the Hypertension clinic at the University Hospital, U.B.C. site. In both cases, potential participants were provided with the telephone number of the Psychophysiological Laboratory at U.B.C. , and they were asked to contact by telephone the personnel at the Laboratory. At the time of contact, they were given general information about the nature of the study, and the requirements for participation. They were screened for any exclusion criteria (see below) by asking brief questions about their medical status, and they were given appointments for their office screening visit.

B. Inclusion Criteria

The goal of this study was to recruit participants from the community in order to obtain a sample of individuals with a wide range of BP values. Advertisement was done through a small ad placed in the newspaper with the heading "Blood Pressure Study - do you have high blood pressure?." Flyers were posted around the university and local community centres, and a journalist wrote a brief article describing the study, which appeared in the Vancouver Sun newspaper. Upon contacting the laboratory, individuals were told that this was a study with two main investigative goals. They were informed that we were looking at different methods in BP assessment and that we were also interested in examining psychological factors associated with BP changes. Potential

participants were informed that they would receive a comprehensive BP examination, including 24-hour monitoring, and that they would receive the results of all the BP measures taken over the course of the study.

Table 1

Participant Demographic Data

	N	Age		Height (cm)		Weight(kg)	
		$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Females	32	55.7	11.9	165.5	5.67	68.5	19.2
Males	31	50.7	14.8	177.2	7.34	86.4	16.8
Total	63	53.3	13.51	171.2	8.73	77.1	20.0

C. Exclusion Criteria

Individuals above 120% of their ideal body weight, or those who had a history of coronary artery disease or any other organic heart disease, asthma, chronic obstructive pulmonary disease or secondary hypertension were asked not to participate in the study. Individuals currently under medical treatment for hypertension were also excluded from the study.

D. Instrumentation

Office blood pressure measurements were obtained using both a standard mercury sphygmomanometer and an automated ambulatory monitor. Simultaneous readings were obtained by placement of the stethoscope directly below the ambulatory blood pressure monitor cuff and through a T-tube device connected to both the cuff of the ambulatory monitor and the tube for inflation of the mercury sphygmomanometer. This was the procedure used throughout the study to obtain physician and nurse measured BP. The

mercury sphygmomanometer procedure of physician and nurse BP measurement was included in the protocol in order to approximate the BP measurement procedures that participants would have typically encountered during a visit to their physician's office.

Self measured office BP (self BP) was obtained using only the automated ambulatory monitor. Participants were given verbal and written instructions, and observed a demonstration of how to activate the monitor. The self BP measurements reported are the measures obtained from the ambulatory monitor.

Twenty-four hour ambulatory blood pressure monitoring was performed by use of a portable, noninvasive recorder (Spacelabs Model 90207, Redmond Washington), with the blood pressure cuff fitted on the non dominant arm. These ambulatory devices weigh about 0.7 kg and are worn in a protective pouch. Monitoring was done on a typical workday, and participants were encouraged to pursue their typical activities and to relax their arm at their side when the cuff inflated. A standard cuff and large cuff were available to provide best fit with the participant's arm size. BP recordings were taken automatically every 20 minutes for the 24 hour monitoring period. Participants were asked to keep a diary of activities to be used later to guide the editing process. The ambulatory monitoring device used in this study has been previously evaluated, and is considered a valid measurement device (O'Brien, Mee, Atkins, and O'Malley, 1991; Parati et al, 1991).

E. Procedure

Participants in the study were required to make four visits to the Hypertension Clinic, have 21 office BP recordings, wear an ambulatory monitor for twenty-four hours, and complete a number of self report questionnaires. Outlined below is a brief summary of the study protocol which participants were asked to complete.

Office Screening Visit: Hypertension Clinic

(1) Participants met with Dr. K. who confirmed the inclusion and exclusion criteria for participation in the study.

(2) Dr. K. obtained a brief medical history and measured the participant's height and weight.
(3) Dr. K. was responsible for taking "screening" BP measurements during this visit. BP was measured three times. Dr. K recorded three "manual" BP values which were obtained simultaneously during the recording of three BP values measured by the automated BP monitor. Dr. K. activated the ambulatory monitor to inflate the cuff and using his stethescope he recorded BP values, based upon changes in the mercury column, at the same time as the ambulatory monitor was recording BP.

Office Visit 1: Hypertension Clinic

(1) The experimental protocol was reviewed with participants and written consent was obtained.
(2) During this office visit, and also during the Office Visit 2, a total of 9 automated BP measurements were taken. The order in which the physician, nurse or participant themself took the BP readings was randomly assigned prior to their arrival at the office. For example, if an individual was assigned the *"nurse, physician, self order"*, the protocol was as follows:

(i) Participants received a package of self-report questionnaires in which they were instructed to fill in the questionnaires designated to be completed *prior* to the nurse taking their BP.

(ii) After a few minutes the nurse would enter the office and take 3 BP readings. Similar to the method used by Dr. K. during the screening visit, the nurse would initiate inflation of the BP cuff via the ambulatory monitor. The nurse would take three "manual" BP readings simultaneously with the ambulatory monitor recordings. This procedure resulted in 3 automated readings in the presence of the nurse and 3 simultaneous "manual" readings. Note however, that the total of BP readings was considered 3, since only the automated BP recordings were used in the data analyses.

(iii) After the nurse left the office, the written instructions given to the participants asked them to complete the self-report questionnaires relevant to the nurse having measured their BP. They were also asked to answer questionnaires relevant to their anticipation that the physician would next measure their BP.

(iv) After a few minutes the physician would enter the office and initiate 3 BP measurements using the ambulatory monitor while simultaneously recording the 3 "manual" values.

(v) Once the physician left the office the written instructions asked the participant to complete the self-report questionnaires relevant to just

having their BP measured by a physician and then to complete the questionnaires relevant to anticipating that they would next measure their own BP.

(vi) The participants were given written instructions and verbal instructions (prior to any of the BP measurements) on how to initiate a BP reading with the ambulatory monitor. They proceeded to obtain 3 BP readings using the ambulatory monitor which was recorded in the data base.

(vii) After the participants had measured their own BP 3 times, they completed the rest of the questionnaires which asked them about their experience of taking their own BP.

(3) After the 9 office BP measurements were taken (3 nurse, 3 physician and 3 self) participants were given instructions about ambulatory monitoring operating procedures. They were told that the monitor would automatically measure their BP every 20 minutes for the next 24 hours. They were also given instructions on how to complete their ambulatory monitoring diary.

Office Visit 2: Hypertension Clinic

(1) Participants returned to the office with the ambulatory monitor.
(2) Office BP measurements were again taken following the same protocol used during Office visit 1. Participants had their BP measured 3 times by a nurse, 3 times by the physician and they measured their own BP 3 times for a total of 9 automated BP measurements. The order of BP measurement was identical to that done during Office Visit 1. Before and after each BP measurement situation (nurse, physician and self) participants completed the self-report state questionnaires as outlined in the procedure for Office visit 1.
(3) Participants were given a package of trait psychological questionnaires to be completed prior to their follow-up visit.

Follow-up Visit: Hypertension Clinic

(1) Participants returned the trait psychological questionnaires.
(2) Participants were provided the results of their ambulatory and office BP measurements. These results were discussed with them by both Dr. K. and the principal investigator.
(3) Participants were provided a thorough debriefing of the study goals and objectives.

(1) Blood Pressure Measurements

All clinic BP measurements were taken after the participant had been seated quietly for approximately 10 minutes. BP readings were taken at approximately 1- 2 minutes intervals with the patient in the seated position. For office visit 1 and visit 2, manual physician and nurse BP measurements were taken simultaneously with the automated BP measurements. Three BP measurements were taken during the screening visit. Simultaneous automated BP measurements were obtained on 40 of the 63 subjects. Three BP measurements were taken during each measurement situation (physician, nurse and self) for a total of 9 BP measurements per office visit. For self measured office BP and for ambulatory BP recordings, the ambulatory monitor was programmed to not display the readings. The order of BP measurements for office visit 1 and 2 was randomly assigned to each subject. Six possible orders (e.g. self, nurse, physician or physician, self, nurse, etc.) were assigned participants prior to their arrival at the clinic.

(2) Office Visits

(i) Office Screening Visit

Participants were initially scheduled to meet with Dr. K. during the screening visit to the hypertension clinic. They were asked to provide a brief medical history (see APPENDIX A). Dr. K. also confirmed that potential participants did not meet any of the exclusion criteria as outlined above. Participants who were found to meet exclusion criteria, (not previously screened during their initial telephone contact), were later contacted and thanked for their participation in the study. Individuals who agreed to continue on with the study were told they would be contacted by telephone to schedule further office visits.

(ii) Office Visit 1

Participants were scheduled for office visit 1 between the hours of 8:00 and 11:00 am. They were brought into the physician's office and the principal investigator reviewed

the study protocol with them. They were asked to read and sign the consent form (see APPENDIX B), and encouraged to ask questions about the procedures.

At this point, participants were shown the automated ambulatory monitor and given an explanation of how the monitor works and records information. Each participant was fitted with the monitor and a BP measurement was taken. They were then asked to initiate a BP measurement on their own, so that they would become familiar with the procedure prior to the self BP protocol. Participants were left with a package of self-report questionnaires and a single page of information (see APPENDIX C), describing the order in which the three sets of BP measurements would be taken, instructions on when to complete the self-report questionnaires, and a written reminder which describing how to activate the BP monitor. Participants were instructed to complete two self-report questionnaires, one questionnaire to be completed immediately prior to each of the three BP measurement situations, and one brief questionnaire to be completed immediately afterwards. The total time to complete these questionnaires was approximately 2-5 minutes.

Within each BP measurement situation (e.g. physician, nurse, self) three BP measurements were taken during a 6 to 10 minute period of time. After all office BP data were obtained, participants were instructed on the use of the ambulatory monitor for the following 24 hours. They were given a diary (see APPENDIX D), to complete during this time period. They were also provided a pamphlet describing the purpose of the study, the names of the investigators and a phone number to contact the principal investigator if they had any questions. Participants were scheduled to return to the clinic the following day, at the same time they had been scheduled for office visit 1.

(iii) Office Visit 2

At the beginning of office visit 2, participants were given the opportunity to discuss their ambulatory monitoring experiences. The BP measurement protocol of visit

2 was replicated, following the same order of BP measurement situations, and the completion of the same self-report questionnaires. Participants were then given a package of self-report questionnaires to complete at home and a follow-up visit was scheduled.

(iv) Follow-up Visit

Participants returned the self-report questionnaires and received two copies of their ambulatory and office measured BP results, one for their own records and one for their primary physician. The principal investigator reviewed the results with them, explaining the various graphs and data print-outs. Participants had the opportunity to ask the physician (Dr. K) any questions and to discuss the possible treatment implications of the results. Participants were fully debriefed about the nature of the study and were informed of the primary questions which were being investigated. They were encouraged to ask questions and offered the opportunity to receive a final copy of the published results of the study.

(3) Psychological Measures

(i) State Measures

Participants were asked to complete the Spielberger State Anxiety Inventory (STAI-Form Y-1) prior to each office BP measurement, and once during ambulatory monitoring. This measure meets psychometric criteria for reliability and validity (Spielberger, Gorsuch, Lushene, Vagg & Jacobs, 1983). Each subject completed a total of 8 STAI forms (1x screening, 3x visit 1, 3x visit 2, and 1x ambulatory monitoring). The STAI had an additional set of instructions printed on the reverse of the form, which the participants read first. The text read as follows:

> "PLEASE COMPLETE THIS QUESTIONNAIRE **BEFORE** THE (PHYSICIAN, NURSE, AMBULATORY MONITOR) MEASURES YOUR BLOOD PRESSURE.

ANSWER THE QUESTIONS THINKING ABOUT THE SITUATION IN WHICH YOU ARE ABOUT TO HAVE YOUR BLOOD PRESSURE MEASURED."

Immediately after each BP measurement situation, participants were asked to complete an additional questionnaire designed specifically for this study. They were asked to endorse the presence or absence of physical symptoms which they experienced either before, during or after BP measurements. In addition, they were asked whether or not they had any catastrophic ideation, e.g., "When my blood pressure is being taken, I think it may do damage to my heart", (see the complete questionnaire in APPENDIX E). Participants read the following instructions, written on the reverse of the form, prior to completing the questionnaire:

"PLEASE COMPLETE THIS QUESTIONNAIRE **AFTER** THE (PHYSICIAN, NURSE, AMBULATORY MONITOR) HAS MEASURED YOUR BLOOD PRESSURE.

ANSWER THE QUESTIONS THINKING ABOUT THE SITUATION IN WHICH YOU HAVE JUST HAD YOUR BLOOD PRESSURE MEASURED."

(ii) Trait Measures

At the end of visit 2, participants were given a package of self-report questionnaires and asked to complete these questionnaires prior to returning for the follow-up visit. Psychological measures included: Spielberger's Trait Anxiety Inventory (STAI Form Y-2); the Balanced Inventory of Desirable Responding (BIDR); Cognitive-Somatic Anxiety Questionnaire (CSAQ); Multidimensional Health Locus of Control Scales (MHLC); Spielberger Anger-Expression Scale (SAES); Perceived Involvement in Care Scale (PICS); and, the Toronto Alexithymia Scale (TAS).

The BIDR consists of 20 items each referring to unreasonable claims about one's thoughts and private behaviors (self-deception), or to unreasonable claims about one's own public behaviors -- an impression management subcale (Paulhus, 1984). The BIDR

was included to permit testing of response sets. Paulhus (1984) analyzed a battery of response set (social desirability) questionnaires including lie scales, and measures of defensiveness, denial and impression management, and found that the item pool could essentially be reduced to two main factors. Lie scales and similar deception measures loaded on one factor that was labelled impression management, or other-deception. Different measures including repression and self-deception scales loaded on the second factor, or self-deception. The BIDR therefore taps two dimensions of defensiveness. Scores range from 1 - 20 for both scales.

The CSAQ (Schwartz, Davidson & Goleman, 1978) comprises 14 items which are simply worded aspects of cognitive and somatic anxiety. The CSAQ is considered to be a trait measure of anxiety, and has concurrent validity, as it correlates with the STAI (trait). It also has known group validity, differentiating between groups who cope with anxiety by exercise or meditation (Schwartz et al , 1978).

The MHLC (Wallston, Wallston & DeVillis, 1978) is an 18 item instrument measuring three dimensions of locus of control as it pertains to health. It assesses individual's belief about three sources of control over health: internal health locus of control (IHLC), powerful other locus of control (POLC) and chance locus of control (CHLC). Each sub scale has six items and answers are based upon a six point Likert scale ranging from "strongly agree" to "strongly disagree". The scale has adequate criterion and concurrent validity and reliability ranges from .67 to .77.

The SAES (Spielberger et al, 1985) consists of 24 items endorsed using a 1-4 scale and is used to calculate three sub scale scores: (1) anger-in tendencies (2) anger-out tendencies and, (3) anger control.

The PICS (Lerman et al, 1990) is a 13 item scale developed to assess patient's perceptions of their relationship with their primary care physician. It is comprised of three factors: (1) doctor facilitation of patient involvement (DF); (2) level of information

exchange (PI); and, (3) patient participation in decision making (PDM). Both the PI and DF factors are related to the patient's perceptions regarding their physician's efforts to encourage and facilitate their participation during a medical visit, patient's level of understanding, control, reassurance, and expected functional improvement. Only the DF factor was related specifically to satisfaction with the physician. The PDM factor was found to be primarily related to satisfaction with the technical aspects of their care.

The TAS is a self-report instrument comprising 26 five-point Likert Scales (Bagby, Taylor, & Ryan, 1986). The instruments assesses four factors of alexithymia: (1) the ability to identify and distinguish between feelings and bodily sensations; (2) ability to describe feelings; (3) daydreaming; and, (4) externally oriented thinking. Possible scores range from 26 to 130. The TAS is a psychometrically sound instrument, with well documented reliability and validity (for review see, Linden, Wen & Paulhus, 1995). The first page of the package included the following instructions:

> "Attached are a number of self-report questionnaires. There are instructions at the top of each form. Please do not spend a lot of time on them; however, try to answer them as honestly as you can. A "subject ID" has been placed on them to ensure anonymity and confidentiality. Once you have completed the questionnaires please place them back in the envelope and seal it. You are asked to return this envelope during your next visit to the Clinic where you will receive the results of the blood pressure measurements. I will be happy to answer any questions you have about these questionnaires or, any questions you have about the study in general. Thank you once again for your participation.

III. Results

A. Data Reduction

(1) Office BP Measurements

Within each office visit (screening, visit 1 and visit 2), the average measurement situation (e.g. physician, nurse and self) BP was calculated as the mean of the three BP values recorded (see also the protocol summary on pp. 40-41). Overall average office BP values were calculated as the average of six BP measurements obtained during visit 1 and visit 2, for each measurement situation (physician, nurse, self). All office BP values reported (except those noted as "manual") were the systolic and diastolic BP measurements recorded by the automated ambulatory monitor. When reported, "manual" BP refers to office BP measured by the physician or nurse using the standard mercury sphygmometer protocol.

Two participants had missing self BP data. One participant had missing data from visit 1 and the other from visit 2. The data were replaced by the self BP data for the same participants obtained during the office visit in which the data were available.

(2) Office BP Descriptives

Table 2 depicts the average screening BP and the average office BP for the physician, nurse and self.

(3) Ambulatory BP Measurements

Ambulatory data were transferred to an IBM XT/AT/PS2 for data analysis, report printing and archiving, by direct connection of the monitor to a data interface unit and printer. Readings were automatically edited and subsequently deleted by the system if systolic BP was less than 70 mm Hg or greater than 285 mm Hg and, if diastolic BP values were less than 40 mm Hg or greater than 200 mm Hg. Other pre-programmed criteria for automated editing included: technical malfunctions, improper cuff placement or arm position and excessive movement. The mean number of successful readings

Table 2

Summary of Office BP Measurements

	N	Systolic (SD) (mm Hg)		Diastolic (SD) (mm Hg)	
Screening Visit					
Physician Automated	38	149.7	(17.8)	92.4	(15.4)
Physician Manual	62	145.2	(20.5)	91.3	(15.3)
Visit One					
Physician Automated	63	135.2	(20.1)	82.6	(13.8)
Nurse Automated	63	135.4	(19.9)	82.1	(13.4)
Self Automated	62	137.9	(17.7)	86.3	(14.8)
Visit Two					
Physician Automated	63	133.0	(18.7)	81.2	(14.0)
Nurse Automated	63	132.2	(18.1)	80.7	(13.4)
Self Automated	62	134.3	(18.5)	82.9	(13.8)

obtained per participant in the sample was 79, with a standard deviation of 19. This high standard deviation was due to a small number of readings recorded during monitoring by 11 of the 63 participants. These 11 participants only wore the monitor during waking hours. The number of successful readings represents an average of 91% of the readings obtained, with a range between 58% and 100%. The lower range limit is due to two participants in particular, who obtained a low percent of accurate readings (58% and 65%). Inspection of the event code data revealed that one participant had removed the cuff and monitor without turning the monitor off, which resulted in a series of "error"

readings (and therefore increased the ratio of error/valid readings). The other participant experienced technical difficulties (a kinked hose), excessive movement and also had removed the cuff and monitor without turning the monitor off. These erroneous BP readings observed for the above mentioned two participants occurred primarily during the asleep period of monitoring and this data, as discussed below, was not part of the data analyses.

Ambulatory monitoring BP data was categorized as either awake, asleep or 24 hour. Awake ambulatory values were determined using information from each participant's diary. The awake BP was calculated as the mean of all BP measurements recorded during the time in which the participant was awake. Asleep BP represents the mean BP values of those BP measurements recorded during the time in which the participant was asleep. Total, or 24 hour values represent the average of all ambulatory BP measurements recorded during the entire ambulatory monitoring period. The total 24 hour ambulatory monitoring BP values were not used in the data analyses because 11 of the 63 participants did not wear the monitor during their sleeping hours, primarily because of sleep disturbance. Since the loss of these data (approximately 18%) was substantial, relative to the sample size, it was decided to use awake ambulatory values for the main analyses. Mean ambulatory BP values for the entire sample are displayed in Table 3. Average office BP values obtained by the physician, nurse and self are also included in Table 3 for comparison purposes. In general, there was a trend for the sample as a whole to show higher awake ambulatory BP values compared to lower office BP values, regardless of measurement situation (see Table 3).

Table 3

Average Ambulatory and Office BP Measurements

	N	Systolic (SD) (mm Hg)		Diastolic (SD) (mm Hg)	
Ambulatory Monitoring					
Awake	63	138.1	(17.4)	86.6	(12.0)
Asleep	52	119.1	(15.5)	70.0	(10.7)
24 hour	52	128.5	(15.1)	78.0	(10.2)
Clinic					
Physician	63	134.1	(18.9)	81.9	(13.6)
Nurse	63	133.8	(18.4)	81.4	(12.9)
Self	63	136.1	(17.6)	83.9	(12.9)

(4) Response Style

(i) Group Definition

Participants were placed in one of three Response style groups based on the difference between the average of physician systolic BP (visit 1 and 2) and awake ambulatory systolic BP. Individuals who had a difference of less than 0 mm Hg (e.g. physician measured BP greater than awake ambulatory BP) were considered to be *Office responders*. Participants with change scores between 0 mm Hg and 8.6 mm Hg were considered *Non responders*; and, participants with change scores equal to or above 8.7 were considered *Home responders*. The criterion for the Office responders was based on the obvious notion that these individuals show a decrease in BP after they leave the

office. The choice of cutoff for the Non responders and Home responders was somewhat more arbitrary. Given the relatively small sample size (n=63), and the understanding that approximately equal group sizes increases power, it was decided to split the remainder of the sample into these two groups. This cutoff, however, is not unreasonable, given that others who have examined these same three response styles used almost an identical change score of 9 mm Hg and above for Home responders (Gerardi et al, 1985).

Based on the cutoff criterion, the Non responder group comprised participants who had ambulatory BP values higher than office BP values, however, these differences were not of a magnitude which could be considered clinically meaningful for most individuals. Therefore, the label of "Non responders" does not imply an absence of the white coat effect (see earlier discussion in Introduction under terminology), rather it implies a minimal or typical effect. For example, it has been shown that normotensives typically have ambulatory values which are similar to, or slightly higher than their office BP (for review see Zachariah and Krier, 1991). Relatively high ambulatory versus lower office BP was reported in studies which used population-based samples (Pearce et al, 1992). The population-based samples included individuals who had normal BP. The participants in this study cannot be considered a population-derived sample per se since they were selected through advertising. However, they were not excluded if, upon initial screening, their blood pressure was within the normal range. The BP change criterion for the Non responders used in this study therefore is justified as it is considered representative of typical ambulatory-office BP differences seen in a sample which is not selected on the basis of screening for intially high office BP values.

(ii) The White Coat Effect

Table 4 summarizes the mean and standard deviation of the white coat effect (mean physician-ambulatory systolic BP difference) for the three groups of responders.

Table 4

Mean and Standard Deviations of Physician White Coat Effect for the Entire Sample

Group	n	Mean	SD	95% C.I.
Office responder	17	-9.40	4.98	-11.97 to -6.83
Non responder	23	4.31	2.90	3.06 to 5.57
Home responder	23	13.65	4.39	11.76 to 15.5

Three One-Factor Analyses of Variance (ANOVAs) were performed to determine if there were any significant differences between the groups on the demographic variables of age, weight, and height. No significant group differences were observed. Female/male ratios were approximately equal in the Office responders. There was an approximate 2:1 ratio of females/males in the Non responder group and an approximately 1:2 ratio of females/males in the Home responders.

(iii) Office and Ambulatory BP Descriptives

Table 5 displays BP values for both office and ambulatory monitoring reported by response style. There are some apparent trends in the data, such as the "normal" office BP values compared to relatively elevated ambulatory BP values. The Office responders showed a relative decrease in BP between office BP and ambulatory BP, and the Non responders show little relative change between office BP and ambulatory BP values. These trends were not surprising given that Response style group definition was based on the difference between ambulatory monitoring systolic BP and average physician measured systolic BP. The data for diastolic BP followed the same trend as that

Table 5

Average Ambulatory and Office BP by Response Style

BP (mm Hg)	Response Style		
	Office	**Non**	**Home**
Awake Ambulatory BP	n=17	n=23	n=23
Systolic (SD)	135.2 (14.3)	138.9 (16.4)	139.5 (20.6)
Diastolic (SD)	84.2 (12.0)	85.9 (10.7)	89.1 (13.3)
Asleep Ambulatory BP	n=14	n=21	n=17
Systolic (SD)	119.3 (17.6)	120.0 (15.3)	117.6 (14.9)
Diastolic (SD)	70.7 (13.0)	69.6 (9.2)	69.9 (11.0)
24 Hr. Ambulatory BP	n=14	n=21	n=17
Systolic (SD)	127.1 (16.1)	129.3 (15.4)	128.5 (14.7)
Diastolic (SD)	77.1 (12.1)	77.6 (9.7)	79.2 (9.7)
Office Physician BP	n=17	n=23	n=23
Systolic (SD)	144.6 (16.0)	134.6 (17.1)	125.9 (19.3)
Diastolic (SD)	87.3 (14.1)	80.3 (11.9)	79.4 (14.4)
Office Nurse BP	n=17	n=23	n=23
Systolic (SD)	140.9 (15.8)	134.3 (18.6)	128.0 (18.7)
Diastolic (SD)	84.6 (13.9)	80.6 (12.6)	79.8 (12.7)
Office Self BP	n=17	n=23	n=23
Systolic (SD)	142.1 (15.6)	136.4 (16.3)	131.3 (19.4)
Diastolic (SD)	90.4 (14.4)	82.2 (10.5)	82.7 (14.4)

for systolic, however, the office-ambulatory differences in diastolic data were not used for group classification.

(5) BP Diagnostic Categories

(i) Group Definition

When participants were divided into groups based on "Response" styles, the three groups had comparable awake ambulatory BP values (seeTable 5). This similarity was not surprising, since within each of the three response style groups, there were individuals who would have been classified as hypertensive (HT), normotensive (NT), white coat hypertensive (WCHT), and white coat normotensive (WCNT).

The entire sample was divided into the following BP Diagnostic groups: *hypertensives* (both office and wake ambulatory BP $\geq$140 mm Hg); (2) *white coat hypertensives* (physician office BP $\geq$140 mm Hg systolic and/or $\geq$ 90 mm Hg diastolic and awake ambulatory BP $\leq$140/90 mm Hg); (3) *normotensives* (both office and ambulatory awake BP $\leq$ 140/90 mm Hg); and, (4) *white coat normotensives* (office BP $\leq$140/90 mm Hg with ambulatory awake BP $\geq$ 140 mm Hg systolic and/or $\geq$ 90 mm Hg diastolic). The office BP used to define these four BP diagnostic categories was calculated as the average of the last three BP readings taken by the physician which were obtained during office visit 2. This definition of office BP provided a conservative estimate of the incidence of white coat hypertension for this sample, and took into account the effect of habituation. Table 6 shows how the classification of individuals changed from the initial screening visit to office visit 2. Specifically, the number of white coat hypertensives was reduced from 23% (n=14) of the sample to 13% (n=8) of the sample over the course of BP measurement.

Table 6

Change in BP Diagnostic Groups from Screening Visit to Office Visit 2

	HT	WCHT	NT	WCNT
Screening Visit (n=62)	n=24	n=14	n=17	n=7
Office Visit 2 (n=63)	n=19	n=8	n=26	n=10

HT=hypertensive, WCHT=white coat hypertensive, NT=normotensive, WCNT= white coat normotensive

Table 7

Office and Awake Ambulatory BP by BP Diagnostic Groups

	HT n=19	WCHT n=8	NT n=26	WCNT n=10
Office BP				
Systolic (SD)	150.8 (14.2)	144.7 (5.2)	117.8 (12.2)	129.4 (7.7)
Diastolic (SD)	94.8 (11.6)	86.3 (6.7)	70.3 (9.4)	79.5 (6.1)
Ambulatory BP				
Systolic (SD)	155.9 (15.1)	132.4 (5.1)	124.2 (8.8)	145.2 (9.2)
Diastolic (SD)	98.1 (11.2)	80.4 (7.1)	78.0 (6.8)	92.2 (3.6)

HT=hypertensive, WCHT=white coat hypertensive, NT=normotensive, WCNT= white coat normotensive

(ii) Office and Ambulatory BP Descriptives

Table 7 depicts the office and awake ambulatory BP values for the BP Diagnostic groups described above (hypertensives, white coat hypertensives, normotensives and white coat normotensives). It is evident, that within this sample, individuals presented to the clinic with a wide range of BP values, and discrepancies between their office and ambulatory BP.

(6) Assumptions

Tests of the general assumptions for both univariate and multivariate data were performed according to procedures outlined in Tabachnick and Fidell (1989) and Stevens (1992). Where violations of assumptions occurred, they have been discussed in the applicable sections below.

B. Methodological Factors and the White Coat Effect

(1) Comparison of Situationally Determined White Coat Effect

(i) Entire Sample

The white coat effect (WCE), defined as difference between average office BP and awake ambulatory BP, was calculated for all three measurement situations (physician, nurse and self). Two one way repeated measures ANOVAs were performed, one for systolic BP and one for diastolic BP. For both, the within subjects factor was the BP measurement situation with three levels (physician, nurse and self). A significant effect of measurement situation was found for systolic WCE, $F(2,124) = 4.30$, $p=.017$, and diastolic WCE, $F(2,124) = 8.85$, $p<.0001$. Since the hypothesis that self BP would result in a lower WCE was stated aprior, the T-tests were planned and alpha remained at $p<.05$ (see Table 8). For the entire sample, the absence of a health care professional resulted in a smaller WCE. For both systolic and diastolic BP, self BP more closely approximated ambulatory BP values than either physician or nurse BP values. Figure 1

shows the magnitude of the WCE for systolic and diastolic BP measurements for the entire sample.

Table 8

Comparisons of the WCE between Measurement Situations for the Entire Sample

WCE (mm Hg)	N	Mean Difference	t	df	p
Systolic WCE					
Physician vs. Nurse	63	0.31	0.39	62	.70
Physician vs. Self	63	-1.96	-2.51	62	.015*
Self vs. Nurse	63	-2.28	-2.45	62	.017*
Diastolic WCE					
Physician vs. Nurse	63	0.50	0.77	62	.45
Physician vs. Self	63	-2.20	-3.42	62	.001*
Self vs. Nurse	63	-2.70	-3.63	62	.001*

* $p < .05$

(ii) Response Style

A 3 (group) by 3 (levels of the repeated measures) ANOVA was performed with measurement situation as the repeated factor (physician, nurse and self) and grouping factor was Response style (Home, Office, Non). Significance level was set at $p < .05$. P values were adjusted using the Greenhouse-Geisser epsilon to correct for deviations from sphericity. The main effect of Response style was highly significant ($F(2,60) = 78.3$, $p < .0001$). On the average, the Home responders and Office responders showed a larger magnitude of the white coat effect (Home=11.2 mm Hg, Clinic = -7.35 mm Hg)

compared to the Non responders (3.8 mm Hg). The main effect of measurement situation was also significant, F (2,120) = 82.0, p=.004, for the entire sample. This effect was described in the section above (B(1)). Importantly, the interaction between measurement situation and Response style was significant (F(4,120) = 4.01, p=.006).

In order to explore the relationship between physician, nurse and self WCE, within Response style groups, separate repeated measures ANOVAs were performed for each Response style group. The within factor was measurement situation. For the Office responders, no significant effect of measurement situation was observed (F(2,32) = 1.96, p=.17). For this group of Office responders, the WCE was not statistically reduced in the absence of a health care professional (see Table 9). The group of Non responders also demonstrated no significant difference between size of the WCE across measurement situations (F(2,44) = 1.9, p=.17). In contrast, only the Home responders showed a reduction in the WCE in the absence of a health care professional. The main effect of measurement situation was highly significant (F(2,44) = 9.32, p=.0006). Post-hoc Tukey's HSD comparisons were done to compare differences between measurement situations for the Home responders. Self BP produced a significantly smaller WCE than that observed for either physician or nurse BP; and, physician and nurse WCE did not differ from each other. It appeared that the differential white coat effect seen in the entire sample, where self WCE is significantly lower than either physician or nurse, was primarily a result of the response pattern seen in the Home responders. Figure 2 provides a graphical representation of the mean WCE across measurement situations by Response style groups.

Table 9

Magnitude of the White Coat Effect by Response Style across Measurement Situations

	WCE (SD) mm Hg		
	Physician	**Nurse**	**Self**
Office responder	-9.40 (5.0)	-5.76 (8.1)	-6.89 (9.3)
Non responder	4.31 (2.9)	4.54 (5.7)	2.50 (4.4)
Home responder	13.65 (4.7)	11.60 (7.4)	8.32 (4.7)

Please note that the data presented in Table 9 were not presented for the purposes of comparing the magnitude of the physician white coat effect *across* groups since this was the variable upon which groups were defined. The data was presented to allow comparisons *within* Response style groups since it was not necessarily true that nurse WCE or the self WCE would be equivalent to the physician WCE for the Office, Home or Non responders.

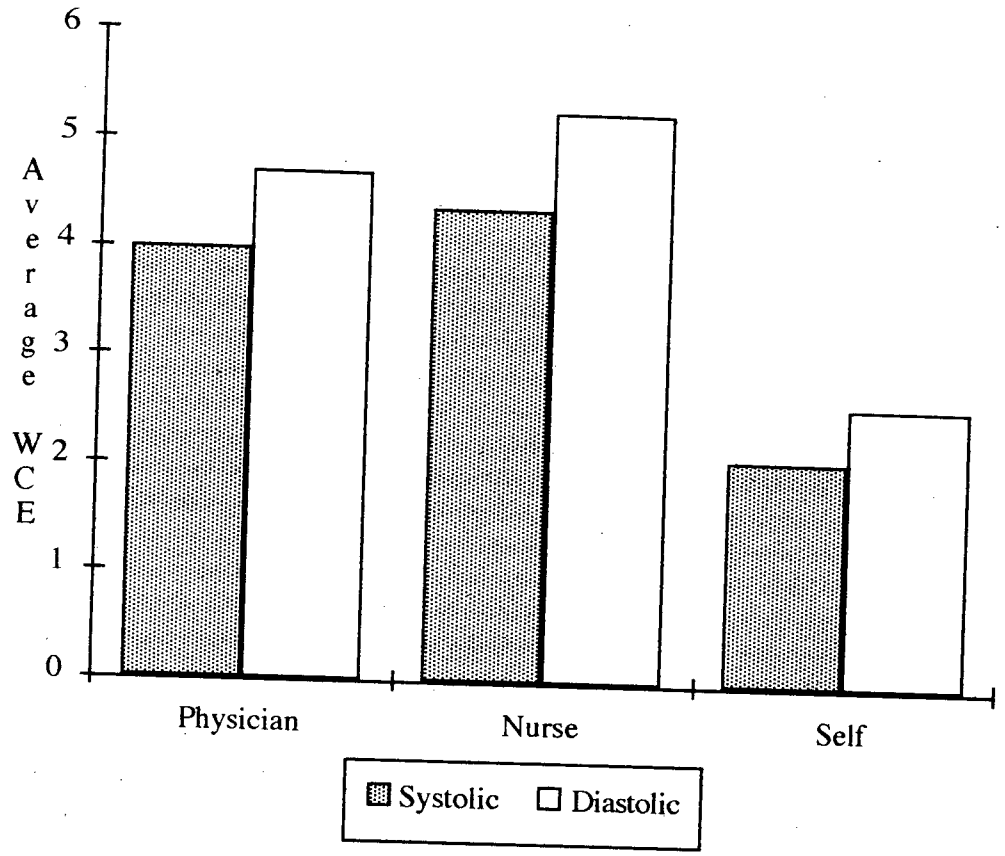

Figure 1

Magnitude of the Average White Coat Effect (mm Hg) across Measurement Situations for the Entire Sample.

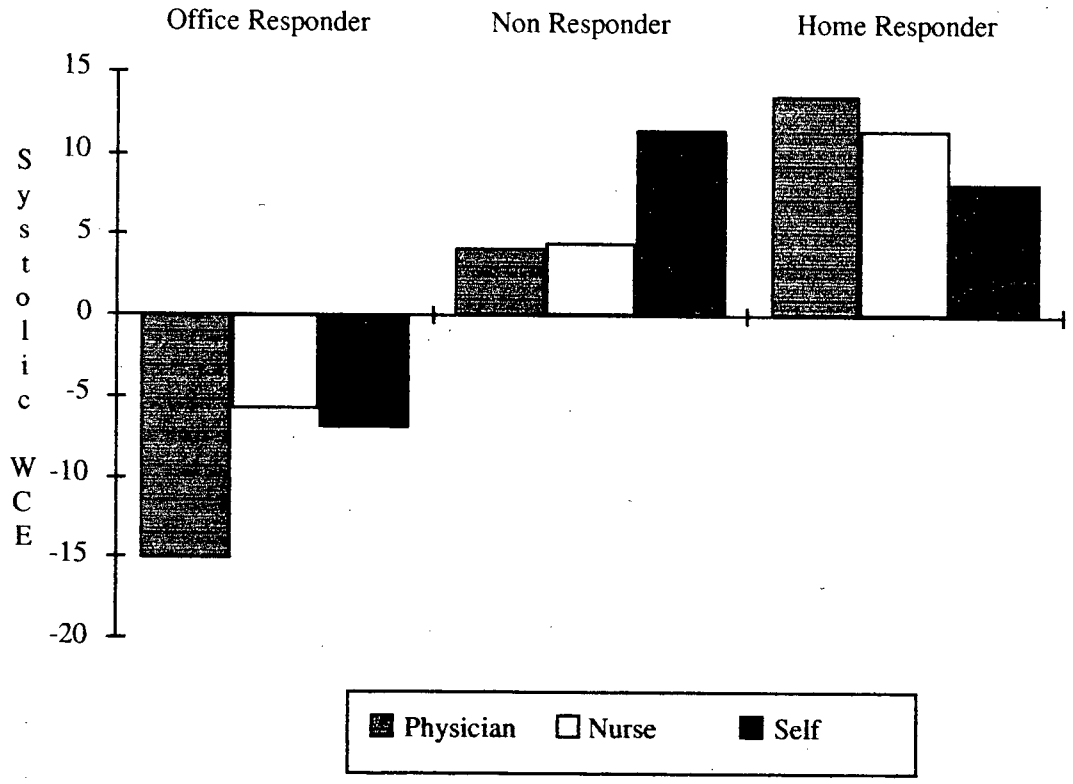

Figure 2

Magnitude of the Average Systolic White Coat Effect (mm Hg) across Measurement Situations by Response Style Groups.

(iii) BP Diagnostic Groups

Figure 3 depicts the means and standard deviations of the systolic WCE for all four BP diagnostic groups (hypertensives, white coat hypertensives, normotensives, white coat normotensives). A 4 (group) by 3 (levels of the repeated measure) ANOVA was performed on the magnitude of the white coat effect. Grouping factor was BP diagnostic status (HT, WCHT, NT, WCNT), within factor was measurement situation (physician, nurse, self). The significance level was set at $p < .05$, and P values were adjusted using Greenhouse-Geisser epsilon to correct for heterogeneity of covariance. The main effect of BP diagnostic group was highly significant ($F(3,59) = 11.8$, $p = .0001$).

On the average, the magnitude of the WCE was lower for both hypertensives (3.7 mm Hg) and normotensives (4.3 mm Hg) compared to WCE values for the white coat hypertensives (-8.8 mm Hg) and the white coat normotensives (10.7 mm Hg). As discussed above, the direction of the WCE was different between WCHTs and the WCNTs as anticipated, based upon the original BP cutoff grouping criteria. No significant interaction between measurement situation and BP diagnostic status was found ($F(6, 118) = .97$, $p=.45$).

Although the interaction was not significant, it was decided to pursue an exploratory investigation of the relationship between levels of physician, nurse and self WCE between the four BP diagnostic groups. Separate repeated measures ANOVAs were performed, one for each BP diagnostic category. No significant effect of measurement situation was observed for the hypertensives ($F(2,32) = .06$, $p=.95$) or for the white coat hypertensives ($F(2,14) = .79$, $p=.47$). Therefore, for the individuals who had high office BP, the magnitude of the WCE was similar across measurement situations. In contrast, a significant main effect for measurement situation was found for the normotensive group ($F(2,50) = 4.4$, $p=.02$), and for the white coat normotensive group ($F(2,18) = 4.5$, $p=.03$). Post-hoc Tukey's comparisons were performed. The results indicated that for the two BP diagnostic groups who presented with normal office BP values, the WCE for the self BP was significantly smaller than the WCE observed for either physician or nurse BP. The physician and nurse WCE did not differ from each other.

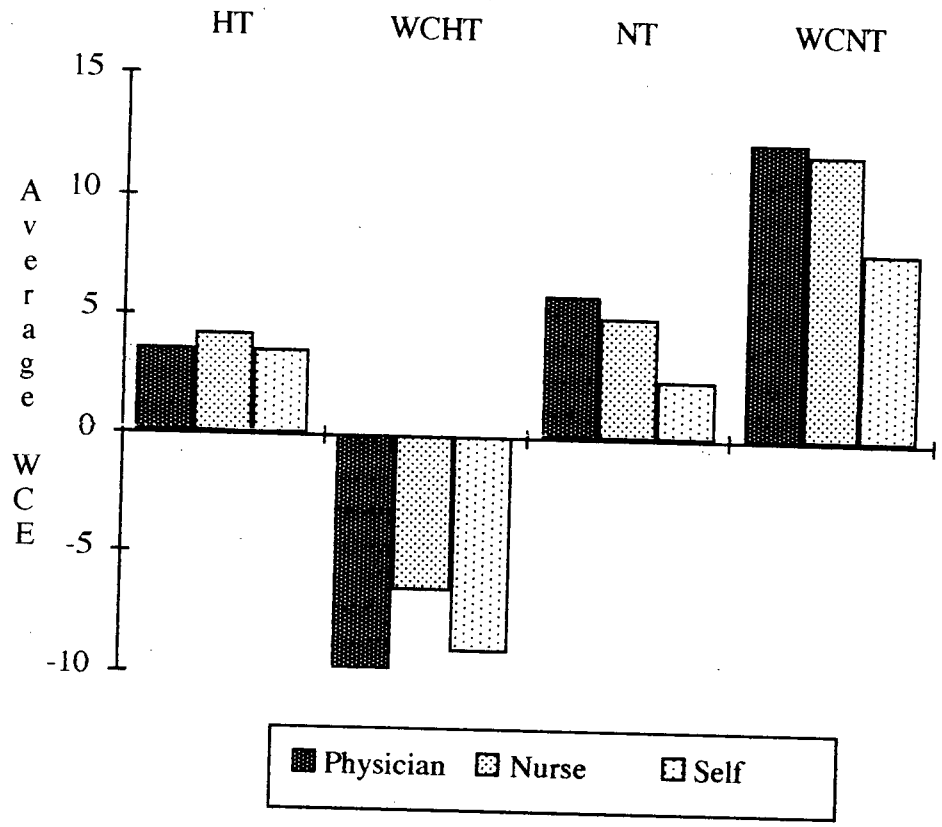

Figure 3

Magnitude of the Average White Coat Effect (mm Hg) across Measurement Situations for the BP Diagnostic Groups.

(2) Office BP Prediction of Awake Ambulatory Monitoring BP

(i) Entire Sample Correlations between Office and Ambulatory Monitoring BP values

Table 10 shows the correlations between office BP, measured in all three situations, and awake ambulatory monitoring. It is quite clear that the office BP values, across all three situations, were highly correlated with ambulatory BP values. There were no significant differences between the office-ambulatory correlations for the three measurement situations.

Table 10

Correlations between Ambulatory Awake BP and Office BP (mm Hg)

	Office BP values (mm Hg)		
Ambulatory BP	**Physician**	**Nurse**	**Self**
Systolic	.85	. 85	.88
Diastolic	.83	.84	.86

In an attempt to appreciate the effect of repeated measurements over time, Table 11 shows the correlations between office BP values and awake ambulatory monitoring BP values as they changed from the initial screening visit to the final office visit 2. As can be seen, the correlation between ambulatory and office BP, at least for the physician, improved from the screening visit to office visit 1. It should be noted as well, that BP measurements taken by the physician during visit 1 were equivalent to BP readings taken by the nurse and the participant themselves during visit 2. This was because it would have been the second exposure to the physician measurement situation. This comparison was confounded, however, by the ambulatory monitoring procedures which occurred prior to the second self and nurse measurement situation, and which did not occur between the screening visit and office visit 1 for physician BP.

Table 11

Correlations between Ambulatory Awake BP and Office BP (mm Hg) from Screening Visit to Office Visit 2

		Office BP values (mm Hg)		
	N	**Physician**	**Nurse**	**Self**
Screening Visit	38			
Systolic		.66		
Diastolic		.78		
Office Visit 1	63			
Systolic		.86	.79	.83
Diastolic		.85	.80	.82
Office Visit 2	63			
Systolic		.81	.84	.88
Diastolic		.78	.72	.84

(ii) Response Style Correlations between Clinic and Ambulatory Monitoring BP values

Table 12 shows the correlations between awake ambulatory BP and office BP for the three Response style groups. T-tests for independent correlations were performed to determine if there were any group differences in their correlation between office and ambulatory BP within each measurement situation. No two groups differed from each other in any of the measurement situations.

Table 12

Correlations between Ambulatory awake BP and Office BP (mm Hg) by Response Style Groups

		Office BP values (mm Hg)		
Ambulatory BP	**N**	**Physician**	**Nurse**	**Self**
Office Responders	17			
Systolic		.95	.86	.81
Diastolic		.92	.88	.91
Non Responders	23			
Systolic		.99	.95	.96
Diastolic		.87	.89	.88
Home Responders	23			
Systolic		.98	.93	.97
Diastolic		.92	.89	.94

(ii) BP Diagnostic Category Correlations between Office and Ambulatory Monitoring BP Values

Table 13 shows the correlations between office and ambulatory BP for the four BP diagnostic groups. Similar to the results reported for the Response style groups, no significant differences in the correlations were found within each measurement situation for the BP Diagnostic groups. There was a distinct pattern, however, in which the white coat hypertensives show low systolic BP correlations between office and ambulatory measures, and the Home responders showed low, negative diastolic BP correlations between office and ambulatory BP.

Table 13

Correlations between Awake Ambulatory and Office BP (mm Hg) by BP Diagnostic Groups

		Office BP values (mm Hg)		
Ambulatory BP	**N**	**Physician**	**Nurse**	**Self**
Hypertensives	19			
Systolic		.74	.74	.81
Diastolic		.84	.78	.84
WC Hypertensives	8			
Systolic		.32	.11	.25
Diastolic		.49	.68	.81
Normotensives	26			
Systolic		.83	.81	.85
Diastolic		.79	.84	.71
WC Normotensives	10			
Systolic		.90	.80	.80
Diastolic		-.33	-.12	-.08

(C) Psychological Factors and the White Coat Effect

(1) Habituation of Office BP measurement and Desensitization to Wearing the Ambulatory Monitor

Table 14 shows the mean difference between systolic BP from the initial screening visit to visit 1. The BP measurements for both the screening visit and visit 1 are those obtained by the physician using the mercury sphygmomanometer (because of the missing data for automated measures during the screening visit). Dependent paired T-tests were performed for each group to determine if the systolic BP measurements changed from screening visit to office visit 1. A Bonferroni adjustment was done to reduce Type I error, with significance determined to be $p=.016$ (.05/3). Only the Non responder group showed significant habituation. Members of this group would have been classified as hypertensive during the screening visit, however, upon their second set of BP measurements (visit 1), their BP values fell within the normotensive range. Office responders did not show significant BP habituation and remained classified as hypertensive at office visit 1. Home responders, like Office responders, showed no significant BP habituation and their classification as normotensive was consistent across office visits.

Table 15 shows the mean differences in systolic BP between office visit 1 and visit 2 for physician, nurse and self measured BP. All of the BP values reported were those obtained using the automated ambulatory monitor. T-tests for dependent pairs were performed within each measurement situation (physician, nurse, self) and a Bonferroni adjustment was done to reduce Type 1 error within each measurement situation. Significant p values were determined to be .016 (.05/3). During office visit 2, which was the equivalent of the third time participants had their BP measured by the physician, none of the three groups showed any significant habituation from office visit 1. The Office responders would remain, at visit 2, classified as hypertensives, and both

the Non responders and Home responders would continue to be classified as normotensives.

Table 14

Habituation of Systolic BP between Screening Visit and Office Visit 1

Response Style	Systolic BP PHYSICIAN (manual) Screen	Visit 1	Mean Difference.	t	df	p
Office	154.7	148.5	6.2	2.26	15	.04
Non	145.7	136.0	9.7	3.66	22	.001*
Home	138.1	131.2	6.9	2.07	22	.05

*Significant using Bonferroni correction, alpha=.05/3 = .016

Between office visit 1 and 2, only the Office responders showed significant habituation when BP was measured by either nurse or self. During visit 1, the Office responders would have been classified as hypertensives, yet by visit 2 they habituated to nurse and self measured BP to the extent they would have been classified as normotensives. These results ruled out the hypothesis that desensitization to the BP measurement process (via repeated measures with the ambulatory monitoring) occurred for the Office responders. Habituation across all three measurement situations was not observed. As the results indicated, the Office responders showed no significant habituation in response to physician measured BP. However, the results did indicate that there was a differential effect of habituation between the measurement situations for the Office responders such that both nurse and self BP habituated to a larger degree (even with one less exposure to the measurement situation) than for the physician. This

differential pattern of habituation was clinically significant as it represented a change in diagnostic categories from hypertensive to normotensive for both the nurse and self BP situations.

Office responders showed a differential pattern of habituation compared to Non responders and Home responders. These results were based upon relative changes within each group. In order to assess the absolute degree of BP change (e.g. reactivity) between the groups, four one factor ANOVAs were conducted. The ANOVAs examined absolute values of BP change for each group. Between screening visit and office visit 1, no significant differences were found between the groups in terms of the degree of habituation ($F(2,60)=.38$, $p=.69$). Between office visit 1 and office visit 2 no significant differences in the level of habituation were observed for physician BP ($F(2,60)=.21$, $p=.81$) nurse BP ($F(2,60)=1.7$, $p=.19$), or self BP ($F(2,60)=.58$, $p=.57$). The hypothesis that Office responders would show a greater degree of habituation, in terms of absolute value of BP change, was not supported. In summary, Office responders demonstrated a significantly different pattern or BP habituation, however, their absolute BP reactivity was not significantly different from physician or nurse reactivity.

(2) Situational State Anxiety

(i) Response Style

In order to test the hypothesis that the response style groups would experience different levels of state anxiety, a repeated measures ANOVA was conducted. Response style was the grouping factor (Office, Non and Home), and state anxiety (measured by the STAI) was the dependent variable assessed within the four measurement situations (physician, nurse, self and ambulatory monitoring). State anxiety was calculated as the average of the STAI scores obtained during office visit 1 and 2 for each measurement situation. Ambulatory monitoring state anxiety scores were obtained by asking participants to complete the questionnaire immediately prior to an automated BP

Table 15

Habituation of Systolic BP between Office Visit 1 and 2 for Physician, Nurse and Self Measurement Situations

Response Style	Systolic BP Visit 1	Visit 2	PHYSICIAN (automated) Mean Difference.	t	df	p
Office	145.8	143.4	2.4	1.49	16	.16
Non	135.2	133.9	1.3	0.74	22	.47
Home	127.4	124.4	3.0	1.48	22	.15
Response Style	**Systolic BP Visit 1**	**Visit 2**	**NURSE (automated) Mean Difference.**	**t**	**df**	**p**
Office	144.3	137.5	6.8	3.96	16	.001*
Non	135.3	133.3	2.0	1.01	22	.32
Home	128.8	127.1	1.8	0.76	22	.46
Response Style	**Systolic BP Visit 1**	**Visit 2**	**SELF (automated) Mean Difference.**	**t**	**df**	**p**
Office	144.7	139.4	5.4	3.08	16	.007*
Non	136.7	135.2	2.4	1.41	22	.17
Home	133.1	129.5	3.6	1.67	22	.11

*Significant using Bonferroni correction, alpha=.05/3 = .016

recording. Of the original 63 cases, one case was dropped from the analysis on the basis of being a total sample outlier (+4 SD).

The main effect of group was significant, $F(2,59) = 6.97$, $p=.002$, indicating group differences in state anxiety were present when scores were collapsed across the four measurement situations. Post-hoc Tukey's HSD comparisons were performed to determine the nature of the group differences. The Office responders reported significantly higher levels of state anxiety across all four measurement situations (STAI=49.9) compared to both the Non responders (STAI=42.1) and Home responders (STAI=43.8). No significant effect of measurement situation was found ($F(3,177) = .29$, $p=.83$) suggesting that overall levels of state anxiety did not differ across measurement situations. A significant interaction was not observed ($F(6,177) = 1.57$, $p=.16$).

Following a strictly statistical approach, the non significant interaction would typically preclude analyses of between group differences within the four measurement situations. However, an exploratory analysis was undertaken based on the previous knowledge that Office responders (or white coat hypertensives) have not been shown to differ with respect to state anxiety outside of the office setting (see Introduction). Three of the four measurement situations, in which state anxiety was assessed, occurred within the office setting, and the fourth occurred outside of the office setting during ambulatory monitoring. Univariate analyses were performed following the repeated measures ANOVA to assess these within measurement situation group differences. Table 16 summarizes the F statistics for the four situations in which state anxiety was measured prior to BP. The results in Table 16 indicate that within the office setting, prior to physician, nurse and self measured BP, the level of state anxiety was significantly different between groups. Outside of the office setting, however, the groups are not differentiated in terms of their degree of state anxiety.

Table 16

Source table for ANOVAs Comparing State Anxiety within Measurement Situation by Response Style Groups

Source State Anxiety (STAI)	df	MS	F	p
Office Physician BP	2,59	360.41	7.86	.001*
Office Nurse BP	2,59	289.24	6.76	.002*
Office Self BP	2,59	403.14	12.01	.000*
Ambulatory BP	2,59	178.30	2.0	.144

*Significant at p.<.05

Table 17 provides a summary of the between group Bonferroni corrected T-tests for each BP measurement situation. Based on the moderate departure from sphericity (Greenhouse-Geisser epsilon=.56) observed in the repeated measures analysis, a Tukey's post-hoc procedure would have produced an inflated Type I error for the multiple comparisons (Stevens, 1992). A Bonferroni T statistic therefore was employed to examine the mean group differences between response style and state anxiety within the four BP measurement situations. The Bonferonni correction resulted in an adjusted p value of .004 for significance at alpha=.05.

Post-hoc analyses indicated a clear pattern of different levels of state anxiety reported by the three groups. Within the office, prior to BP measurements, the Office responders (white-coat response) reported a significantly higher level of anxiety (50.0) than Home (41.5) responders; and, a trend for this difference when compared with the Non responders (44.0). State anxiety prior to nurse BP followed the same pattern as that seen for anxiety reported prior to physician BP. Office responders reported a significantly

Table 17

Post-Hoc Response Style Group comparisons of State Levels of Anxiety Related to BP Measurement Situation

Group comparisons of STAI scores by Mesurement Situation	**t**	**df**	**p**
State Anxiety prior to Physician BP			
Office vs. Non-Responders	4.10	37	.000*
Office vs. Home Responders	2.44	38	.020
Home vs. Non-Responders	-1.31	43	.20
State Anxiety prior to Nurse BP			
Office vs. Non-Responders	3.96	37	.000*
Office vs. Home Responders	2.21	38	.030
Home vs. Non-Responders	-1.39	43	.170
State Anxiety prior to Self BP			
Office vs. Non-Responders	4.90	37	.000*
Office vs. Home Responders	3.33	38	.002*
Home vs. Non-Responders	-0.96	43	.350
State Anxiety prior to Ambulatory BP			
Office vs. Non-Responders	1.65	37	.110
Office vs. Home Responders	1.66	38	.070
Home vs. Non-Responders	0.04	43	.750

*Significant using Bonferroni correction, alpha=.05/12=.004

higher level of state anxiety prior to nurse BP (49.8) compared to the Non responders (42.1), but not when compared to the Home responders (44.7). Only for self BP did the Office responders endorse a significantly higher level of state anxiety (50.6) compared to both the Non responders (41.9) and Home responders (43.4). Across all of the BP measurement situations, the level of state anxiety for the Non responders and Home responders was equivalent.

Outside of the medical setting, during ambulatory monitoring, the three groups were not differentiated in terms of the level of state anxiety experienced prior to ambulatory BP measurements (Office (48.4), Non (43.6) and Home (42.7)).

(ii) BP Diagnostic Groups

Unlike the differential pattern of self-reported state anxiety seen between the Response style groups, different levels of state anxiety preceding office BP measurements were not observed between BP Diagnostic groups. There was a trend in the data which revealed that white coat hypertensives reporteded higher levels of state anxiety. However, a repeated measures ANOVA was performed, and the results indicated there was no significant main effect for measurement situation ($F3,174=.25$, $p=.86$) or group factor ($F(3,58)=2.61$, $p=.06$) on the dependent variable of state anxiety.

(3) Habituation of State Anxiety

Table 18 shows the mean difference between state anxiety reported immediately prior to BP measurements taken by the physician during the screening visit, and subsequent office visit 1. Dependent paired T-tests were performed for each response style to determine if subjective state anxiety differed from the screening visit to office visit 1. A Bonferroni adjustment was done to reduce Type I error, with significance determined to be $p=.016$ (.05/3). Only the Home responder group showed a statistically significant reduction in subjective anxiety prior to BP mesurements. Office and Non

responders did not show any significant habituation of state anxiety related to BP measurements.

Table 19 shows the mean differences in subjective state anxiety reported prior to BP measurements taken during office visit 1 and visit 2 for physician, nurse and self measured BP. T-tests for dependent pairs were performed within each measurement situation (physician, nurse, self) and a Bonferroni adjustment was done to reduce Type 1 error within each

Table 18

Habituation of State Anxiety between Screening Visit and Office Visit 1

Response Style	**STAI scores prior to Screen**	**PHYSICIAN BP Visit 1**	**Mean Diff.**	**t**	**df**	**p**
Office	51.2	52.3	-1.06	-0.58	16	.57
Non	45.2	42.7	2.8	1.96	21	.06
Home	50.7	44.7	6.0	4.40	22	.00*

*Significant using Bonferroni correction, alpha=.05/3 = .016

measurement situation. Significant p values were determined to be .016 (.05/3). As can be seen from the results presented in Table 19, none of the response style groups demonstrated any significant habituation of state anxiety between office visit 1 and office visit 2 in response to BP measurements taken by the physician, nurse, or the participants themselves.

In summary, for both the Office and Non responders, levels of state anxiety did not habituate over time within any of the three measurement situations. For the Office

responders state anxiety was high across measurement situations. For the Non responders, who demonstrated significantly lower state anxiety than the Office responders, their lower subjective experience of anxiety also remained stable across office visits and measurement situations. In the case of the Non responders, their consistent low level of subjective state anxiety did not correspond with the pattern of BP habituation (see above discussion). From screening visit to office visit 1 the Non responders did show a significant habituation (e.g. BP lowered from screening visit to visit 1) despite no change in the state anxiety they experienced. The Home responders also showed a discrepant pattern of BP habituation versus anxiety habituation. From screening visit to office visit 1 the Home responders showed a marked reduction in subjective anxiety, yet no corresponding reduction in BP was seen. The Office responders presented with a parallel pattern of BP-anxiety habituation. That is, BP levels and state anxiety remained relatively high across all measurement situations and office visits.

(4) The Role of Distorted Cognitions and Disturbing Physical Symptoms

(i) Response Style

Immediately after participants had their office BP measured, they were asked to endorse their experiences, if any, of disturbing physical sensations and distorted cognitions. They were asked whether these events occurred (if at all) prior to, during, or after their BP was taken. The total number of disturbing physical symptoms endorsed across all three measurement situations was calculated and defined as a "symptoms" variable. The number of distorted cognitions was also added across all three measurement situations and defined as a "cognitions" variable. Two separate one way ANOVAs were performed with symptoms and cognitions as the dependent variables and response style as the

Table 19

Habituation of State Anxiety between Office Visit 1 and 2

for Physician, Nurse and Self Measurement Situations

Response Style	STAI scores prior to PHYSICIAN BP Visit 1	Visit 2	Mean Difference.	t	df	p
Office	52.3	47.8	4.4	2.18	16	.04
Non	42.4	40.6	1.7	1.56	21	.13
Home	44.7	43.2	1.5	1.65	22	.11
Response Style	**STAI scores prior to NURSE BP Visit 1**	**Visit 2**	**Mean Difference.**	**t**	**df**	**p**
Office	51.2	48.4	2.8	2.13	16	.05
Non	42.4	41.8	.55	0.66	21	.52
Home	44.7	44.3	.87	0.56	22	.58
Response Style	**STAI scores prior to SELF BP Visit 1**	**Visit 2**	**Mean Difference.**	**t**	**df**	**p**
Office	52.3	48.9	3.4	1.74	16	.10
Non	42.2	41.5	.73	0.67	21	.51
Home	44.1	42.6	5.1	1.40	22	.18

*Significant using Bonferroni correction, alpha=.05/3 = .016

grouping factor. The three groups did not differ with respect to the number of disturbing physical symptoms ($F(2,62) = .24$, $p=.79$) experienced, or the number of distorted cognitions ($F(2,62)=.46$, $p=.63$) reported. Means and standard deviations for both symptoms and cognitions are reported in Table 20.

(ii) BP Diagnostic Classification

The four BP diagnostic groups were also compared with respect to their experiences of disturbing physical sensations or cognitions. Two one way ANOVAs were performed to assess group differences. The four diagnostic groups did not differ with respect to number of physical symptoms experienced ($F(3,62)=.02$, $p=.99$), or disturbing cognitions reported ($F(2,62)=1.34$, $p=.27$). The group mean values and standard deviations for these two variable can be seen in Table 20. The white coat hypertensives showed a trend of reporting a larger number of distorted cognitions compared to the other three diagnostic groups.

Four paired T-tests were performed to determine if there was a differential pattern, within groups, between the reporting of physical symptoms versus cognitions. With a Bonferroni correction, a significant difference required $p < .013$. The Office responders showed no significant difference between the number of symptom reports and the number of cognitions (mean difference 0.75, $t=.40$, $p=.70$). This was in contrast to the normotensives who clearly reported a lower number of distorted cognitions compared to physical symptoms (mean difference = 4.50, $t= 6.6$, $p<.001$). The mean difference between reports of physical symptoms and cognitions was also large for both hypertensives (3.95, $t=2.45$. $p=.025$) and white coat normotensives (5.20, $t=1.84$, $p=.10$), however these differences were not statistically significant.

Table 20

Means and Standard Deviations for Distorted Cognitions and Disturbing Physical Symptoms

Group	Cognitions (SD)	Symptoms (SD)
Office Responder	4.2 (5.8)	8.6 (7.2)
Non Responder	3.2 (3.6)	7.8 (5.3)
Home Responder	3.7 (5.0)	6.8 (5.6)
Hypertensives	3.5 (4.9)	7.5 (6.5)
White Coat Hypertensives	6.6 (6.6)	7.4 (5.3)
Normotensives	3.3 (4.2)	7.8 (4.3)
White Coat Normotensives	2.4 (3.7)	7.6 (9.2)

(5) Trait Psychological Indices

(i) Response Style

To explore the nature of group differences with respect to trait psychological variables, four individual MANOVAs were performed. Since there was a disproportionately large number of psychological variables compared to the number of participants, the psychological variables were grouped for purposes of statistical analyses, as follows: (1) Anxiety: STAI-Trait, CSAQ-Som and CSAQ-Cog., (2) Anger: IN, OUT and CON factors of the SAES, (3) Health Control: PICS, and the three factors of the MHLC (IHLC, POLC, CHLC), and, (4) Coping Styles: SD and OD of the BIDR and the TAS. The results of these four analyses are easily summarized -- no trait psychological variable was able to discriminate between the three response style groups. The F values

and significance levels for the four MANOVAs were: $F(6,100)=.25$, $p=.99$ for measures of anxiety; $F(6,108)=.11$, $p=.99$ for anger expression; $F(8,94)=.44$, $p=.90$ for measures of health control; and $F(6,110)=.94$, $p=.75$ for coping style indices. Table 21 shows the mean group scores for all of the trait psychological indices. In summary, none of the multivariate analyses were significant, and as can be seen in Table 21, the three groups produced remarkably similar scores for each of the psychological indices studied.

(ii) BP Diagnostic Groups

To parallel the investigation of trait psychological Response style group differences, four similar MANOVAs were conducted for BP Diagnostic groups. The results of these analyses were consistent with the results reported for response style groups. No trait psychological variable was able to discriminate between the four BP diagnostic groups. The F values and significance levels for the four MANOVAs were: $F(9,132)=.98$, $p=.46$ for measures of anxiety; $F(9,129)=1.15$, $p=.33$ for anger expression; $F(9,122)=.88$, $p=.57$ for measures of health control; and $F(9,132)=1.53$, $p=.14$ for coping style indices. Table 22 shows the group means and standard deviations for the trait psychological indices.

(iii) Alexithymia

No group differences (Response style or BP diagnostic) were found in terms of alexithymic traits. There was a trend, however, for participants who had "high" office BP values (e.g. the white coat hypertensives and true hypertensives) to endorse higher levels of alexithymic traits compared to individuals who had normal office BP values (normotensives and white coat normotensives). As a secondary goal, the relationship between physiological and psychological stress was explored. The entire sample was divided into terciles according to TAS scores. Table 23 shows the demographic information for the low, moderate and high alexithymic groups.

Table 21

Mean Scores of Trait Psychological Indices by Response Style Groups

Psychological Measure	Response Style		
	Office	Non	Home
Anxiety			
STAI-Trait	52.3 (10.1)	51.8 (7.9)	52.7 (11.2)
CSAQ-Cog.	16.4 (4.5)	15.3 (6.0)	16.5 (5.4)
CSAQ-Som	16.4 (4.6)	15.6 (5.9)	25.6 (5.4)
Anger			
IN	15.8 (3.0)	16.2 (5.8)	16.1 (4.0)
OUT	15.1 (3.7)	15.6 (4.9)	15.5 (3.9)
CON	14.1 (4.6)	23.3 (5.8)	22.7 (5.8)
Health Control			
PICS	5.5 (3.0)	5.6 (2.7)	6.7 (3.2)
IHLC	25.8 (3.7)	26.9 (4.8)	27.8 (4.7)
POLC	14.7 (5.2)	14.7 (6.7)	15.1 (5.1)
CHLC	15.7 (3.1)	16.4 (6.2)	16.5 (5.2)
Coping Style			
BIDR-OD	11.4 (3.9)	12.2 (5.9)	10.2 (3.5)
BIDR-SD	9.9 (3.1)	10.1 (3.8)	9.2 (3.5)
TAS	61.1 (11.2)	62.5 (12.0)	59.8 (10.0)

Table 22

Mean Scores of Trait Psychological Indices by BP Diagnostic Category Groups

Psychological Measure	BP Diagnostic Groups HT	WCHT	NT	WCNT
Anxiety				
STAI-Trait	52.5 (10.3)	56.4 (10.4)	50.3 (10.0)	49.4 (10.6)
CSAQ-Cog.	14.9 (4.4)	19.8 (5.4)	15.8 (5.5)	16.4 (4.7)
CSAQ-Som	15.4 (5.2)	16.8 (5.4)	16.7 (16.1)	15.1 (5.6)
Anger				
IN	17.2 (4.3)	18.8 (4.7)	15.0 (4.4)	13.9 (2.9)
OUT	14.9 (4.3)	16.6 (4.0)	15.2 (4.3)	16.0 (4.0)
CON	23.4 (5.5)	21.0 (4.1)	24.3 (5.7)	22.5 (5.6)
Health Control				
PICS	6.4 (3.8)	3.8 (2.0)	6.2 (2.1)	6.0 (3.4)
IHLC	25.9 (4.2)	26.0 (5.2)	28.0 (3.8)	27.1 (6.7)
POLC	16.5 (5.4)	13.5 (2.7)	13.7 (6.5)	15.8 (3.8)
CHLC	16.8 (6.1)	14.3 (3.8)	16.4 (5.0)	16.0 (3.9)
Coping Style				
BIDR-OD	10.6 (4.7)	9.9 (5.6)	12.7 (4.1)	9.3 (3.8)
BIDR-SD	9.6 (2.9)	8.3 (3.6)	10.5 (3.8)	9.7 (3.4)
TAS	65.5 (10.6)	66.6 (8.3)	58.0 (11.2)	57.6 (9.7)

Table 23

Demographic Information by TAS Groups

TAS Range	Total (n)	Female (n)	Male (n)	Mean Age (± SD)
LOW (37 - 56)	19	11	8	49.6 ± 15.2
MOD (57 - 54)	20	6	13	53.6 ± 10.5
HIGH (65 - 85)	22	10	10	54.5 ± 12.7

Within each alexithymic group, correlations between state anxiety, (measured immediately prior to self measured systolic BP), and self measured systolic BP were calculated. As can be seen in Table 24, the group considered low alexithymia in traits showed a high positive correlation between subjective anxiety and subsequent BP, and this relationship was significantly different from zero. The correlation between state anxiety and BP dropped significantly for individuals with moderate to high levels of trait alexithymia, as these correlations were not significantly different from zero .

A Fischer's Z transformation was performed to allow for between group comparisons. The low alexithymia group differed significantly from the two groups presenting with moderate ($z=2.01$, $p<.05$,) and high alexithymia traits ($z=2.49$, $p<.05$). The moderate and high groups were not significantly different from each other ($z=1.30$, $p>.05$).

These data suggest that individuals high in alexithymia traits showed a decoupling between their psychological (or subjective), and physiological stress. Alexithymia as an underlying moderator variable in the expression of the white coat effect was not found. In fact, the percentage of individuals considered high in alexithymic traits was

remarkably similar across Response style groups (Office = 38%, Non = 41%, and Home = 30%). The presence of alexithymic traits may, instead, represent a suppressor variable in terms of prediction of Response style groups (e.g. the magnitude and direction of the WCE).

Table 24

Correlations between State Anxiety and BP values by TAS Groups

Level of Alexithymia Traits	**N**	**Correlation between State Anxiety and Self Measured Office BP**
Low	(n=19)	.74*
Mod	(n=20)	.27
High	(n=22)	.13

*Correlation differs significantly from zero at $p<.01$

(6) Methodological Factors and Psychological Indices as Predictors of Response Style Group Membership

(i) Discriminant Function Analysis for Group Classification

The ultimate goal of this study was to provide psychological and/or methodological variables which would allow prospective identification of individuals at risk for misdiagnosis. Results of methodological analyses indicated that self BP was most representative of ambulatory systolic BP for the entire sample, and in particular for the Home responders. State anxiety, measured immediately prior to self BP was found to be significantly higher in the Office responders compared to either the Non or Home responders. In an earlier analysis it was reported that Office responders did not show

significant habituation of state anxiety between office visits when it was measured immediately prior to physician BP. This variable was also added as a predictor in the discriminant function along with the variable which representing habituation to physician BP. Recall that Office responders did not show any significant habituation between office visits in response to physician BP. Four variables: (1) self measured systolic BP (SBP), (2) average state anxiety prior to self measured BP (ANX), (3) habituation of physician measured systolic BP (HPBP), and (4) habituation of state anxiety prior to physician measured BP (HANX) were entered into a Discriminant Function analysis as predictors of group membership for purpose of group classification. Response style was the basis for group membership (Office, Home and Non-Responders).

Of the original 63 cases, one case was dropped from the analysis on the basis of being a total sample outlier (+4 SD) based on univariate analysis. Of the 62 remaining cases, 6 instances of missing data were detected. Of the two missing values for Self measured systolic BP, the subject's average BP measurement from the visit in which the data were available were used to replace the missing values. Four data points were missing on the State Anxiety variable (office=1, non=2, home=1) and replaced by the group mean value of State Anxiety reported prior to all Clinic BP measurements (Physician, Nurse, Self on visit 1 and 2), providing a conservative estimate of this variable (Tabachnick and Fidell, 1989).

Two discriminant functions were calculated with a combined $X^2(8)=30.74$, $p<.001$. After removal of the first function, the association between groups and predictors is diminished $X^2(3)=5.06$, $p=.17$. The two discriminant functions accounted for 86% and 14% respectively of the between group variability.

The loading matrix of correlations between predictors and discriminant functions, seen in Table 25, suggests that the best predictor for distinguishing between the Office responders and the other two response style groups (first function) was the level of self-

reported state anxiety prior to self measured BP. Office responders reported a higher level of state anxiety (mean=50.6) than either the Non responders (mean=41.9) or Home responders (mean=43.4). The degree to which state anxiety habituated was the best predictor on the second discriminant function to differentiate between the Home responders group and the other two groups. The Home responders showed a larger magnitude of change in levels of reported stated anxiety in between office visits (mean difference=6.0) compared to either the Office responders (mean difference=-1.1) or Non

Table 25

Source Table for Discriminant Function Analysis

Predictor Variables	Correlation of Predictor Variables with Discriminant Functions (1)	(2)	F (2,59)	Pooled within Group Correlations among Univariate Predictors HANX	SBP	HPBP
Self-Anxiety (ANX)	.82	.54	12.01*	-.00	.19	.15
Habituation State Anxiety (HANX)	-.51	.56	5.13		.17	.11
Self-BP (SBP)	.31	-.33	1.86			.21
Habituation Physician BP (HPBP)	.01	.32	0.28			
Canonical R	.60	.29				
Eiegen Value	.56	.09				

* $p < .001$

Responders (mean difference=2.8).

The classification results based upon the discriminant function analyses are seen in Table 26. The percent of participants classified correctly into Response style groups was approximately 63%. Based on prior probabilities, calculated upon group size, chance classification would have resulted in a correct classification of 37%. This was a moderate improvement over chance for the entire sample. For the group of Office Responders, 11 of 17 participants (65%) were classified correctly, representing a 38% improvement over chance classification of 27%. Discriminant function classification improved the percentage of correctly classified participants by 28% for the Non responders, and 24% for the Home responders.

Table 26

Discriminant Function Classification Table for Response Style Membership

Actual Group by Response Style	**n**	**Predicted Group Membership**		
		Office	**Non**	**Home**
Office	17	(11)	(2)	(4)
		64.7%	11.8%	23.5%
Non	22	(1)	(14)	(7)
		4.5%	63.6%	31.8%
Home	23	(3)	(6)	(14)
		3.0%	26.1%	60.9%

Grouped cases correctly classifed=62.9%

IV. Discussion

The ultimate goal of this investigation was to identify specific psychological and/or methodological variables, observable *within* the medical setting, which would prospectively identify individuals at highest risk for BP misdiagnosis. As discussed earlier, "high risk" individuals are characterized by having a large discrepancy between ambulatory and office BP values (e.g., the white coat effect). The ability to identify prospectively individuals at risk for BP misdiagnosis, would allow allocation of ambulatory monitoring resources to primarily those in need.

In this investigation, an alternative to the traditional BP diagnostic classification was employed to define group membership. Instead of individuals being grouped on the basis of high or normal office BP compared to high or normal ambulatory BP, participants in this study were grouped based on the average difference between physician measured office BP and awake ambulatory BP values (the white coat effect). This grouping criterion not only captured the traditional white coat hypertensives, but also identifed hypertensives who showed a marked increase in office BP compared to ambulatory BP (those that may have been considered treatment resistent hypertensives). The grouping criterion also allowed for identification of the seldom reported white coat normotensives, or Home Responders.

(1) The White Coat Effect

The results of this study indicated that, for the entire sample, the magnitude of the white coat effect (WCE) was not significantly larger for physician BP compared to nurse BP. This finding is inconsistent with previous reports which have repeatedly observed a larger WCE in response to physician BP compared to a smaller WCE in response to nurse BP (Pickering & James, 1989; Porchet et al, 1986; Veerman & Montfrans, 1993). However, in the absence of a health care professional, participants did show a statistically significant reduction in the magnitude of the white coat effect. When

participants measured their own BP at the medical office, their self BP was more representative of ambulatory monitoring BP values than either physician or nurse BP. This result cannot be compared to previous findings, as it is the first time individuals have been asked to measure their own BP at the office using a BP measurement method which is consistent with the method used by both the physician and nurse. It can be concluded that regardless of actual BP status, the WCE for both systolic and diastolic BP was minimized in the absence of a health care professional.

These results, based upon the sample as a whole, are consistent with the prediction that self BP would produce a smaller WCE compared to physician or nurse BP. The original prediction was based primarily upon the hypothesis that individuals who show a high degree of reactivity to the office setting (in particular the Office responders), would have lower self BP values compared to those taken by a nurse or physician. This was not the case -- self BP was, on average, higher than nurse or physician BP. The higher self BP was more representative of awake ambulatory BP values which, for this study, were higher than those obtained in the office. Others, however, have reported similar results where both mean awake ambulatory monitoring and 24-hour ambulatory monitoring values were higher than office BP (Pearce et al, 1992).

Self measured BP was included in the methodological design as it was anticipated that self BP would be more representative of ambulatory BP by virtue of eliminating the "pressor" response elicited in the presence of a health care professional. When the data was analyzed in the context of Response style groups, it was found that only for the Home responders was self BP most representative of ambulatory BP. For both Office responders and Non responders, the magnitude of the WCE did not differ across measurement situations. Therefore, whether a health care professional was present or absent, and whether the professional was a physician or a nurse, the two groups showed

no relative difference in the magnitude of the WCE. In contrast, the Home responders, who had elevated BP outside of the office, also had elevated self BP within the office and this resulted in a significantly smaller WCE than seen in response to either the physician or the nurse.

These latter results did not support the prediction that the Office responder's self BP would be lower than the physician or nurse BP. In contrast, the prediction that the Non responders would show little difference between physician, nurse or self BP was supported, as well as the hypothesis that Home responders would have higher self BP than physician or nurse BP. This last finding contributed to the lower WCE for self BP seen for the entire sample.

For the BP diagnostic groups, the magnitude of the WCE did not vary across measurement situations for individuals who had high office BP. That is, for both the hypertensives and white coat hypertensives, self BP did not result in a significantly lower WCE. However, for the two groups who presented at the office with normal BP values (normotensive and white coat normotensives), self BP resulted in a smaller WCE compared to physician WCE. Nurse WCE and self WCE did not differ between these groups.

In summary, for the sample as a whole, ambulatory BP values were generally higher than office BP values, with self BP values higher than physician or nurse BP values. Regardless of Response style or BP Diagnostic grouping, the degree of physician and nurse WCE was not statistically different as had previously been reported. The design of this study allowed comparison of BP values without the confound of measurement artifact. This was accomplished by using the automated ambulatory monitor to record all BP values used to make measurement situation BP comparisons. Very few researchers have acknowledged this possible confound when group differences were interpreted, especially when the groups themselves were defined on the basis of

office-ambulatory BP differences (Jamner et al, 1993). However, as Jamner et al. (1993) has argued, one can assume that the variations in BP methodology would be consistent across participants or at least randomly distributed. The results of this study indicated that the magnitude of the WCE reflected the participant's reaction to the various BP measurement situations, and *not* randomly distributed measurement artifact. This is especially true, since it is not only the different BP measurement methods which can produce artifact, but individual health care professionals may be susceptible to different measurement error biases.

The equivalent WCE seen in response to physician and nurse BP, may have reflected the nature of the sample under study. It has been shown that office-ambulatory differences are typically larger in samples previously screened for inclusion of office hypertension, versus samples which included normotensive patients (Pickering, 1992). Further, the WCE calculation was based upon the average BP measured over two office visits for the physician nurse and self. On the whole, participant's BP was significantly higher during the screening visit than for subsequent office visits, and higher than ambulatory BP values. If the screening visit BP had been used to calculate the physician WCE (instead of the average physician BP of visit 1 and 2), a large discrepancy between physician and nurse WCE would likely have been observed.

An alternative explanation for the lack of difference between physician and nurse WCE may be due to the particular physician involved in this study. Dr. K. was a very quiet, warm and generally perceived as "nice" and "non-intimidating". His personable and unassuming demeanor may have contributed to minimizing the WCE typically seen as a result of BP measurement interactions with physicians.

(2) Habituation

Office responders did not show a differential WCE in response to the three measurement situations as originally anticipated. They did, however, show a differential

pattern of BP habituation in response to physician, nurse and self measured BP. Participants had their first series of BP measurements taken by the physician during the screening visit. This visit was typically 1 to 2 weeks prior to office visit 1. Of the three groups, only the Non responders showed a significant habituation effect from their first encounter with the physician to their second encounter. This group of Non responders would have been diagnosed as hypertensive based on their BP values obtained during the screening visit. However, the degree to which they exhibited marked habituation to physician BP, resulted in normotensive physician BP values by visit 1. No further significant BP habituation occurred between office visit 1 and office visit 2 (the third encounter with the physician). These results were consistent with others who have observed a significant drop in BP values from first to second office visits (White et al,1989). Further, these results underscore the importance of improving BP diagnosis accuracy by increasing the number of visits, and not the number of measurements per visit, before diagnosing hypertension (Pickering, 1992).

The Home responders showed no significant nor differential BP habituation in response to the different measurement situations, and between office visits. From the screening visit to office visit 1, their systolic BP dropped an average of 7 mm Hg. Although this effect was not significant, it suggested that, for this group, the degree of BP habituation would result in office BP values which were even less representative of ambulatory BP, as the screening BP best approximated ambulatory values.

In contrast to the Home responders and Non responders, the group of Office responders showed a differential habituation effect across measurement situations. For physician BP, the Office responders did not show any significant habituation, and continued to be classified as hypertensive from screening visit through office visit 2. This result was consistent with the notion that, at least for the white coat hypertensives, physician BP produces a stable and persistent large WCE, generally resistant to

habituation (Lerman et al, 1989; Siegel et al, 1990; Touyz et al, 1990). However, the Office responders showed a significant effect of habituation such that by office visit 2 they would have been considered normotensive based upon nurse and self measured BP values. This significant and differential BP habituation has diagnostic implications. For both nurse and self BP measured during visit 1, the Office responders would have been diagnosed as hypertensive. These results indicated that, at least for the Office responders, self and/or nurse BP may provide more accurate BP diagnostic information over repeated office visits. It has been previously reported that nurse BP offered an improvement in diagnostic accuracy over physician BP (Veerman & Montfrans, 1993). This is the first time it has been reported that self BP has been shown to also improve diagnostic accuracy, at least for the group of Office responders.

Although the Office responders showed a differential pattern of habituation, it cannot be concluded that ambulatory monitoring provided desensitized their experience of having BP measured. It would have been necessary for this group to show no habituation between the screening visit and office visit 1 for physician BP, followed by a significant habituation between office visit 1 and 2. This did not occur, and the habituation effect seen for nurse and self BP cannot be assumed to be a selective effect of desensitization.

(3) Psychological Factors

Within the context of a review which discussed the relationship between stress and hypertension, Boone (1993) suggested that the influence of psychological stress on physiological factors is multifaceted. He proposed that the relationship between psychological and physiological stress is mediated by the following determinants: "(1) the characteristics or nature of the given stressor, (2) the perception of the individual regarding that stressor, (3), the heredity, psychological and physiologic susceptibility of the individual experiencing the stressor, and (4) the ability of the individual to perceive

positive control over the outcomes potentially generated by the stressor" (Boone, 1993 p. 623). This study was designed to examine closely the psychological determinants, if any, underlying the physiological response of having BP measured within the office setting.

The most obvious psychological stressor which would be associated with the white coat effect is anxiety. It has been widely reported that state anxiety is *not* related to the increase in BP seen in the presence of a health care professional. I proposed earlier that this conclusion may have been due to a conceptual error, since a direct relationship between subjective anxiety and subsequent BP has never been properly studied.

The results of this study clearly indicate that Office responders presented with significantly higher levels of subjective state anxiety, prior to office BP measurements, compared to Non responders. Prior to BP measurements taken during the screening visit, office visit 1 and office visit 2, the Office responders were more anxious than Non responders, regardless of measurement situation (physician, nurse or self). Further, subjective anxiety reported by both the Office and Non responders did not habituate over repeated visits. That is, the Non responders presented with relatively low subjective anxiety, and this did not change with time, nor did the relatively high level of state anxiety change over time for the Office responders. These results are consistent with the only study in which the relationship between state anxiety and BP measurements was approximated (McGrady & Higgins, 1990). These authors suggested that two separate phenomena exist to explain the anxiety-BP relationship. Specifically, they suggested that anxiety is related to an initial elevation in office BP, which subsequently diminishes through the process of habituation, and that anxiety is unrelated to a persistent elevation in office BP when ambulatory BP is low. In contrast to these suggestions, anxiety was directly related to BP measurements which do not habituate over time (as seen for physician measured BP) for the group of Office responders. Conversely, the Non responder group did show habituation from initial physician BP values, yet they

consistently reported lower levels of state anxiety than the Office responders. In summary, state anxiety or anticipatory anxiety was directly related to office BP values which were higher than ambulatory BP values.

This point is made even clearer when Office responders and Home responders were compared. Both groups presented with equivalent levels of state anxiety prior to screening visit BP measurements. In contrast to the Office responders, the Home responders showed dramatic habituation of state anxiety from screening visit to office visit 1 in the absence of any significant BP habituation. On the other hand, Office responders showed a significant habituation effect of self measured BP, not seen in the Home responders, yet they endorsed significantly higher levels of state anxiety prior to the self BP than did the Non responders.

Superficially, there appears to be some evidence which supports McGrady and Higgins (1990) suggestions. State anxiety was not significantly different between any of the BP diagnostic groups across any of the measurement situations. There was a trend for the white coat hypertensives to show more anxiety than the other groups although these differences were not significant. However, it cannot be concluded that there is no relationship between state anxiety, and BP which does not habituate. Instead, these results reflect the more subtle distinction between relative office-BP discrepancies versus diagnostic discrepancies. Recall that the Office responders comprised not only white coat hypertensives (41%) but also hypertensives (29%), and normotensives (29%). Although these participants did not share the same BP diagnostic classification, they did share in common ambulatory BP which was lower than the average physician BP. This direction of the white coat effect, or Response style, may be a more sensitive indicator of high state anxiety rather than BP diagnostic classification, which would exclude both the true hypertensive and normotensive individuals.

Consistent with earlier reports, is the finding that, outside of the clinic, the three groups did not report significantly different levels of state anxiety. What is more relevant, however, is the fact that these subjective reports of state anxiety were made during ambulatory monitoring. These results provided confirmation that outside of the clinic setting, but not independent of BP measurement per se, the Office responders did not endorse significantly higher levels of state anxiety than the other two groups. In parallel with this finding, it was not surprising that trait anxiety did not differentiate between the Response style groups nor BP Diagnostic groups. This result was in accordance with the multiple investigations which have produced similar results (Gerardi et al, 1985; Julius et al, 1992; Lerman et al, 1990; Siegel et al 1990). In summary, it has often been discussed that the white coat hypertensives (in this case an expanded group of office responders") have a "pressor" response specific only to the clinic (Donner-Banzhoff, 1997). For the first time, levels of subjective anxiety reflect the psychological corollary of this specific response.

In light of the observed relationship between state anxiety and elevated office BP, understanding the "nature" of this anxiety is useful. The results indicated that the Office responders did not experience anxiety in a more "cognitive" manner versus a "somatic" manner. It was speculated that catastrophic cognitions or at least misinterpretation of disturbing body sensations may moderate the specific white coat response. However, this was not found to be true -- the Office responders did not endorse a significantly higher number of distorted cognitions related to BP measurement than their Non and Home responder counterparts, nor did they endorse a significantly larger number of disturbing physical symptoms.

The only significant finding within the context of anxiety expression, was the fact that the white coat hypertensive group reported disturbing physical sensations to the same degree as catastrophic cognitions. This result was in contrast to the normotensive

group who reported a similar number of disturbing physical sensations, but a significantly smaller number of catastrophic interpretations. The hypertensive and white coat normotensive group showed a similar response pattern, however the difference between physical sensations and cognitions was not significant.

Following the hypotheses stated earlier, it was speculated that perhaps the white coat hypertensives or Office responders perceived less control in terms of their general health, specifically in the context of their interactions with their physicians. If for example, Office responders perceived less internal locus of control or more a "powerful" other locus of control, this may exacerbate, or moderate their levels of anxiety within the medical setting. In parallel, a diminished sense of positive interactions with their primary care physician may also influence their BP reactivity at the office. Both hypotheses were tested by asking participants to complete to MHLC and PICS. No significant differences for either BP Diagnostic or Response Style groups were found in terms of locus of control (internal vs. powerful other vs. chance). There was a non significant trend, however, for the white coat hypertensives to indicate a more negative view of their interactions with their primary care physician compared to the other three diagnostic groups.

There is some physiological evidence which may put into perspective the obvious BP reactivity to the clinic in the absence of any other apparent physiological arousal, and lend corroborating physiological support to the finding that Office responders are indeed more anxious at the clinic. Pickering (1995) pointed out that white coat hypertensives typically do not show tachycardia while at the clinic compared to normotensives or hypertensives. He stated that this absence of tachycardia indicated that the white coat effect was not a manifestation of anxiety. A recent study offers an explanation for this apparent paradox (Pannarale, Isea, Coats, Conway and Sleight, 1991). These authors investigated hemodynamic responses in both white coat hypertensives and normotensives

in response to mental stress tasks in the laboratory. They found that the changes in heart rate from baseline, for both groups, were similar. However, the two groups were differentiated in terms of the "cardiac response" (characterized by peak velocity, minute distance, stroke distance and peripheral resistance). The white coat hypertensives showed a specific pattern of cardiac stimulation coupled with vasodilatation. The authors concluded that these hemodynamic changes were akin to cardiac responses seen when hypertensives are infused with adrenaline. This specific cardiac response pattern, however, was observed in the laboratory under conditions of mental stress and not specifically related to BP measurements. In another study, plasma adrenaline was measured in individuals who, immediately prior to BP measurements, had been given false information indicating they had high BP. An increase in adrenaline was seen in the individuals who received false feedback, and not in those who had not received feedback (Rostrup & Ekeberg, 1992). The authors suggested that adrenaline release was specifically associated with fear, threat or anticipatory anxiety. Assessment of hemodynamic responsiveness and invasive blood sampling were clearly not in the scope of this investigation. However, it may be useful in future studies, to characterize additional physiological responses related to anxiety associated with office BP measurements.

In summary, state anxiety prior to self measured office BP was the best predictor of the magnitude and direction of the WCE, defined in this study by Response style. Gerardi et al (1985) stated that it was basically redundant to prove that the Office responders are more anxious, since we know this by virtue of their elevated BP. This point is well made. However, it is very informative to know that the same individuals who respond to the experience of having BP measured with increased state anxiety (which can be measured), are the same individuals who will have the largest discrepancy between office and ambulatory BP values (e.g. the largest white coat effect). This ability

to identify individuals who are the highest risk for misdiagnosis, will allow informed decisions to be made about the allocation of expensive ambulatory monitoring resources.

None of the trait psychological measures related to anxiety, perception of control, anger, or coping styles were able to differentiate between groups defined by either Response style or BP Diagnostic categories. The results did not reflect a differential pattern in the experience and expression of anger as many others have found (for review see, Suls et al, 1995). Neither BP diagnostic groups nor Response style groups demonstrated different degrees of self or other deception, suggesting, at least for this sample, repression or impression management are not underlying factors in expression of the white coat effect.

There was a trend for the two groups who presented with office hypertension (the white coat hypertensives and the true hypertensives) to endorse higher levels of alexithymia compared to either the normotensives or white coat normotensives. This trend was not significant however. This result, and the other results discussed in terms of BP diagnostic groups should be considered tentative. The size of the four BP diagnostic groups was considerably unequal, and some of them rather small (e.g. 19,8,26 and 10). Given that the primary focus of this investigation was based upon Response style, the uneven group membership represented the sample as selected and not planned. The analyses were performed to provide comparative information, and were not considered primary to this investigation.

The predicted relationship between Office responders and alexithymia was not found. However, secondary analyses indicated that individuals considered high in alexithymic traits showed a clear pattern of desynchrony between psychological and physiological responsiveness. The data suggested that alexithymia may be considered a suppressor variable within the context of predicting the magnitude of the white coat response on the basis of state anxiety measures. Specifically, if the correlation between

self BP and subjective anxiety prior to the BP measurement was consistently high, then one could confidently predict that elevated office BP associated with high state anxiety scores would reflect a significant white coat effect. What can be concluded, in the context of this study, is that identification of "high risk" individuals would be enhanced for participants who were considered low in alexithymic traits.

(4) Methodological and Psychological Predictors of the White Coat Effect

Self measured systolic BP, for the sample as a whole, was the most representative of ambulatory monitoring values, especially for the Home responders. State anxiety, reported immediately prior to self BP, was able to discriminate the Office responders from the Non responders and Home responders. Differential patterns of habituation in response to physician measured BP and state anxiety levels measured prior to BP measurements, were observed among the three Response style groups. These variables were used as predictors in a discriminant function analysis in an attempt to classify individuals into Response style groups. All of these variables represent information that can be obtained prior to ambulatory monitoring, and which would allow for apriori identification of Response style within the clinic. For the data available from 62 participants of this study, 63% of the participants were correctly classified into corresponding Response style groups. This ability to identify individuals within the clinic is well above chance. The single most valuable predictor of group membership was state anxiety -- the variable previously dismissed as irrelevant to expression of the white coat effect.

(5) Limitations

Although the participants were screened for basic inclusion and exclusion criteria, the sample cannot be considered homogeneous per se. Some participants were taking medication for other physical or psychiatric conditions that may or may not have had an effect on their BP. Participants also varied in their lifestyle habits, for example: physical

fitness, overall health, smoking, alcohol consumption, etc. These factor were not controlled for . The average age of the subjects may have also had an impact on their baseline BP levels, as BP increases with age in individuals who have high salt diets and other related medical conditions. Finally, the study sample was comprised of people, who one can assume, had the available free time to participate in a study with a significant time requirement and a strong motivation to pursue health information they felt was important. The generalizability of the results is limited to a middle aged population, with varied medical histories and who have the time and motivation to participate in a time consuming research project related addressing their BP concerns.

The design of the study may have provided an extra source of anxiety not typically encountered within the medical setting -- that is, the requirement that participant's were asked to measure their own BP. Participants were exposed to the ambulatory monitor at the outset of the study (during the screening visit). During visit 1 they were give a demonstration on how to activate the monitor and were asked to activate the monitor themselves (in the presence of the principal investigator) prior to any office BP measurements. The ambulatory monitor was used to reduce measurement artifact and to provide data for self measured BP within the office setting. Although essential to the study design, the use of the ambulatory monitor within the office setting cannot be considered an innocuous procedure without effect on the participants psychological and/or physiological response to the measurement situation.

The discussion of habituation of both state anxiety and BP values was based upon a dependent pairs t-test which only allowed for comparison between two consecutive BP measurement situations (e.g. screening visit vs. visit 1, or visit 1 vs. visit 2). The data analyses likely produced a conservative estimate of habituation for physician BP since it was measured on three separate occasions. A trend analyses, or evaluation of the slope over time may have provided a more liberal approach to examine habituation.

(6) Future Directions

Overall, underlying trait variables and coping styles failed to consistently differentiate groups classified either by the magnitude of the WCE or by diagnostic categories. There is some tentative evidence which suggests that alexithymia may be higher in individuals who have office hypertensive compared to those who have office normotension. This relationship should be explored further.

Evidence from this study and previous others cited in the literature indicate that the white coat effect is a situationally specific phenomenon. Further investigations with larger samples should attempt to replicate the result that state anxiety is a predictor of the magnitude of the white coat effect. Moreover, laboratory research investigating the cardiac functions of Office responders should be directly applied to the BP measurement situation, as it typically occurs within the clinic setting. Combining physiological measures with the psychological variables found in this study, would allow a more comprehensive and detailed profile of the Office responders. Ideally, a treatment study aimed at alleviating the specific anxiety associated with BP measurement should be undertaken. If this specific anxiety can be reduced substantially, the corresponding pressor response may also be minimized such that the possibility of misdiagnosis is reduced. Finally, future studies which plan to investigate the "white coat effect" should be more inclusive, to allow a more comprehensive evaluation of white coat normotensives or the Home responders.

References

Appel, L.J. & Stason, W.B. (1993). Ambulatory monitoring and blood pressure self-measurement in the diagnosis and managment of hypertension. Annuls of Internal Medicine, 118, 867-882.

Ayman, D. Goldshine, A.D., (1940). Blood pressure determinations by patients with essential hypertension: The difference between clinic and home readings before treatment. American Journal of Medical Sciences, 200, 465-474.

Bagby, R.M., Taylor, G.J. & Ryan, D. (1986). Toronto alexithymia scale: a comparative study of three self-reprt measures. Psychotherapy and Psychosomatics, 45, 207-215.

Boone, J.L. (1993). Stress and hypertension. Primary Care, 18, 623-649.

Carey, R.M., Reid, R.A., Ayers, C.R., Lunch, S.S., McLain, W.L., & Vaughan, E.D. (1976). The Charlottesville blood-pressure survey: Value of repeated blood pressure measurements. Journal of the American Medical Association, 236, 847-851.

Cardillo, C., De Felice, F., Campia, U. & Folli, G. (1993). Psychophysiological reactivity and cardiac end-organ changes in white coat hypertension. Hypertension, 21(6), 836-844.

Clark, D.M. (1989). Anxiety states (panic and generalized anxiety) in (Eds.) Hawton, K., Slakovskis, P.M., Kirk, J. & Clark, D.M. Cognitive Behaviour Therapy for Psychiatric Problems. Oxford University Press, New York: pp 52-97.

Cumes-Rayner, D.P. & Price, J. (1990). Understanding hypertensives behavior II: Perceived social approval and BP reactivity. Journal of Psychosomatic Research, 34, 141-152.

Degaute, J.P., van de Borne, Kerkhofs, M., Dramaix, M. & Linkowski, P. (1992). Does non-invasive ambulatory blood pressure monitoring disturb sleep? Journal of Hypertension, 10, 879-885.

Donner-Banzhoff, N., Chan, Y., Szalai, J.P. & Hilditch, J.R. (1997). Is the 'clinic-home blood pressure difference' associated with psychological distress? A primary care-based study. Journal of Hypertension, 15, 585-590.

Duggan, J. (1994). Ambulatory blood pressure monitoring. Pharmacology & Therapeutics, 63 (3), 313-321.

Enstrom, I., Thulin, T. & Lindholm, L. (1991). How good are standardized blood pressure recordings for diagnosing hypertension? A comparison between office and ambulatory blood pressure. Journal of Hypertension, 9, 561-566.

Enstrom, I., & Pennert, K. (1996). Does it matter whether ambulatory blood pressure is recorded during a work day or a non-work day? Journal of Hypertension, 14, 565 - 569.

Fark, A.R. (1993). A pilot study of white-coat and labile hypertension: Associations with diagnosis of psychosocial dysfunction. Family Practice Research Journal, 13 (1), 71-80.

Fredrikson, M. (1992). Blood pressure reactivity to active and passive behavioral conditions in hypertensives and normotensives. Scandanavian Journal of Psychology, 33, 68 - 73.

Friedlander, L., Lumley, M.A, Farchione, T., & Doyal, G. (1997). Testing the alexithymia hypothesis: Physiological and subjective responses during relaxation and stress. The Journal of Nervous and Mental Disease, 185, 233-239.

Gerardi, R.J., Blanchard, E.B., Andrasik, F & McCoy, G.C. (1985). Psychological dimension of 'office hypertension'. Behaviour Research and Therapy, 23 (5), 609-612.

Harshfield, G.A., Pickering, T.G., Kleinert, H.D., Blank, S., & Laragh, J.H. (1982). Situational variation of blood pressure in ambulatory monitoring by hypertensive patients. Psychosomatic Medicine, 44, 237-245.

Irvine, M.J., Garner, D.M., Olmstead, M.P. & Logan, A.G. (1989). Personality differences between hypertensive and normotensive individuals: Influence of knowledge of hypertensive status. Psychosomatic Medicine, 51, 537-549.

James, G.D., Pickering, T.G., Yee, L.S., Harshfield, G.A., Riva, S. & Laragh, J.H. (1988). The reproducibility of average ambulatory, home and clinic pressures. Hypertension, 11, 545-549.

Jamner, L.D., Shapiro, D., Hui, K.K., Oakley, M.E., & Lovett, M. (1993). Hostility and differences between clinic, self-determined, and ambulatory blood pressure. Psychosomatic Medicine, 55, (2), 203 - 211.

Julius, S., Jamerson, K., Gudbrandsson, T., & Schork, N. (1992). White coat hypertension: A follow up. Clinical and Experimental Hypertension - Theory and Practice, A14, (1&2), 45-53.

Kleinert, H.B., Harshfield, G.A. & Pickering, T.G. (1984). What is value of home blood pressure measurements in patients with mild hypertension? Hypertension, 6, 574-578.

Laughlin, K.D., Sherrard, D.J. & Fisher, L. (1980). Comparison of clinic and home blood pressure levels in essential hypertension and variables associated with clinic-home differences. Journal of Chronic Diseases, 33, 197-206.

Lavie, C.J., Schmieder, R.E., & Messerli, F.H. (1988). Ambulatory blood pressure monitoring: Practical considerations. American Heart Journal, 116 (4), 1146 - 1151.

Lerman, C.E., Brody, D.S., Hui, T., Lazaro, C., Smith, D.G. & Blum, M.J. (1989). The white-coat hypertension response: prevalence and predictors. Journal of General Internal Medicine, 4, 226-231.

Lerman, C.E., Brody, D.S., Caputo, G.C., Smith, D.G., Lazaro, C.G. & Wolfson, H.G. (1990). Patient's perceived involvement in care scale: Relationship to attitudes about illness and medical care. Journal of General Internal Medicine, 5, 29-33.

Linden, W., Paulhus, D.L. & Dobson, K.S. (1986). Effects of response style on the report of psychological and somatic distress. Journal of Consulting and Clinical Psychology, 54, 309-313.

Linden, W., Herbert, C.P. Jenkins, A. & Raffle, V. (1989). Should we tell them when their blood pressure is up? Canadian Medical Association Journal, 141, 409-415.

Lamensdorf, A.M. & Linden, W. (1992). Family history of hypertension and cardiovascular changes during high and low affect provocation. Psychophysiology, 29, 558-565.

Linden, W., Wen, F.K. & Paulhus, D.L (1995). Measuring alexithymia: reliability, validity and prevalence. Advances in Personality Asessment, 10, 51-95.

Lynch, J.J., Long, J.M., Thomas, S.A., Malinow, K.L. & Honori Katcher, A. (1981). The effects of talking on the blood pressure of hypertensive and normotensive individuals. Psychosomatic Medicine, 43, 25-33.

Mancia, G., Grassi, G., Pomidossi, G., Gregorini, L., Bertinieri, G., Parati, G., Ferrari, A. & Zanchetti, A. (1983). Effects of blood pressure measurement by the doctor on patient blood pressure and heart rate. The Lancet, 2, 695-697.

Mancia, G., Parati, G., Pomidossi, G., Grassi, G., Casadei, R. & Zanchetti, A. (1987). Alerting reaction and rise in blood pressure during measurement by the physician and nurse. Hypertension, 9, 209-215.

Mancia, G., & G. Parati. (1990). Clinical significance of "white coat" hypertension. Hypertension, 16, 624 - 625.

Martin, J.B. & Pihl, R.O. (1986). Influence of alexithymia characteristics on physiological and subjective stress responses. Psychotherapy and Psychosomatics, 45, 66-77.

McCubbin, J.A., Wilson, J.F., Bruehl, S., Brady, M., Clark, K., & Kort, E. (1991). Gender effects on blood pressures obtained during an on-campus screening. Psychosomatic Medicine, 53, 90-100.

McGrady, A. & Higgins, J.T., (1990). Effect of repeated measurements of blood pressure on blood pressure in essential hypertension: Role of anxiety. Journal of Behavioural Medicine, 13 (1), 93-101.

Melamed, S. (1987). Emotional reactivity and elevated blood pressure. Psychosomatic Medicine, 49, 217-225.

Melamed, S. (1996). Emotional reactivity, defensiveness and ambulatory cardiovascular response at work. Psychosomatic Medicine, 58, 500-507.

Nemiah, J.C. (1977). Alexithymia: theoretical considerations. Psychotherapy Psychosomatics, 28, 199-206.

O'Brien, E., Mee, F., Atkins, N., & O'Malley, K. (1991). Accuracy of the Spacelabs 90207 determined by the British Hypertension Society Protocol. Journal of Hypertension, 5, 573-574.

Omboni, S., Ravogli, A., Parati, G., Zanchetti, A., and G. Mancia, (1991). Prognostic value of ambulatory blood pressure monitoring. Journal of Hypertension, 9 (suppl 3), S25-S28.

Padfield, P.L., Lindsay, B.A., McLaren, J.A., Pirie, A., & Rademaker, M. (1987). Changing relation between home and clinic blood-pressure measurements: Do home measurements predict clinic hypertension. The Lancet, 2, 322-324.

Pannarale, G., Isea, J.E., Coats, A.J.S., Conway, J., & Sleight, P. (1991). Cardiac and blood pressure response to mental stress in reactive hypertensives. Clinical and Experimental Hypertension - Theory and Practice, 13(1), 1-12.

Papciak, A.S., Feuerstein, M. & Spiegel, J.A. (1985). Stress reactivity in alexithymia: Decoupling of physiological and cognitive processes. Journal of Human Stress, 11, 135-142.

Parati, G., Groppelli, A., Omboni, S., Trazzi, S., Frattola, A. & Mancia, G. (1991). Testing the accuracy of blood pressure monitoring devices in ambulatory conditions. Journal of Hypertension, 9 (suppl 8), S7-S9.

Parker, J.D., Taylor, G.J., Bagby, R.M. and Acklin, M.W. (1993). Alexithymia in panic disorder and simple phobia: A comparative study. American Journal of Psychiatry, 150 (7), 1105-1107.

Paulhus, D.L. (1984). Two-component models of socially desirable responding. Journal of Personality and Social Psychology, 46, 598-609.

Pearce, K., Grimm, R.H., Rao, S., Svendsen, K., Liebson, P.R., Neaton, J.D. & Ensrud, K. (1992). Population-derived comparisons of ambulatory and office blood pressures. Archives of Internal Medicine, 152, 750 - 756.

Pickering, T.G., Harshfield, G.A., Kleinert, H.D., Blank, S. & Laragh, J.H. (1982). Blood pressure during normal daily activities, sleep, and exercise (comparison of values in normal and hypertensive Participants). Journal of the American Medical Association, 247, 992-996.

Pickering, T.G., Harshfield, G.A., Devereux, R.B. & Laragh, J.H. (1985). What is the role of ambulatory blood pressure monitoring in the management of hypertensive patients? Hypertension, 7, 171-177.

Pickering, T.G. & Devereux, R.B. (1987). Ambulatory monitoring of blood pressure as a predictor of cardiovascular risk. American Heart Journal, 114, 925-928.

Pickering, T.G., James, G.D., Boddie, C., Harshfield, G.S., Blank, S. & Laragh, J.H. (1988). How common is white coat hypertension? Journal of the American Medical Association, 259, 225-228.

Pickering, T.C. & James, G.D. (1989). Some implications of the difference between home, clinic and ambulatory blood pressure in normotensive and hypertensive patients. Journal of Hypertension, 7, S65-S72.

Pickering, T.G., Devereux, R.B., Gerin, W., James, G.D., Pieper, C., Schlussel, Y.R., and Schnall, P.L. (1990). The role of behavioral factors in white coat and sustained hypertension. Journal of Hypertension, 8, S141-S147.

Pickering, T.C., (1992). Differing perspectives on white coat hypertension. Archives of Internal Medicine, 152, 691-692.

Pierdomenico, S.D., Mezzetti, A., Lapenna, D., Guglielmi, J.D., Mancini, M., Salvatore, L., Antidormi, T., Costantini, F., & Cuccurullo, F. (1995). 'White-coat' hypertension in patients with newly diagnosed hypertension: evaluation of prevalence by ambulatory monitoring and impact on cost of health care. European Heart Journal, 16 (5), 692-697.

Porchet, M., Bussien, J.P., Waeber, B., Nussberger, J. & Brunner, H.R. (1986). Unpredictability of blood pressures recorded outside the clinic in the treated hypertensive patient. Journal of Cardiovascular Pharmacology, 8, 332-335.

Prattichizzo, F.A. & Galetta, F. (1996). White-coat normotension and blood pressure variability. Angiology, 47 (7), 663 - 668.

Prisant, L. M. (1995). Ambulatory blood pressure monitoring in the diagnosis of hypertension. Cardiology Clinics, 13 (4), 479 - 490.

Reiser, M.F., Reeves, R.B., & Arrington, J. (1955). Effect of variations in laboratory procedure and experiment upon the ballistrocardiogram, blood pressure, and heart rate in healthy young men. Psychosomatic Medicine, 17, 185-199.

Rostrup, M., Kheldsen, S.E., Amundsen, R. and Eide, I. (1988). Does awareness of hypertension per se influence blood pressure, heart rate, plasma catecholamines and response to cold pressor test. Journal of Hypertension, 6, S743-S744.

Roter, D.L. & Ewart, C.K. (1992). Emotional inhibition in essential hypertension: Obstacle to communication during medical visits? Health Psychology, 11, (3), 163 - 169.

Schneider, R.H., Egan, B.M., Johnson, E.H., Drobny, S. & Julius, S. (1986). Anger and anxiety in borderline hypertension. Psychosomatic Medicine, 48 (3/4), 242-248.

Schwartz, G.E., Davidson, R.J., & Goleman, D.J. (1978). Patterning of cognitive and somatic processes in the self-regulation of anxiety: Effects of meditation versus exercise. Pyschosomatic Medicine, 40, 321-328.

Shreve, E.G., Harrigan, J.A., Dues, J.R. and Kaga, K.K. (1988). Nonverbal expressions of anxiety in physician-patient interaction. Psychiatry, 51, 378-384.

Siegel, W.C., Blumenthal, J.A. and G.W. Devine. (1990). Physiological, psychological, and behavioural factors and white coat hypertension. Hypertension, 16, 140-146.

Sifneos, P.E. (1973). The prevalence of "alexithymic" characteristics in psychosomatic patients. Psychotherapy and Psychosomatics, 22, 255-262.

Spielberger, C., Johnson, E.H., Russelll, S.F., Crane, R.J., Jacobs, G.A. & Worden, T.J. The expression and experience of anger: Construction and validation of an anger

expression scale. In: Chesney, M.A., Fosenman, R. (eds). Anger and hostility in cardiovascular and behavioral disorders. New York: MacGraw-Hill, 1985, pp. 5-30.

Spielberger, C.D., Gorsuch, R.L. & Lushene, R.E, Vagg, P.R. & Jacobs, G.A. STAI manual for the Stait-Trait Anxiety Inventory. California: Consulting Psychologists Press, 1983.

Stevens, J. (1992). Applied multivariate statistics for the social sciences (2nd ed.). New Jersey: Lawrence Erlbaum Associates.

Stewart, M.J. & Padfield, P.L. (1994). Measurement of blood pressure in the technological age. British Medical Bulletin, 50, 420-442.

Suls, J., Wan, C.K., & Costa, P.T., Jr. (1995). Relationship of trait anger to resting blood pressure: a meta analysis. Health Psychology, 14 (5), 444-456.

Taylor, G.J., Bagby, R.M. & Parker, J.D.A. (1991). The alexithymia construct - A potential paradigm for psychosomatic medicine. Psychosomatics, 32, 153-164.

Tabachnick, B.G. & Fidell, L.S. (1989). Using multivariate statistics (2nd ed.). New York: Harper Collins.

Touyz, R.M. Milne, F.J. & Reinach, S.G. (1990). Twenty-four hour ambulatory blood pressure in therapeutically resistent hypertensive patients. Journal of Human Hypertension, 4, 393-396.

Van Loo, J.M., Peer, P.G., & Thien, T.A. (1986). Twenty-five minutes between blood pressure readings: The influence on prevalence rates of isolated systolic hypertension. Journal of Hypertension, 4, 631-635.

Veerman, D.P. & van Montfrans, G.A. (1993). Nurse-measured or ambulatory blood pressure in routine hypertension care. Journal of Hypertension, 11 (3), 287 - 292.

Verdecchia, P., Schillaci, G., Boldrini, F., Zampi, I., & Porcellati, C. (1992). Variability between current definitions of "normal" ambulatory blood pressure. Implications in the assessment of white coat hypertension. Hypertension, 20 (4), 555 - 562.

Verdecchia, P., Schillaci, G., Borgioni, C., Ciucci, A., Zampi, I., Gattobigio, R., Sacchi, N., & Porcellati, C. (1995). White coat hypertension and white coat effect. Similarities and differences. American Journal of Hypertension, 8, (8), 790 - 798.

Verdecchia, P. Schilliaci, G., Borgioni, C., Cucci, A. & Porcellati, C. (1997). Prognostic significance of the white coat effect. Hypertension, 29, 1218-1224.

Waeber, B., Jacot Des Combes, B., Porchet, M., Biollaz, J., Schaller, M.D. & Brunner, H.R. (1984). Ambulatory blood pressure recording to identify hypertensive patients who truly need therapy. Journal of Chronic Diseases, 37, 55-57.

Wallston, K.A. , Wallston, B.S., & DeVellis, R. (1978). Development of the Multidimensional Health Locus of Control (MHLC) Scales. Health Education Monographs, 6, 161-170.

Weber, M.A., Smith, D.H., Neutel, J.M., & Cheung, D.G. (1991). Applications of ambulatory blood pressure monitoring in clinical practice. Clinical Chemistry, 37, No. 10(B), 1880 - 1884.

White, W.B., Schulman, P., McCabe, E.J. & Dey, H.M. (1989). Average daily blood pressure, not office blood pressure, determines cardiac function in patients with hypertension. Journal of the American Medical Association, 261, 873-877.

WHO/ISH (1993). 1993 guidelines for the management of mild hypertension: memorandum from World Health Organization/International Society of Hypertension meeting. Journal of Hypertension, 7, 689-693.

Williams, R.B., Kimball, C.P., & Williard, H.N. (1972). The influence of interpersonal interactions on diastolic blood pressure. Psychosomatic Medicine, 34, 194-198.

Wise, T.N. & Mann, L.S. (1995). The attribution of somatic symptoms in psychiatric outpatients. Comprehensive Psychiatry, 36, 407-410.

Zachariah, P.K. & J.D. Krier, (1991). Clinical uses of ambulatory monitoring. Journal of Hypertension, 9, (suppl 1), S7 - S12.

Zeitlin, S.B. & McNally, R.J. (1993). Alexithymia and anxiety sensitivity in panic disorder and obsessive-compulsive disorder. American Journal of Psychiatry, 150, 658 - 660.

APPENDIX A

SITUATIONAL BLOOD PRESSURE STUDY
SCREENING VISIT

Name: _____ **I.D.** _____

Date/Time: _____

D.O.B.: _____

Height: _____

Weight: _____

Male / Female

BP MEASUREMENTS	**MERCURY**	**AUTOMATED**	**TIME**
	Systolic/Diastolic	Systolic/Diastolic	
1.	_____	_____	_____
2.	_____	_____	_____
3.	_____	_____	_____
Average:	_____	_____	

MEDICAL HISTORY: (major illness, prescription medication (birth control pills), non prescription medication, heart disease, stroke, asthma, artery disease, etc.)

APPENDIX B

THE UNIVERSITY OF BRITISH COLUMBIA

DEPARTMENT OF PSYCHOLOGY &
HYPERTENSION CLINIC, UNIVERSITY HOSPITAL

CONSENT FOR PARTICIPATION

SITUATIONAL MEASURES OF BLOOD PRESSURE RESEARCH STUDY

The Department of Psychology and the UBC Hypertension Clinic are conducting a study designed to assess different methods and situations in which to measure blood pressure. As well, we will be asking people how they think and feel about having their blood pressure measured in different circumstances.

In addition to the screening visit which I have already completed, I understand that participation in this research study will involve:

(1) A second visit to the Hypertension Clinic. At this time I will have my blood pressure measured by a physician, nurse and self-measured using the ambulatory monitor. In between these blood pressure measurements I will be asked to complete a number of self-report questionnaires. Once these clinic measures have been completed I will be fitted with the ambulatory blood pressure monitor to be worn over the next 24 hours. I understand that this monitor is a non-invasive device which is set automatically to take blood pressure readings every 20 minutes. I understand that I will be able to turn off the monitor manually should I wish to do so. I will be asked to complete some self-report questionnaires during the time in which I am wearing the ambulatory monitor. I understand that this visit should take approximately one hour.

(2) A third visit to the Hypertension Clinic. I will return the ambulatory monitor during this visit to the clinic. I understand that once again my blood pressure will be measured by a physician, nurse and by myself and I will be asked to complete self-report questionnaires. This protocol is the same as in visit 2 and should take approximately one hour. I understand that I will be asked to take home a number of self-report questionnaires to completed and returned during the final visit. An appointment will be made for me to return to the clinic to receive my blood pressure results.

(3) I understand that I will receive a copy of my blood pressure results which will be explained to me by the physician during the final visit to the Hypertension Clinic. I will also be asked to complete a brief interview conducted by the researcher and at which time I will have an opportunity to ask questions and discuss my participation in the research project. I acknowledge that results of my blood pressure readings will be sent to my referring or family physician upon my request.

APPENDIX B

I have been informed that I will not receive any monetary compensation for participation in this study. I understand that my anonymity will be assured through the use of a data coding system, whereby data obtained from the blood pressure results will be coded through the use of numbers (except in the case above where my physician will receive these results). I understand that personal specifics (such as name, medical history, etc.) will not be used by the researcher.

As a research participant, I acknowledge the right to refuse to participate, and the right to terminate or withdraw at any time without any penalty including any effect on ongoing treatment received from my physician or any members of the Hypertension Clinic.

If I want more information about this study or want to ask any questions, I can contact Dr. Wolfgang Linden, U.B.C. Department of Psychology at 822-4156 or Dr. Jim Wright, Director of the Hypertension Clinic, University Hospital at 822-7134.

I acknowledge that I have read this consent form and that I have received a copy of this form.

Name	Date
Signature	Witness

APPENDIX C

SITUATIONAL BLOOD PRESSURE STUDY

Order 1

(1) BEFORE the PHYSICIAN measures your blood pressure, please complete:

FORM 1

the physician will now take your blood pressure

(2) AFTER the PHYSICIAN has measured your blood pressure, please complete:

FORM 2 & 3

the nurse will now take your blood pressure

(3) AFTER the NURSE has measured your blood pressure, please complete:

FORM 4 & 5

(4) NOW please take your own blood pressure. To do this press the BLUE BUTTON which is marked "start/stop". You should hear a beep and feel the cuff inflate. Allow yourself a couple of minutes in between readings.

*Please measure your blood pressure **THREE** times.*

(5) AFTER you have measured your blood pressure please complete:

FORM 6

	ACTIVITY
9:00 am	
10:00 am	
11:00 am	
12 noon	
1:00 pm	
2:00 pm	
3:00 pm	
4:00 pm	
5:00 pm	
6:00 pm	
7:00 pm	
8:00 pm	
9:00 pm	

	ACTIVITY
9:00 pm	
10:00 pm	
11:00 pm	
12:00 am	
1:00 am	
2:00 am	
3:00 am	
4:00 am	
5:00 am	
6:00 am	
7:00 am	
8:00 am	
9:00 am	

- It is normal to experience tingling in you hand and arm while wearing the monitor.
- If you decide to remove the monitor, please turn the monitor off by turning the small black switch, on the bottom of the monitor, to the **off** position.
- Please do not wear the monitor around your waist when you go to bed. Try to lay the monitor on the bed or floor beside you or on a nighttable.

TIME you went to **SLEEP**: _____
TIME you **WOKE UP**: _____
TIMES you filled in the **QUESTIONNAIRES**: _____

IF YOU HAVE ANY QUESTIONS OR CONCERNS WHILE WEARING THE MONITOR PLEASE CALL THERESA AT **734-0309** OR **822-3800** AND LEAVE YOUR NAME AND THE TIME YOU CALLED.

APPENDIX D

PERSONAL NOTES

TIME	ACTIVITY

SITUATIONAL BLOOD PRESSURE STUDY

AMBULATORY MONITORING DIARY

DATE: _____

ID: _____

APPENDIX E

SITUATIONAL BLOOD PRESSURE STUDY

Date: _____ I.D.:_____

Sometimes people notice physical changes in their bodies just before, during , or after their blood pressure is measured. Below is a list of physical sensations which you may or may not have experienced. If you experienced any of the physical sensations listed below, please indicate this by circling the time which this occurred (e.g. before, during or after). You may circle more than one of these items if it is appropriate, and you may circle more than one time for each item. If there were physical sensations you experienced that have not been listed below, please indicate what they were on the blank lines.

INCREASED HEART RATE	before	during	after	not at all
SHORTNESS OF BREATH	before	during	after	not at all
DIZZINESS	before	during	after	not at all
SWEATING	before	during	after	not at all
WEAK KNEES	before	during	after	not at all
TIGHTNESS IN CHEST	before	during	after	not at all
SHORTNESS OF BREATH	before	during	after	not at all
PRESSURE IN THE ARM	before	during	after	not at all
TIGHTNESS IN THE THROAT	before	during	after	not at all
LIGHT-HEADEDNESS	before	during	after	not at all
_____	before	during	after	not at all
_____	before	during	after	not at all

Please indicate whether or not you had any of these thoughts before, during or after your blood pressure was measured in this situation.

1. I expected that it would be painful when the blood pressure cuff inflated.	yes	no
2. When the cuff inflates I feel as though my veins or arteriers will burst.	yes	no
3. When my blood pressure is being taken I think it may do damage to my heart.	yes	no
4. When my heart starts to race and/or I feel my chest becoming tight, I worry that I might have a heart attack.	yes	no
5. When I feel short of breath, I think that I may stop breathing or suffocate.	yes	no
6. When I feel dizzy and/or light-headed I think I may faint, fall over or pass out.	yes	no
7. When I feel my throat tightening I think I may choke.	yes	no
8. When I notice changes within my body I think I will do something silly or uncontrolled and make a fool of myself.	yes	no
9. When I start to sweat and/or my knees feel weak I think something terrible will happen to me.	yes	no