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The purpose of the present study was to evaluate whether a social variable, demand characteristics, could influence heart rate on the behavioral avoidance test(BAT). Two levels of fear, as measured by the fear survey schedule(FSS), and two levels of demand permitted the simultaneous study of demand, fear, and demand-by-fear interactions on heart rate change(HR-C), BAT, and a self-rating of fear, fear thermometer(FT).

Demand Level was varied by means of testing instructions to the two groups. The Low demand group received testing instruction informing them only that their level of physiological arousal was being measured. High Fear groups were told specifically that their heart rate was being measured. Further, high demand subjects were told that they would be encouraged to continue with each item unless a significant increase was observed in their heart rate.

Discriminant analyses showed that levels of fear and levels of demand could be differentiated using all three measures. No single measure could differentiate fear groups on analyses of variance of HR-C, BAT, or FT.

Only heart rate differed significantly for demand groups. This significant finding could not be accounted for by significant, systematic differences in initial heart rate. Demand level accounted for 49% of the total heart rate variance.

There were no significant interactions, nor did a post-hoc regression analysis of HR-C on FSS rating reveal any significant trends.

THE EFFECTS OF DEMAND CHARACTERISTICS ON HEART RATE: IMPLICATIONS FOR A TRIPLE RESPONSE MODE HYPOTHESIS

by

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INTRODUCTION

Although occasional reports of high correlations among various measures of anxiety have been reported (Thayer, 1970), most reviewers concur that there is generally low correlation among measures of anxiety or fear (Sarason, 1960; Martin, 1961). This lack of concordance and low correlations among measures of fear have led behavior modifiers to think in terms of multiple response modes (Lang, 1968) which may be measured through one of three channels: verbal, overt-motor, and physiological (Bernstein, 1973).

Simultaneously, there has been a growing concern that "cognitive" variables may have strong influences in behavior therapies (Wilkins, 1971). Such cognitive variables include experimenter expectancy, subject expectancy, and demand characteristics, all of which may influence the measurement techniques used in behavior research and therapy.

Due to the fact that behavioral avoidance tests (BAT) are often regarded as the primary measure of therapeutic change, much of the current concern over the impact of demand characteristics and expectancies is directed toward the BAT. Bernstein (1973) and Miller and Bernstein (1972) have cast doubt on the validity of the BAT as a measure of fear by demonstrating that a subject's performance on the BAT can be affected by demand characteristics. In the process, Bernstein has strongly implied that physiological measures of fear would be more valid.

One implication for a triple response mode view of behavior of viewing the BAT as a less valid measure of fear is that response modes differ in their reliability and validity as measures of fear; specifically, the implication is that a physiological measure would be more valid than the BAT.

One means of determining if a physiological measure is more valid and reliable is to determine if it is possible for demand characteristics to influence a physiological response within the context of the BAT. If the physiological mode is a more valid index of fear, it should be resistant to manipulation by demand characteristics.

In introducing the current experiment, three issues on which the experiment is based will be discussed in detail. The first of these is the triple response mode. The second is the nature and importance of demand characteristics. The third section deals with several aspects of heart rate, among these being the relationship between heart rate, autonomic and skeletal activity; the rationale for the use of heart rate in fear research; and the effect of cognitive variables such as expectancy and demand characteristics on heart rate.

Triple Response Mode

The need for measuring from three modes in order to correctly assess fear was first expressed by Paul (1966). He stated that in order to assess anxiety, one must make direct measurements of verbal, motoric, and physiological components of fear. As others before him, he did not find strong correlations between measures of fear that did not come from the same mode.

Mischel (1968), reviewing similar results, limited his discussion to overt-motor and verbal measures: he noted that the more divergent the situation, the lower the correlations between measures on the same device; and that the more divergent the measurement devices used in the same situation, the lower the correlations of their scores. He termed these observations respectively, situation and mode specificity, both of which are due to the operation of learning principles. Mischel argued that there was no necessary relationship between response modes, since their association or dissociation is purely a matter of the learning history of the individual and the current situation.

Lang (1968), in commenting on his research with human fear and its modification by means of systematic desensitization, stated:

> It is both convenient and parsimonious to consider fear a response, or more properly a complex of responses .... These responses may be evidenced in the main, expressive modes of the body. Thus, we expect to find verbal fear responses, overt fear behavior, and relevant somatic responses .... (In therapy.) Fear change should appear in all modes. However, correlations between separate measures of fear change are surprisingly low .... Thus, subresponses of the complex must be measured separately and, at least initially, assessed separately. Furthermore, we must be careful not to assume that one system is more important or fundamental than the others .... These response systems can be shaped and controlled independently. It is reasonable to assume that treatment may be similarly specific. Change in one behavioral mode does not automatically signal change in an overall organismic set.

Lang (1968) explicitly stated the two major implications of his view. First, in the study of fear and fear change as a result of treatment, one must measure subresponses from the three major response modes. Second, in the clinical treatment of fear, clinicians should assess the mode or modes affected and design specific treatments to affect change in that mode.

Subsequently, Bernstein (Bernstein and Paul, 1971; Bernstein, 1973) argued that the BAT frequently employed in analogue studies of small animal fears was not a direct measure of fear. The BAT was a "secondary" operant response. Conceptually, this is in opposition to "primary" respondent responses which are direct measures of anxiety. Bernstein's contention was supported by a series of studies (1973) which suggested the same ease with which performance on the BAT could be affected by demand characteristics.

In summary, areas of agreement and disagreement become apparent. The area of agreement is that there are dissociable response modes; that a good means of classifying them is in terms of available methods of measurement, namely, verbal, motoric, and physiological (Bernstein, 1973); and that in order to assess behavior, one must either select a mode of interest, or else measure from all of the modes.

The central area of disagreement would appear to be the relative value of measurement of the three modes. Lang (1968) suggests that as a working hypothesis, the modes should be regarded as being of equal importance in the measurement of anxiety. Bernstein (1973) argued, in accordance with Krause (1961), that a necessary criterion of fear is evidence of arousal. Therefore, measures of physiological arousal, particularly measures from the physiological mode should be granted special importance as a check on the other measures of anxiety.

Although the above positions were formulated primarily with regard to research evaluation, they also have implications as to how the therapist should treat anxiety problems. If one accepts as a working hypothesis that the modes are separate, equal, and dissociable, it follows that an individual's anxiety response may be limited to one mode and best treated by treating the symptoms in that mode, with success defined by changes in that response. On the other hand, if one assumes evidence of arousal is necessary evidence of anxiety, a client must suffer from anxiety responses in the physiological mode, or, by definition, his problem is not anxiety. It follows that heightened arousal must be diminished by the therapeutic technique in order for it to be termed effective.

Response Mode Relationships

Many theories of behavior accept the idea that one response by an organism can serve as a cue for another response by the same organism. This idea is most evident with respect to the mutual influence of motor and verbal behaviors (Brodsky, 1967; Lovaas, 1964). It is more difficult to specify relationships between physiological or autonomic responses and responses from other modes.

The concept that physiological responses affect and are reciprocally affected by responses from the verbal and motor modes rests on three assumptions about the nature of physiological responses. First is the assumption that the physiological response or some correlate of it can be discriminated; otherwise autonomic responses could not control responses in other modes in any but a reflexive manner. Second is the assumption that responses from other modes can control physiological responses either directly or by means of controlling some correlate of the autonomic response. Third is the assumption that since motor and verbal responses can be controlled by external stimuli, either directly or indirectly exteroceptive stimuli may come to control autonomic responses.

Several independent lines of research tend to support the above assumptions. Anatomical studies tend to indicate discrete afferent and efferent autonomic pathways exist between the visceral organs and the central nervous system. They, also, indicate intimate interrelations at all levels of the nervous system of the autonomic and skeletal nervous systems (Adam, 1967; Ganong, 1969; Guyton, 1972). Brain stimulation studies indicate that cortical control of some autonomic responses is possible (Delgado, 1960) and that even subcortically elicited responses are modifiable by external events (Valenstein et al., 1970).

Learning studies yield similar results. Studies of the classical conditioning of autonomic responses indicate that novel exteroceptive stimuli can come to elicit autonomic responses (Young, 1965). Studies of the operant conditioning of autonomic responses indicate that the external consequences of autonomic responses may come to control those responses (Hnatiow and Lang, 1965; Engel and Hansen, 1966; Klinge, 1972; Martin and Dean, 1970). Studies of interoceptive conditioning indicate that visceral stimuli can serve as either conditioned or unconditioned stimuli for motor or verbal responses (Uno, 1971; Adam, 1967; Chernigoskiv, 1967; Razran, 1961). Studies which indicate that internal responses can also control instrumental responses are also available (Leeper, 1935; Slucki, Adam, and Porter, 1965).

Although physiological and learning studies provide a basis for viewing physiological and motor or verbal responses as having reciprocal effects on one another, they do not provide a means of stating whether this relationship is direct or indirect. The ease with which verbal-perceptual factors affect classical conditioning of autonomic responses have led to many alternative indirect explanations of the phenomenon (Mandel and Bridger, 1973; Smith, 1967; Young, 1965; Grings, 1965). However, it is not clear whether the mechanism of autonomic conditioning is an entirely empirical one (Smith, 1967).

Irrespective of the precise mechanism, it is clear that measures of autonomic responses change in a manner consistent with the view that antecedents and consequences of autonomic responses, be they responses from other modes or exteroceptive stimuli, control those responses in a manner similar to the control they exert over motor and verbal responses. Lacey's (1967) accounts of individual response stereotypy are explicable in these terms.

Response Mode Equality

Having established a basis for the relationship between the response modes, the question arises as to which mode of responding best reflects the subject's anxiety. Bernstein and Paul (1971) definitely propose that physiological measures best reflect the subject's fear.

They implicitly assume that sympathetic activation is a prerequisite of emotion and that sympathetic activation has two kinds of consequences, direct and indirect (Paul and Bernstein, 1973). Sympathetic activation directly causes some responses, such as increased heart rate or galvanic skin response (GSR), stuttering, or hand tremors. It may cause some indirect responses, such as statements of fear or avoidance responses. The lack of correspondence between reported emotion and overt emotional behavior in spinal injured patients lends credence to the first assumption (Hohman, 1966). The second assumption is less tenable.

The major distinction between direct and indirect measures of anxiety would appear to be the degree to which the responses can be controlled by stimuli other than sympathetic arousal. Responses such as self-report are easily modified by demand characteristics; but psychophysiological measures would not appear to be so easily modified (Bernstein, 1973; Miller and Bernstein, 1973; Bernstein and Nietzel, in press).

The previous discussion of conditioning studies suggests another alternative. If the most frequently used psychophysiological measures, heart rate and GSR, are, as has been stated, conditionable and easily influenced by events other than sympathetic arousal. It seems likely, then, that changes in the physiological or verbal modes are not observed simply because no task demands or demand characteristics for such changes existed in the experiments. If an experiment were conducted in which demands for such changes existed, it seems that they would occur.

If the latter view is correct, there may be direct measures of anxiety, but none of the currently used phychophysiological measures would meet the criterion of a direct measure, which is lack of modifiability by conditioned or discriminative stimuli other than sympathetic arousal. The experiment described below is essentially a test of the above logic.

In summary, the set of fear responses may be divided according to the means by which the response is made and observed into subsets of motoric, physiological, and verbal behaviors.

The differential effects of environmental stimuli create the dissociability of modes and individual stereotypy within a mode (Lacey, 1967). Modes are not truly independent, for responses within any one mode may serve as a cue for a response in another mode.

The fact that responses within all of the modes are subject to environmental influence casts doubt on the assumption that measurements of any one mode would more direct measures of fear than responses in another mode. It seems best, then, to regard the modes as equal in importance in the diagnosis, treatment, and evaluation of fear and its modification.

Demand Characteristics

Orne (1959) defined the demand characteristics of the experimental situation as those cues which convey to the subject the experimenter's hypothesis and purpose. Certainly, the main reason to be concerned about conveying experimental hypotheses to the subject is the increased likelihood that the subject's behavior will be altered in a manner consistent with the hypothesis, biasing the results in the desired direction (Orne, 1962).

Demand characteristics in Orne's analysis are effective mainly as a consequence of the subject's past learning history. Lack of past experience, inability to generalize from past experience, or lack of motivation to respond to demand characteristics could all lead to a failure of demand characteristics to change a subject's behavior. Awareness of demand characteristics, however, is not necessary for their effectiveness.

Borkovec (1973b) has spoken of demand characteristics as discriminative stimuli. This seems consistent with Orne's statements of the necessity of prior experience for the demand characteristics to have an effect.

Viewing demand characteristics as discriminative stimuli, one sees that manipulation of many variables not usually termed demand characteristics including experiments in which groups of subjects are treated differently as a consequence of manipulation of experimenter bias; instructional variations designed to vary subject attribution expectancy or perception; or situational variations to alter subject attribution, expectancy, or perception, may be conceptualized as manipulation of demand characteristics.

Initially Orne (1962) attributed the motivation for the operation of demand characteristics to the subject's willingness to be a good subject and help the experimenter. Subsequent research (Weber and Cook, 1972) tends to indicate that psychological experiments cause the subject to fear that he is being personally evaluated by the experimenter; for example, his performance may indicate his intelligence or his mental health. This fear of evaluation is currently viewed as the motivation for responding in accordance with demand characteristics. Several studies (Johnson, 1973; Geller and Endler, 1973; Bruehl and Solar, 1970) indicate that both fear of evaluation and the explicitness of demand characteristics affect the subject's performance. Fear of evaluation appears to affect subjects in a linear fashion, so that the greater their fear, the more likely they are to behave in accordance with the experimental demand characteristics. Explicitness of demand characteristics seems to have a curvilinear effect, such that subjects are most likely to behave in accordance with a moderately explicit demand than little demand or explicit demand.

It has been suggested that demand characteristics may play a large role in the results obtained in small animal phobia analogue research. For example, the title of the experiment (Bernstein, 1973), different expectations of therapeutic gain (Borkovec, 1973b), or more believable therapeutic rationales (Borkovec and Nau, in press) might all differentially affect BAT performance by altering demand characteristics.

It is hypothesized that fear level and demand characteristics interact, so that the performance of moderately fearful subjects is most affected by demand. Therefore, it is essential that subjects used in analogue studies of therapeutic outcome be sufficiently anxious, so that their behavior will not be affected by demand characteristics (Borkovec, 1973a, b; Bernstein, 1973).

Since the BAT is an indirect measure of fear, in that demand characteristics influence performance on the BAT, outcome studies which use the BAT as their primary measure may use less anxious subjects and may not be clinically relevant (Bernstein and Paul, 1971). Therefore, Bernstein and Paul (1971) suggest that physiological measures of arousal be used as a check of BAT performance; this would prevent non-fearful persons from becoming subjects in analogue studies and thereby increase their external validity.

Two studies (Miller and Bernstein, 1973; Bernstein and Nietzel, in press) support Bernstein's position. In the first study, the fear studied was claustrophobia; in the second study, snake-fearful subjects were used. Due to the types of BATs used, actual physiological measures were taken only with claustrophobics. For these subjects, differing instructions affected the duration of time that they would spend enclosed in a small room but not the physiological response to the enclosure (Miller and Bernstein, 1973). Snake-fearful subjects did not show the same results. Instead, demand interacted with testing sequence and subject characteristics. Demand did affect initial performance on the BAT, however. Changes in a direct motoric measure of fear were consistent with the indirect BAT measure (Bernstein and Nietzel, in press). As noted earlier, the distinction between direct and indirect measures of fear and the implied superiority of physiological measures relies on the assumption that physiological measures are not affected by external events. At least three studies of demand characteristics have used tasks where physiological measures of responsiveness to the presentation of stimuli were modified by demand characteristics.

Hicks (1970) showed that, in a perceptual defense task, the nature of the experimenter (automated, reserved female, or social female) resulted in significant differences between groups in both number of taboo words reported and the physiological responses to the words, as measured by heart rate, palmer conductance, and vasoconstriction. Musante and Anker (1972) employed heart rate and GSR as measures of responsivity to a tone. Subjects were instructed to inhibit their responses to the tone. Subjects were able to inhibit their GSR if the experimenter were present, but not if the experimenter were absent. Borkovec (1973a) conducted repeated BATs with or without suggestions of improvement. He found a significant pulse rate decline for those in the suggestion groups over trials. However, due to an interaction effect, he did not interpret his results as indicating the effectiveness of demand characteristics in affecting physiological responses. Hicks (1970) and Musante and Anker (1972) did interpret their results in terms of demand characteristics effects on physiological measures.

Heart Rate

Heart rate has long been taken as a measure of emotion (Canon, 1929; Delgado, 1966). The present study is concerned with factors, other than an increase or decrease in sympathetic activity, that may possibly affect heart rate. These factors are considered in the context of the association of the heart, the autonomic system, and somatic activity.

The heart is innervated by both the sympathetic and parasympathetic systems, the sympathetic by means of the cardiac nerves originating in the cervical ganglia, and the parasympathetic by means of the vagus. Parasympathetic innervation is spread throughout the heart having no single identifiable locus (Ganong, 1967).

In general, one may conclude that sympathetic activity increases heart rate and contractibility, while parasympathetic activity decreases heart rate (Guyton, 1972). Heart rate is maintained by the interaction of these two branches of the autonomic nervous system. Consequently, there are two ways in which heart rate may increase, and two ways in which it may decrease. It may increase by either increased sympathetic activity or decreased parasympathetic activity. On the other hand, either increased parasympathetic or decreased sympathetic activity results in a decrease in heart rate.

One example of the close interaction of the somatic and autonomic nervous systems is the effect of respiration on heart rate.

Inspiration results in a momentary increase in heart rate, while expiration momentarily decreases heart rate. Muscle tension also significantly influences heart rate. The means of these somatic influences is uncertain, but one possibility is the fact that both of these somatic factors affect oxygen and carbon dioxide levels in the blood, levels of these substances affecting receptors in the carotid bodies and thereby heart rate (Ganong, 1969).

Although the exact means by which somatic influences are exerted over heart rate is unclear, the implications for the modifiability of heart rate through the somatic system is clear. Obrist, Wood, and Perez-Reyes (1965), for example, noted that the frequently noted initial cardiac acceleration in the biphasic acceleratory-deceleratory response observed in classical aversive heart rate conditioning is due entirely to a quick, sharp inspiration and that in dogs changes in heart rate are almost entirely accounted for by somatic changes. Sroufe (1971) demonstrated the possibility of controlling heart rate in an operant paradigm by training subjects to control their respiration. This was accomplished primarily by means of controlling depth of respiration, rather than the more frequently controlled for rate of respiration.

Belmaker et al. (1972) demonstrated that heart rate can be increased by telling subjects to tense their chest muscles. This increase is unaccompanied by visible muscle movement or changes in muscle tension as measured by surface electromyograph. These results illustrate the possibility of unmeasured muscle tension affecting he rate in studies of operant conditioning of cardiac functioning and accounting for observed cardiac changes.

Many studies have attempted to control for somatic effects and still obtain conditioning effects. For example, Brener and Hothersall (1967) trained subjects to breathe at a constant rate and depth. After training, subjects were able to control their heart rate without changing their respiration. Obrist et al. (1965), using a similar technique to control for respiration and drugs to block parasympathetic and peripheral sympathetic actions, demonstrated that the deceleration portion of the aversively classically conditioned heart rate response seems to be due to an increase in parasympathetic activity which overrides increased sympathetic activity and not to respiratory or peripheral changes.

Similar physiologically oriented studies have yet to be carried out with operant conditioning of heart rate. Engel (1972) has argued for the involvement of different neural mechanisms within the autonomic nervous system in the acquisition and maintainence of operantly conditioned cardiac changes.

Regardless of the precise source of cardiac changes in classical and operant conditioning, it is clear that these changes can be brought under stimulus control (Engel, 1972). It is likewise clear that at least in the operant paradigm a variety of cognitive and motivational factors influence heart rate increase. Bergman and Johnson (1971, 1972) have shown that information has a great effect on the degree of conditioning. The greater the specificity of the instructions to the subject concerning the response to be altered and the magnitude of external reinforcement increase the efficacy of conditioning.

On the other hand, awareness of one's autonomic responses, at least as measured by questionnaire data (Mandler, Mandler, and Uviller, 1958) seems to be inversely correlated with conditioning of autonomic functions. Greene and Nielson (1966) found that GSR was more difficultly conditioned with high perceivers than low perceivers. Similarly, Blanchard et al. (1972) found that the more aware subjects were of their heart rate the more difficulty they found in conditioning.

These results may be related to studies of the effectiveness of false heart rate feedback in the modification of fear behavior (Valins and Ray, 1967). Such studies indicate that in general either strong heart rate reactivity or strong heart rate perception hinders its effectiveness (Borkovec and Glasgow, 1973) and that in those cases where behavioral changes do occur there are concomitant heart rate decreases (Goldstein et al., 1972; Stern et al., 1972).

Attention seems to be another mediator of heart rate. Dahl and Spence (1971), for example, have found that mean heart rate can be predicted from the nature of task demands: the more complex the task or the response, the higher the heart rate.

In conclusion, heart rate is controlled by the autonomic nervous system. However, the close association of autonomic, including cardiac, functioning with somatic nervous system activity suggests a means by which factors other than generalized sympathetic activity could result in increased cardiac activity. Further, the fact that heart rate is a response conditionable without a general sympathetic arousal and is consequently affected by motivational, cognitive, and perceptual factors not obviously related to sympathetic arousal, strongly suggests the possibility that demand characteristics might affect heart rate on the BAT. At the present time there is no study which tests this prediction.

In order to test this prediction, the present study employed a two-by-two factorial design. The two dimensions were level of stated fear of snakes on the fear survey schedule, and level of experimental demand. Each dimension had a high and a low level. The experimental prediction was that there would be a significant main effect for demand on the dependent measure of heart rate change.

If Bernstein's (1973) analysis of demand characteristics and their effects were correct, demand should have little or no effect on heart rate. In addition, heart rate, as a direct measure of fear, should discriminate between the high fear and low fear groups. Further, there should be an interaction between degree of fear and the effect of demand characteristics, such that moderate degrees of snake-fearfulness should be most affected.

METHOD

Experimental Design

A 2 x 2 experimental design was used. Its two dimensions were (1) level of snake-fearfulness and (2) degree of experimentally-induced demand for change in heart rate. The two levels for each dimension were high and low. College student subjects were assigned to one of four groups: high fear - high demand, high fear - low demand, low fear - high demand, and low fear - low demand. Each subject participated in a behavioral avoidance test (BAT) involving a snake. The dependent measures were the last completed BAT item, fear thermometer (FT) rating on the last item, and the difference in heart rate from an initial rest period to the last completed BAT item.

Subject Selection

A modified fear survey schedule (FSS; see Appendix A; Wolpe and Lang, 1964) was given to students in psychology courses. The FSS employed self-ratings of fear of several items on a five point scale ranging from "no fear" to "terrified". Eight subjects who rated their fear of snakes as one to three were classified as low fear subjects, and eight who rated their fear as four or five were classified as high fear subjects. Within fear levels, subjects were randomly assigned to demand conditions. Of the 16 subjects employed 12 were female and four were male. In the high fear - high demand group, all four subjects were female; in the high fear - low demand group, three female and one male; in the low fear - high demand group, three female and one male; and in the low fear - low demand group, two female and two male.

Procedure

The experiment was conducted within the context of a BAT. Prior to the administration of the BAT, subjects were given certain factual information about snakes (Participant Information Sheet, Appendix B). A printed sheet informed them that they were being asked to participate in a performance test to assess their fear of snakes and that they should proceed in the test as far as they could so that an accurate estimate of their fear could be obtained. If subjects asked if they had to complete the test or item, they were told that they did not have to complete the test or item, but that they should try to do as much as possible so that their fearfulness could be accurately evaluated. The testing instructions constituted a high demand for snake approach. In fact, only one of the 16 subjects refused to touch the snake with gloved hands. This is the criterion usually employed by this experimenter for classifying a person as non-fearful and thereby excluding him from participation in therapy outcome research.

Subjects were examined individually by one male experimenter. A modified Levis apparatus (Levis, 1969) was employed in order to minimize the effects of gross motor movements on the heart rate measure. The apparatus consisted of a straight-backed wooden chair with a pulley track extending in front of it. At the end of the pulley, directly in front of the chair where the subject would be seated, was a red light and a switch on a small control panel. Behind the subject's chair w[illegible] a desk and chair. The experimenter sat at the chair during the experiment. Atop the desk were a main control switch for the Levis apparatus and a Grass model 7 portable polygraph. Closure of the master switch illuminated the red light; subsequent closure of the subject's switch caused the light to go off, and for the snake cage attached to the pulley track to automatically approach one foot closer to the subject on items one through ten. The snake, which was enclosed in a plexiglass cage (18"x16"x14"), was a six-foot boa constrictor which had been used in several previous experiments of this type. During the BAT, three measures were taken, the BAT item completed, a self-report measure, and the heart rate for each item.

The BAT consisted of twenty-one hierarchical items ranging from sitting nine feet from a caged snake (item 1) to picking up the snake with bare hands and holding it in front of the chest for a count of fifteen (item 21). The procedure for each item was the same. The experimenter explicitly stated the nature of the item and pressed a switch which illuminated a red light beside the subject's switch. The subject, upon seeing the red light, rated his fear on a scale one to ten. Then, he either pressed his switch to indicate his willingness to complete the task and thereupon completed it, or he did not press the switch and waited 60 seconds, thereby, terminating the item and the experimental session. During the 60 second interval subjects were encouraged to continue. Two times during the interval the experimenter would ask the subjects to continue. (BAT forms are presented in Appendix B.)

During the BAT, subjects were asked to rate their fear on a scale of one to two, one being no fear and ten being terrified. The rating was to take place during the interval between the illumination of the red light and the subject's pressing or not pressing the switch to indicate their intention or lack of intention to complete the item. The rating scale was termed the fear thermometer (FT; Walk, 1956).

The portable polygraph was used to record heart rate. After entering the experimental room and being seated, the subjects had three electrodes attached to him or her. The electrodes were typically placed on the left wrist, right ear lobe, and left ear lobe, with the left ear lobe electrode serving as the ground electrode. The signal from the electrodes was amplified by means of a Grass 7 p4a amplifier and printed out on paper by the polygraph. If subjects asked if the electrodes would hurt, they were told that the electrodes were used only for measurement of arousal and not for shocking. A five to seven minute interval intervened between the time that heart rate began to be recorded and the time that the BAT actually began. This interval was intended to provide the subject with an opportunity to adjust to the equipment and situation prior to the actual test, and served as a resting measure of heart rate (basal number of beats per minute). An event marker was also attached to the polygraph. The experimenter activated the event marker by a thumb press at the beginning of an item and deactivated it by thumb release at the end of the item. Only heart beats within the period indicated by the event marker on the permanent record were counted in the estimation of heart rate for a given item.

<u>Experimental Manipulation of Demand Characteristics</u>

Assignment to demand conditions was random. High and low demand conditions for heart rate change differed only with respect to two instructional changes for the high demand groups. While attaching the polygraph electrodes, the experimenter told the low demand groups that the electrodes were to measure physiological arousal. The high demand groups were specifically told that their heart rate was being measured. At the end of the reading of instructions to subjects, the experimenter told only the high demand groups that they would be encouraged by him to continue items unless he noticed a significant increase in the subjects heart rate. In fact, no such stipulation was carried out. Subjects were encouraged to continue irrespective of their heart rates. Below are the verbatim instructions read by the experimenter to the subjects.

Low Demand

Please be seated. I am going to attach some electrodes to measure your physiological arousal. I am going to give you certain specific instructions to follow, and you should do exactly as you are instructed to do. Please do not ask any questions at this time. Simply follow my instructions. You will be requested to perform a series of steps of increasing approach to a non-poisonous snake. First, I will describe the nature of the step that you are to perform. Then, at the appearance of the red light directly in front of you, you will state your fear on a scale of one to ten, one being no fear and ten being terrified. Next to the red light is a switch that is presently in the down position. After the red light goes on and after you have estimated your fear from one to ten, you will indicate your intention to complete the requested task by pushing the switch up. Once you push the switch you will be required to complete the step described to you. Therefore, if you think you cannot complete the item, estimate your fear from one to ten, do not push the switch forward and wait 60 seconds.

To repeat, the procedure is as follows. First, you will be told the nature of the step you are to perform. Second, the red light will be illuminated. Third, you will estimate your fear as soon as you see the light. Fourth, you will push the switch in the up position, at which point you will have committed yourself to performing the item. If you cannot commit yourself, estimate your fear, do not push the switch and wait 60 seconds.

High Demand

Please be seated. I am going to attach electrodes to measure your heart rate. I am going to give you certain specific instructions to follow and you should do exactly as you are instructed to do. Please do not ask any questions at this time. Simply follow my instructions. You will be requested to perform a series of steps of increasing approach to a non-poisonous snake. First, I will describe the nature of the step that you are to perform. Then, at the appearance of the red light directly in front of you, you will state your fear on a scale of one to ten, one being no fear and ten being terrified. Next to the red light is a switch that is presently in the down position. After the red light goes on and after you have estimated your fear from one to ten, you will indicate your intention to complete the requested task by pushing the switch up. Once you push the switch you will be required to complete the step described to you. Therefore, if you think you cannot complete the item, estimate your fear from one to ten, do not push the switch forward and wait 60 seconds.

To repeat, the procedure is as follows. First, you will be told the nature of the step you are to perform. Second, the red light will be illuminated. Third, you will estimate your fear as soon as you see the light. Fourth, you will push the switch in the up position, at which point you will have committed yourself to performing the item. If you cannot commit yourself, estimate your fear, do not push the switch and wait 60 seconds. During the 60 seconds, I will encourage you to continue the item unless I notice a significant increase in your heart rate.

Dependent Measures

The measure of primary interest was heart rate change (HR-C). HR-C was defined as the number of beats per minute on the terminal item (HR-T) minus the basal number of beats per minute (HR-B) during the initial period. HR-B was the first 30 seconds of clearly readable heart rate data following the attachment of the electrodes. Multiplying the number of beats in the interval by two yielded a HR in terms of beats per minute. HR-T was calculated from the first 30 seconds of the last completed item of the BAT. If the duration of that item was less than 30 seconds, the number of beats within the observed number of seconds was prorated to provide a beats per minute measure. Subtraction of HR-B from HR-T in order to yield HR-C provided a measure of change in beats per minute.

Other measures were calculated quite simply. The BAT score was simply the number of the last item completed. The subject's FT score was the subject's self-reported fear on a scale of one to ten on the last completed BAT item.

RESULTS

Multivariate Analyses

When using multiple dependent measures, it is desirable to conduct a multivariate preliminary test of significance. In most psychological designs the multivariate test of preference is a multivariate analysis of variance. This may be followed by either other multivariate procedures or univariate analyses of variance (Hummel Sligo, 1970). In order to use the multivariate analysis of variance the product of the degrees of freedom in the experiment must be equal to or greater than the number of dependent measures. Since this con tion did not hold in the current experiment, discriminant analysis (DA) was used as an alternative.

DA is a means of testing the significance of the distance between two multivariate normal population. The specific stastic used is the Mahalanobis D-square. Further, the particular computer program used to analyze the data from this study (UCLA, biomedical 05M) also yields equations which maximize the distance between the two populations and, thus, provide the best means of discriminating the two populations. Employing these equations, the computer classifies the subjects into groups. The accuracy of the classification gives an indication of the adequacy of the equation.

Insert Table 1 about here

Table 1

Discriminant Analysis:

Demand Characteristics

Test of Significance		
D-square	18.94	$p < .001$

Function

Coefficient	Low Demand	High Demand
HR-C	-0.07	0.30
BAT	1.51	1.36
FT	1.03	.81
Constant	-17.79	-19.29

Classification Matrix

Experimental	Computer Classification	
Group	Low Demand	High Demand
Low Demand	7	1
High Demand	1	7

The results for demand characteristics of a discriminant analysis are summarized in Table 1. The probability of obtaining the D-square 18.94 is less than .001. This result indicates that the difference between the low demand and high demand groups on all three dependent measures is significant, permitting one to reject the multivariate null hypothesis that there are no differences between the two groups.

Employing the equations, subjects were classified by the computer as having been more probably in either the low or high demand group. Of the 16 subjects, only two of the subjects were incorrectly classified.

Insert Table 2 about here

In Table 2, the DA for fear groups is presented. D-square was significant at the .05 level, indicating that the multivariate hypothesis of no differences between low and high fear subjects may be rejected. Employing the discriminant function it was again possible to correctly classify 7 out of the 8 subjects in each group as having more likely been in their own group. (Tabular presentation of the date and tabular and graphic presentation of group means are contained in Appendix C.)

Univariate Analyses

In order to discover the sources of variation which led to the significant differences between the two levels of each factor a univariate analysis of variance (ANOVA) was performed for each of the three measures. In addition to knowing whether an effect is significant or not, it is desirable to know how important an effect is in terms of the per cent of

Table 2

Discriminant Analysis:

Fear Levels

Test of Significance		
D-square	8.66	$p < .05$

Function

Coefficient	Low Fear	High Fear
HR-C	0.12	0.07
BAT	1.92	1.59
FT	0.53	0.84
Constant	-22.77	-17.78

Classification Matrix

Experimental	Computer Classification	
Group	Low Fear	High Fear
Low Fear	7	1
High Fear	1	7

the total variance which can be accounted for by that effect. Therefore, omega-square (Hays and Winkler, 1971) was computed for any significant effects and for the largest F ratio in an ANOVA regardless of significance.

Insert Table 3 about here

Table 3 is a summary of the ANOVA for heart rate change, the measure of primary concern. For heart rate, there is neither a significant interaction effect nor a significant effect for fear. There is a significant effect only for the main effect of demand characteristics on heart rate. Omega-square indicated that forty-nine per cent of the total heart rate variance was accounted for in terms of the effect of demand characteristics on heart rate.

Insert Table 4 about here

A particular concern in the case of heart rate was the possibility that adventitious differences in the initial heart rate of one group might have led to spurious differences in the heart rate change scores. Therefore, an ANOVA of initial heart rate was performed. Table 4 indicates that there were no significant differences between groups on the initial heart rates.

Insert Table 5 about here

Table 3

Analysis of Variance:

Heart Rate Change

Source	df	MS	F
Fear (A)	1	56.25	1.46
Demand (B)	1	625.00	16.29***
AxB	1	16.00	0.42

*$p < .01$ **omega-square = .49

Table 4

Analysis of Variance:

Initial Heart Rate

Sources	df	MS	F
Fear (A)	1	33.06	0.15
Demand (B)	1	7.56	0.04
AxB	1	5.06	0.02

Table 5

Analysis of Variance:

Behavioral Avoidance Test

Source	df	MS	F
Fear (A)	1	52.56	4.24***
Demand (B)	1	.56	.05
AxB	1	.56	.05

*p < .10 **omega-square = .35

The ANOVA of BAT scores, presented in Table 5, does not indicate any significant F values. The F value for fear does approach significance with a probability of less than .10. Omega-square indicated that 35 per cent of the BAT variability could be accounted for by the subjects fear level.

Insert Table 6 about here

In Table 6, the ANOVA for the FT is presented. No significant F values are present. The omega-square of the largest value, fear level, indicated that only nine per cent of the variance in FT ratings is accounted for by fear level.

Regression Analysis

In the hope of gaining data relating to the suggestion (Bernstein, 1973; Paul and Bernstein, 1973) that the susceptibility of subjects in BAT situations to be influenced by demand characteristics would vary with their fear in an inverted U function, a regression analysis was attempted. The regression of heart rate change and rating on the FSS was analyzed and is presented in Table 7. An ANOVA yielded no significant F value. This failure to confirm Bernstein's prediction may be due to the small N in this study, making the regression trends more difficult to see.

Insert Table 7 about here

Table 6

Analysis of Variance:

Fear Thermometer

Source	df	MS	F
Fear (A)	1	25.00	2.59**
Demand (B)	1	1.00	.10
AxB	1	12.25	1.27

** omega-square = .09

Table 7

Analysis of Variance:

Regression

Linear	1	2.19	0.04
Quadratic	2	18.48	0.21
Cubic	3	12.40	0.13
Quartic	4	76.02	0.98

Summary

Although fear levels were significantly different from each other in terms of the multivariate hypothesis, no one measure contributed significantly to that effect according to ANOVAs. Levels of demand were also significantly different in terms of the multivariate null hypotheses. The only ANOVA which yielded significant differences between the two groups was the heart rate change scores.

Despite the fact that the experimental design permitted the analysis of interaction effects between levels of fear and demand, neither the ANOVAs nor a post hoc regression analysis showed any indication of an interaction between the two experimental variables or between fear and heart rate change.

DISCUSSION

Implications for a Triple Response Mode

The most interesting finding in the study was the degree to which heart rate could be affected by the experimental manipulation of demand characteristics. Forty-nine per cent of the variability in heart rate could be accounted for by manipulation of demand, indicating a very powerful effect. The magnitude of the effect and the lack of a fear level by demand level interaction cast severe doubt on the assumptions of Bernstein (1973); rather it supports Lang's (1968) position. It would seem that the best current approach to response modes continues to be to regard them as of equal importance in the assessment of fear.

The fact that verbally presented demand characteristics can affect heart rate without affecting BAT or FT performance demonstrates quite clearly the dissociability of the modes. However, the corresponding fact that it was verbally presented demand which influenced heart rate demonstrates the interrelatedness of the modes.

The control of the verbally presented demand over a physiological response is clear. The nature of that control, is unclear, however, falling neatly into neither an operant or respondent definition.

Neither is the mechanism by which the control operates clear. The present experimenter, however, prefers an explanation in terms of minimal increments in muscle tension (Belmaker et al., 1972), despite the absence of means of confirming or disconfirming that hypothesis in this study.

Implications for Therapy

Viewing measures of the three response modes as being equally indirect and of equal importance in the definition of fear has definite implications for therapy and research. In therapy, it becomes important to assess all three modes in order to determine the client's anxiety: verbal, motoric, physiological, or some combination thereof. Treatment should, then, be directed specifically towards the mode or modes and responses therein which constitute the fear. Unless physiological responses are implicated by the assessment, there should be no need to attempt to modify those responses. Elevated physiological responsivity is not essential to the presence of "fear", nor decrease in arousal a criterion of successful therapy. The sole criterion of successful therapy is reduction of the behaviors previously identified as constituting the "fear".

Implications for Research

The same two critical findings, namely, the magnitude of the effect of experimentally manipulated demand and the lack of interaction which support the equality of the response modes, suggest that a physiological measure would not serve as an adequate control for other measures in assuring that only individuals with clinically relevant fear would be selected as subjects in analogue studies.

Reduction of Effects of Demand Characteristics

A consequent salient problem then is by what means can an experimenter eliminate or at least reduce the impact of demand characteristics on the results of his experiment. Borkovec's (1973b) observation that analogue studies which use more stringent BAT criteria are less likely to show subject expectancy effects, suggests a means of reducing the effectiveness of demand characteristics. The more stringent one's criterion of fearfulness on some measure, the less likely demand characteristics are to influence changes in performance, at least on that measure.

The observation that knowledge of the physiological response to be changed greatly facilitates the effectiveness of operant conditioning of visceral responses (Bergman and Johnson, 1971, 1972) suggests that in a BAT situation, knowledge of the response being measured might be a necessary requirement for the subject to change that response. Therefore, if the specific physiological responses being measured are not revealed to the subject, it is unlikely that demand characteristics could affect the physiological measure without the concomitant occurrence of large scale changes in other measures.

Despite such precautions, it is possible for a sophisticated subject to be aware of the response being measured. A post-experimental questionnaire can reveal such subjects, however. One might also choose to use one of the quasi-controls suggested by Orne (1969).

In summary, the results of the present study indicate that demand characteristics can have a substantial influence on heart rate in the BAT. By implication, the results indicate that at the present time, a physiological measure, such as heart rate, cannot be used as the essential criterion of fearfulness. Fear can best be conceptualized as a construct, which can best be measured by a combination of verbal, motoric, and physiological means without giving preference to one mode over the other in the assessment of fear. These conclusions support similar comments by Lang (1968) and do not support Bernstein's conclusions (1973).

SUMMARY

According to the triple response mode, the set of fear responses may be divided according to the means by which a response is made and observed into subsets of motoric, physiological, and verbal behaviors.

The differential effects of environmental stimuli create the dissociability of modes and individual stereotopy within a mode (Lacey, 1959).

Modes are not truly independent. For responses within one mode may serve as a cue for responses in another mode.

The fact that responses within all of the modes are subject to environmental influence casts doubt on the assumption that measurements of any one mode would be more direct measures of fear than responses in another mode. It seems best, then, to regard the modes as equal in importance in the diagnosis, treatment, and evaluation of fear and its modification.

Heart rate seems easily modified by environmental events, as evidenced by studies of the operant and classical conditioning of cardiac responees. Both respiration and muscle tension may play large roles in the learning of cardiac responses. As with any learned response a large number of variables may influence learning. Many of these variables are cognitive or social.

The purpose of the present study was to evaluate whether a social variable, demand characteristics, could influence heart rate on the behavioral avoidance test (BAT). Two levels of fear, as measured by the

fear survey schedule(FSS), and two levels of demand permitted the simultaneous study of demand, fear, and demand-by-fear interactions on heart rate change (HR-C), BAT, and a self-rating of fear, fear thermometer (FT).

Demand Level was varied by means of testing instructions to the two groups. The low demand group received testing instruction informing them only that their level of physiological arousal was being measured. High fear groups were told specifically that their heart rate was being measured. Further, high demand subjects were told that they would be encouraged to continue with each item unless a significant increase was observed in their heart rate.

Discriminant analyses showed that levels of fear and levels of demand could be differentiated using all three measures. No single measure could differentiate fear groups on analyses of variance of HR-C, BAT, or FT.

Only heart rate differed significantly for demand groups. This significant finding could not be accounted for by significant, systematic differences in initial heart rate. Demand level accounted for 49% of the total heart rate variance.

There were no significant interactions, nor did a post-hoc regression analysis of HR-C on FSS rating reveal any significant trends.

These results were interpreted as refuting the presumed superiority of measures of autonomic arousal in fear research or therapy for the diagnosis or treatment. It was suggested that more rigid criteria of fear or in the case of physiological measures declining to fully inform the subject of the response being measured should reduce the likelihood that demand characteristics would influence experimental measurements and results.

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APPENDIX A

Name ______________________ Local Address ____________________

Local Telephone ______________ Alternative Telephone ____________

Sex __________ Class ________

The items in this questionnaire refer to things and experiences that may cause fear or unpleasant feelings. Write the number of each item in the column that describes how much you are disturbed by it nowadays.

	Not at all	A little	A fair Amount	Much	Very Much
Speaking in public					
Snakes					
People in authority					
Dogs					
Bats					
Spiders					

APPENDIX B

BEHAVIORAL AVOIDANCE TEST (BAT)

1. Sitting 9 feet from a caged snake.
2. Sitting 8 feet from a caged snake.
3. Sitting 7 feet from a caged snake.
4. Sitting 6 feet from a caged snake.
5. Sitting 5 feet from a caged snake.
6. Sitting 4 feet from a caged snake.
7. Sitting 3 feet from a caged snake.
8. Sitting 2 feet from a caged snake.
9. Sitting 1 foot from a caged snake.
10. Sitting directly before a caged snake.
11. Touching the cage with gloved hand. (draw hand back)
12. Touching the cage with bare hand. (draw hand back)
13. Lifting the lid of the cage. (placing lid back down)
14. Placing the gloved hand in the cage. (placing lid back down)
15. Placing the ungloved hand in the cage. (placing lid back down)
16. Touching the snake with gloved hand. (placing lid back down)
17. Touching the snake with ungloved hand. (placing lid back down)
18. Picking up the snake with two gloved hands momentarily. (placing lid back down)
19. Picking up the snake with two bare hands. (placing lid back down)
20. Holding smake near chest with gloved hands for 15 seconds. (placing lid back down)
21. Holding snake near chest with bare hands for 15 seconds. (placing lid back down)

The end of an item is defined as follows:
1-10; when the cage stops moving
11-12; when S removes hand from cage
13-21; when S closes the lid of the cage

Participant Information Sheet

PLEASE READ

Dear Participant:

You are being asked to participate in a study of fear reduction. A first requirement of such a study is an accurate measure of a person's fear. The examiners will be attempting to get such a measure by actively encouraging you to perform fearful items in a prearranged test situation. Please cooperate with them.

The test involves a snake. His name is Balboa. He is a non-poisonous boa constrictor of approximately five feet in length. He has been used in many such experiments and is quite harmless. Like most snakes you will see him flick his tongue out. This is not any indication of danger. Like most snakes Balboa has poor eyesight. He uses his tongue as a scent receptor to explore his environment. In touching Balboa, you will find that he is not wet or slimy, rather he is dry and cool. His coolness is a result of the fact that he is not warmblooded. Therefore his body temperature is room temperature and that is cooler than your body temperature. When you hold him, it is quite likely that he will coil around your arm. This is done purely for support. An animal of his length cannot be easily supported between two hands. Thank you for your cooperation.

Sincerely,

The Experimenters

INDIVIDUAL DATA SHEET

SUBJECT ______________________ EXAMINER ______________________

	BAT			FT			HR			LAT		
	Pr	Po	Ch	Pr	Po	Ch	Pr	Po	Ch	Pr	Po	Ch
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20												
21												

SRIA		
Pr	Po	Ch

ANX. DIFF.		
Pr	Po	Ch

S's Expectation before _____, after session #1 _____, after session #6 _____

Therapist Likeability _________

Therapist Competence _________

APPENDIX C

Table 8

Raw Data

		High Fear				Low Fear			
Subjects		1	2	3	4	1	2	3	4
High	FSS	3	3	1	1	1	2	2	3
Demand	HR-B	84	68	80	100	84	64	96	78
	HR-C	22	41	16	22	10	16	6	11
	BAT	21	21	21	21	21	21	21	21
	FT	10	10	1	5	2	2	7	10
Low	FSS	4	5	4	5	5	5	4	4
Demand	HR-B	102	78	82	54	72	80	94	69
	HR-C	14	22	20	22	10	6	10	10
	BAT	18	13	21	19	21	8	18	21
	FT	6	6	10	7	9	10	10	9

FSS- Fear Survey Schedule; HR-B - Base Heart Rate; HR-C - Heart Rate Change Score; BAT - Behavioral Avoidance Test; FT- Fear Thermometer.

Table 9

Demand Level Mean Scores

	Low Demand	High Demand
HR-C	9.88	22.38
BAT	19.00	19.38
FT	7.38	6.88

Table 10

Fear Level Mean Scores

	Low Fear	High Fear
HR-C	18.00	14.25
BAT	21.00	17.38
FT	5.88	8.38

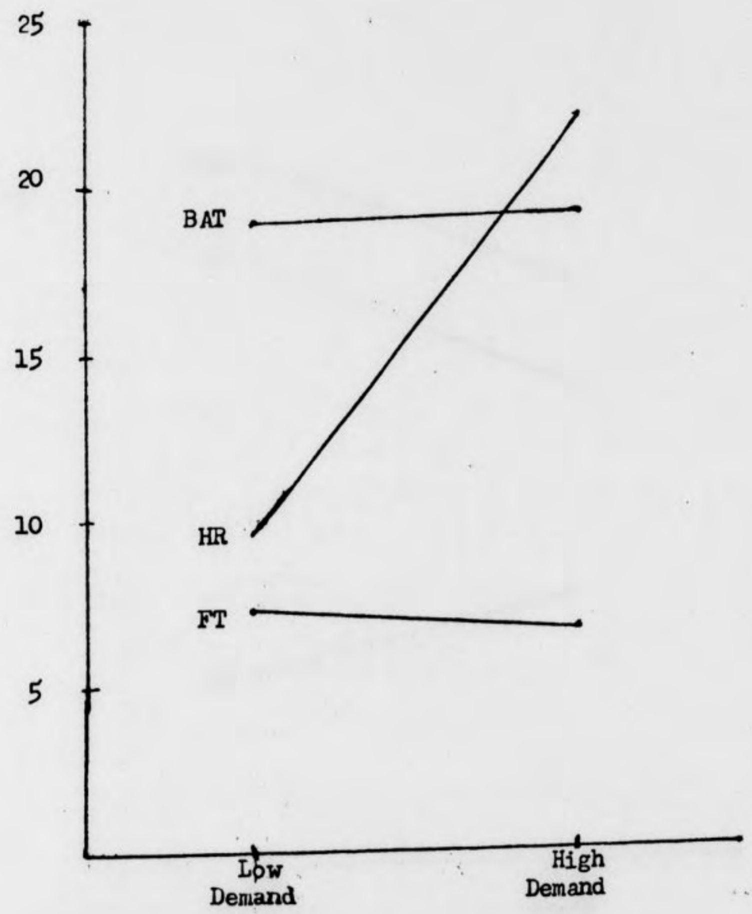
HR-C - Heart Rate Change Score

BAT - Behavioral Avoidance Test

FT - Fear Thermometer

Figure 1

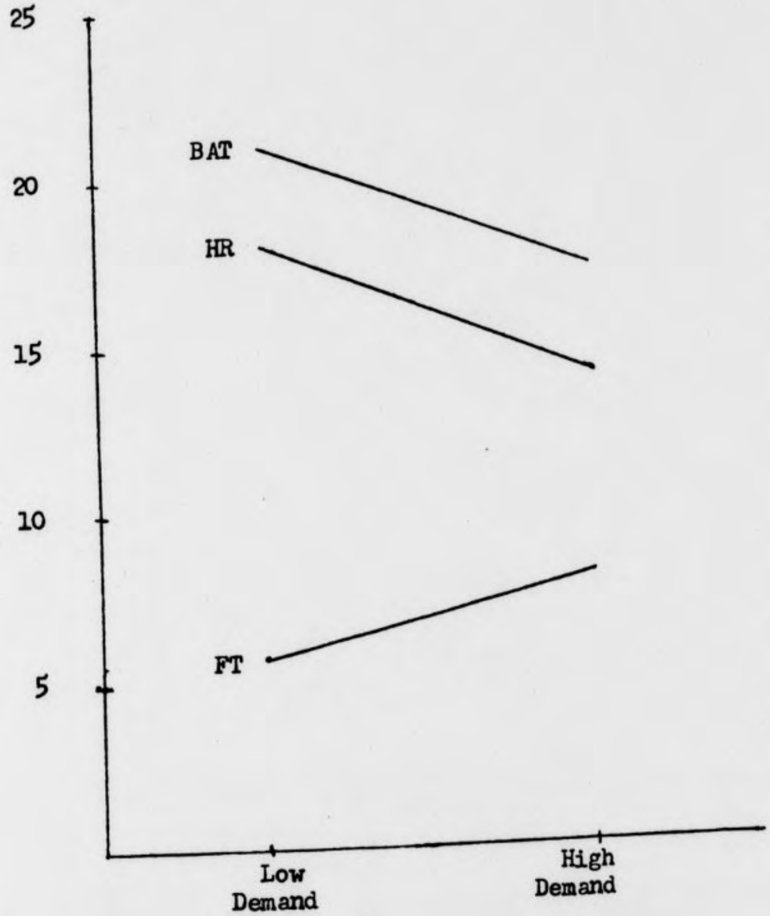
Demand Level Mean Scores



Heart Rate (HR) is a change score expressed in number of beats per minute from initial to terminal heart rate on the final BAT item. BAT is the number of the final behavioral avoidance test item completed. FT is the rated fear on the final BAT item on a scale of 1 to 10.

Figure 2

Fear Level Mean Scores



Heart Rate (HR) is a change score expressed in number of beats per minute from initial to terminal heart rate on the final BAT item. BAT is the number of the final behavioral avoidance test item completed. FT is the rated fear on the final BAT item on a scale of 1 to 10.