THE UNIVERSITY OF MANITOBA

# THE EFFECTS OF ANXIETY ON THE REACTIVITY OF THE PALMAR SWEAT INDEX

by

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## ABSTRACT

Recently, psychophysiological indices have been used along with verbal and behavioral measures, as dependent variables in psychological stress research. However, the short-comings that autonomic measures share with their paper and pencil counterparts, such as the reactive effects of measurement that are elicited in a subject when he is exposed to some sort of assessment procedure, have not been seriously investigated.

The reactive effects of measurement in experiments using autonomic indices may be considered in the context of an orienting type of response to a novel stimulus. The application of the physiological instrument is analogous to the presentation of a novel stimulus to which the experimental subject must react and habituate over repeated applications. Thus, studies dealing with habituation and related phenomena may provide a basis for the investigation of the obtrusiveness of these devices. In addition, an individual's anxiety level may affect the magnitude and pattern of his/her initial response to the measurement device and the degree to which he/she habituates to it over time. It has been shown that anxious individuals exhibit greater reactivity to the initial stimulus presentation and take longer to habituate than normals or nonanxious control subjects (see Lader & Wing, 1966).

The present study was designed to examine the obtrusiveness of the Palmar Sweat Index (PSI), a device that is gaining popularity in field studies and other naturalistic experiments. Also, the effects of a subject's anxiety level and sex on his/her reactivity to the measurement procedure were investigated. Specifically, it was hypothesized that subjects in an anxiety condition would give quantitatively as well as qualitatively different responses to the first presentation of the PSI. In addition, it was postulated that individuals in the anxiety group would take longer to habituate to the measurement device.

Sixty-two subjects were randomly assigned to one of two experimental conditions. The first condition consisted of an induced anxiety situation, threat of shock, and the second a nonanxious control condition. Both experimental groups were blocked for sex. Subjects in each group were exposed to eight presentations of the PSI and their reactions to this device were evaluated by using heart rate and skin potential activity as dependent measures. In addition, a state anxiety measure, the Multiple Affect Adjective Check List, was administered to determine individuals' subjective ratings of the experimental situation.

Subjects' reaction to the initial presentation of the PSI was observed to be a complex phenomenon. Females in the anxiety condition had a tendency to react to the PSI with more "defensive" responses than females in the control group. On the other hand, males in the anxiety condition responded to the stimulus by exhibiting an increase in orienting responses, and males in the control group showed a defensive pattern of responding similar to females in the anxiety condition. In addition, subjects in the anxiety group and females in general, took longer to habituate to the PSI. These results are discussed in terms of Lader and Mathews' (1968) model of evaluating anxiety, sex differences in electrodermal responding, and individuals' interest in the study's procedures.

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# INTRODUCTION

Researchers in the social sciences are starting to employ measures from a variety of response systems (verbal, behavioral, autonomic) to validate psychological constructs. Traditionally paper and pencil tests and verbal reports were the main instruments used to measure concepts such as anxiety. However, the disadvantages of these devices, such as response sets and misinterpretation of items, resulted in experimenters searching for other indices which could circumvent these problems and have greater interpretive power. Psychophysiological measures have become very popular in meeting this demand, especially in psychological stress research. Several advantages, like the examination of temporal trends and the applicability to nonverbal populations, are attributed to these instruments as dependent variables in experiments assessing constructs dealing with emotional arousal ( e.g., anger, anxiety). However, the short-comings that autonomic measures share with their paper and pencil counterparts, such as the reactive effects of measurement that are elicited in a subject when he is exposed to some sort of assessment procedure, have never been seriously investigated. The obtrusiveness of dependent measures has been explored for paper and pencil tests and interviews but has for the most part been ignored in psychophysiological research. This is somewhat surprising since the devices employed to monitor autonomic systems are quite commanding and provide a "reactive hazard".

The reactive effects of measurement may be considered in the context of an orienting type of response to a novel stimulus. The application of the physiological instrument is analogous to the presentation of a novel stimulus to which the experimental subject must react and adapt. Since psychophysiological indices are usually of a continuous nature (the subject is repeatedly exposed to them), the subject's reaction to them may be viewed as the habituation to the orienting response, and hence results from studies dealing with this area may provide a basis for the investigation of their obtrusiveness.

An individual's initial reaction to a novel stimulus and the time it takes for him to habituate to it have been considered as indicators of how an individual can cope with stress situations. More precisely, anxious individuals show greater reactivity to the initial stimulus presentation (Martin, 1961) and take longer to habituate than normals (Lader, 1969; Lader & Wing, 1966; Stewart, Winokur, Stern, Guze, Pfeiffer, & Hornung, 1959). However, the results of these studies have been quite variable, a situation that may somewhat be attributed to a failure to control for factors like appropriate baseline adaptation. Nevertheless, the "reactive effect" of a psychophysiological instrument and its possible link to the orienting response may be significantly affected by an individual's emotional lability, since in the experimental situation the recording equipment is the first set of stimuli that are experienced by the subject. In addition, determining a person's reaction to the measuring instrument may in itself provide an index of his reactions to novel or stress situations in general.

The purpose of the present study was to investigate the obtrusiveness of psychophysiological measures and to determine how obtrusiveness may be affected by anxiety. The particular measure that will be investigated is the Palmer Sweat Index, a device that is gaining popularity in field studies and other naturalistic experiments. The following discussion elaborates on the issues that have been briefly presented.

The Increased Use of Psychophysiological Measures

Many researchers have advocated a multiple confirmation approach for the testing of various psychological constructs (Campbell, 1957; Campbell & Fiske, 1959; Webb, Campbell, Schwartz, & Sechrest, 1966). It is believed that once a construct has been confirmed by two or more measurement processes, the uncertainty of its interpretation is greatly reduced. Measurement of constructs calls for multiple indices which are hypothesized to share theoretically relevant components but have different patterns of irrelevant components. This is especially important in the social sciences where knowledge of all sources of variation is poor, our detection instruments crude, and our subject matter complex. In the past investigators have relied on using instruments of the same modality in their attempt at the multiple confirmation approach, namely paper and pencil measures. The popularity of these indices is attributed to the fact that they are readily administered and scored. However, recently alternative modalities of measurement are being considered for multiple confirmation procedures. In psychological stress research psychophysiological indices are being more frequently introduced due to improvements in instrumentation and the development of more portable techniques like radio telemetry and the Palmer Sweat Index (Lyman, 1970; Pronko, 1968; Thomson & Sutarman, 1953). Moreover, researchers are suggesting that stress reactions be evaluated in terms of three basic response systems: verbal, gross motor, and physiological (see Hersen & Bellack, 1976). The first system is measured by questionnaires and verbal reports. The second system is monitored by behavioral observation and the third by autonomic indices. While all three systems should be represented in any comprehensive stress evaluation, certain advantages are afforded to psychophysiological measures that are unavailable in other techniques (Lazarus, 1966; Lyman, 1970). These advantages are: a) autonomic indices are less susceptible to the subject's conscious control, thus the distortions produced by the subject's defensive operations, both conscious and unconscious, are attenuated; b) the use of continuous recording devices in autonomic measures permits the investigation of temporal trends which are difficult to obtain by other means; c) the cognitive output and interpretation needed in verbal measures are unnecessary with these techniques; and d) autonomic measures can be applied to nonverbal populations such as neonates and yield accurate data. In addition, many researchers consider psychophysiological indices to be more direct measures of emotional responding since they tap sympathetic nervous activity and hence the body's reaction to emergency or stress situations (Duffy, 1962, 1972; Malmo, 1959). The information provided by these measures is not only recognized as being more direct but also partially independent of that provided by the other two systems (Lacey, 1967; Taylor & Epstein, 1967). This is illustrated by the low correlations between autonomic indices, behavioral observations, and paper and pencil tests (Katkin, 1965; Leitenberg, Agras, Butz, & Wincze, 1971).

Reactive Effects of Measurement

Another factor which seems to have increased the utilization of psychophysiological techniques is the potential biases that are found in behavioral observation methods and paper and pencil tests. Behavioral observations have the problems of perceptual bias, selective decay on the part of the observer (Webb et al., 1966) and the representativeness of the behavior observed in terms of content and time (Goldstein & Lanyon, 1971). Moreover, with questionnaires and surveys there arises the problem of the demand characteristics of the testing situation. One very important aspect of these demand characteristics is the respondent's attempts to analyze the situation he is confronted with and his role in it. This intrusion on the measurement process has been termed by some as the "reactive effects of measurement" (Campbell, 1957; Campbell & Stanley, 1963). The subject who sees himself being tested may react by trying to create a good picture of himself by giving socially desirable responses (Crowne & Marlowe , 1964) or by being overly cooperative (Orne, 1962) to the extent of fulfilling the hypotheses conveyed by certain experimental cues (Adair, 1973). On the other hand, the subject may react in an uncooperative manner and sabotage the experiment by only giving negative (Goldberg, 1965; Silverman & Kleinman, 1967) and/or defensive responses (Rosenberg, 1969). The role the subject perceives himself in and its subsequent effects on the magnitude and direction of experimental outcomes has been well documented (Adair, 1973; Orne & Evans, 1965; Silverman, 1977). Adair has suggested that the laboratory subject should be seen as a reactive organism that responds to the measuring instrument and the person giving it in a manner equivalent to any other social interaction, rather than an inactive entity. In addition, the act of measuring may change the subject by having him gain interest in the topic being considered and result in opinion change or initiation as well as contributing to practice effects. Anastasi (1958) illustrated how these factors affect intelligence tests. Other problems with paper and pencil tests are response sets such as acquiescence (Cronbach, 1946) and directional responding due to the wording of items. Webb et al. (1966) describe various naturalistic and laboratory settings using paper and pencil or interview techniques where increased or decreased rapport, increased awareness of the researcher's goals, and decreased fear provide plausible alternative explanations for the apparent change recorded. They also suggest that the aforementioned problems may be selectively troublesome within trials of an experiment. That is, training trials may accommodate the subject to the task but practice effects may exist that either enhance or inhibit the reactive bias. Thus, early responses may be contaminated, later ones not, or vice versa (Underwood, 1957).

Mechanical Recording

Some of these reactive effects are being attenuated by the use of unobtrusive measures (Webb et al., 1966), by the inclusion of scales such as the validity scales of the MMPI and the Social Desirability Scale (Crowne & Marlowe, 1960), by extensive training of behavioral observers, and by appropriate time sampling. Unfortunately researchers in the area of psychophysiology have not given serious consideration to the obtrusiveness of their instruments. This is unusual given the fact that these instruments are visually commanding and for the most part frightening for the subject. Webb et al. (1966) suggest that as the novelty of the testing situation increases so does the probability of having a significant amount of reactive bias. Also, reactive bias is seen as a threat to internal as well as external validity (Campbell & Stanley, 1963) and is considered by some to be the reason for the great amount of variability in the results of attitude research (Silverman & Shulman, 1970). Furthermore, if something as subtle as the experimenter's expectancies can be conveyed to the subject and subsequently affect the outcome of an experiment (Rosenthal, 1966, 1967), it seems improbable that a series of electrodes emanating from a subject's body and connected to a polygraph will not affect a study's results. Some indirect evidence for the obtrusiveness of psychophysiological measures can be obtained from studies that use analogous types of equipment (VTR units, tape recorders) and the changes observed in psychophysiological experiments due to some of the demand characteristics described above.

Several studies in the psychotherapy literature have shown how the presence of recording equipment and its use affects the client's and the therapist's verbal output during therapy sessions (Cohen & Cohen, 1961; Lamb & Mahl, 1956). Roberts and Renzeglia (1965) showed that clients have a tendency to make significantly more positive self-statements when a tape recorder is visible and running, as compared to sessions where only a microphone was present, and to make more negative self-statements when no recording equipment is visible. Therapists gave more interpretative comments during taped sessions. Haggard, Hiken and Isaacs (1965) found that patients differed widely in the extent to which they made direct and indirect responses to being observed (audio versus videotape recording) and in terms of when and how they expressed their feelings. Purcell and Brady (1966) found that children habituated to a transmitter attached to their clothing only after two to four days of constant wearing. Moos (1968) found the average effects of observation conditions with a transmitter clipped to psychiatric patients to be small, but found great individual differences in the reaction to the device, with the most disturbed patients exhibiting the greatest reaction to being monitored.

Psychophysiological measures have also been shown to be affected by the role requirements of the experiment. Chapman, Chapman and Brelje (1969) discovered that subjects' pupillary responses to sexual stimuli differed according to the dress and presenting style of the experimenter. It has been found that the use of a sociable experimenter, in contrast to a reserved or automated experimenter, results in decreases in heart rate, sweating, and the time taken to report taboo words (Hicks, 1970). Other researchers have found that subjects' GSR responses were different according to the race and sex of the experimenter (Fisher & Kotses, 1973, 1974). In yet another study, the manner in which the researcher asked his subjects to extend a 16 hour fast to a 20 hour fast significantly altered their plasma free fatty acids as well as their perceived degree of hunger (Bogdonoff, Brehm, & Black, 1964). Hodges and Speilberger (1966) showed that individuals who saw the experimental milieu as more anxiety-provoking in comparison to persons who were not anxious, had higher heart rates in both threat and non-threat conditions. These examples illustrate that even physiological experiments are affected by demand characteristics.

Determining the obtrusiveness of psychophysiological measures has special implications for the field of psychophysiological stress research. Conflicting results have been reported by investigators using psychophysiological indices as a means of differentiating between the stress reactions of anxious and normal subjects to various types of stimulation. Some researchers (Kelly, 1966; Lader & Wing, 1966; Wing, 1964) have found anxious individuals to be less reactive than controls, whereas other studies have found normals to be less reactive than anxious subjects (Davis, Malmo,& Shagass, 1954; Malmo & Shagass, 1952; Martin, 1961). Lader (1969) has suggested that these discrepancies may somewhat be attributed to the pre-stimulation levels being already at a high level due to the general experimental situation and hence further stimulation would result in insignificant gains in activation. He recommends that a reactivity score (initial response to a stressor) be abandoned as a means of comparing subject populations for stress tolerance.

These discrepancies may be resolved to a certain extent if the experimental situation itself were examined in greater detail and the factors contributing to elevated pre-stimulation levels were adequately defined and quantified. One factor that could be a significant contributor to variable pre-stimulation levels and hence the aforementioned discrepant results, is the obtrusiveness of the psychophysiological instruments being used. It is conceivable that individuals who react strongly to the application of the experimental apparatus (electrodes, paste, etc.) are reacting in a manner that will attenuate or even eliminate the effects of any subsequent stimuli, thus resulting in a ceiling effect. On the other hand, a subject's reaction to the recording instrument may accentuate the effects of subsequent stimuli on his autonomic activity by creating depressed baselines or directional changes in autonomic responding. Therefore, depending on whether an individual reacts to the psychophysiological measure by accelerating or decelerating physiological systems like heart rate and skin conductance, his response to proceeding stimuli may result in spurious directional responding leading to accentuation, attenuation, or elimination. For example, if a subject responds to the presentation of the psychophysiological instrument by decreasing his heart rate, his reactions to subsequent stimuli may ostensibly be accentuated if he responds to them by increasing his heart rate, attenuated if he responds to them by decreases in heart rate or nullified if the degree of deceleration offsets any acceleration that may be initiated.

These reactions may vary from individual to individual since there seems to be large individual differences in subjects' reactions to being monitored (Moos, 1968; Purcell & Brady, 1966) as well as their perception of the monitoring situation. Individual differences in the degree of arousal to experimental instrumentation are in line with the general intersubject variability that is found in psychophysiological research (Duffy, 1972; Lacey & Lacey, 1958a). Lacey, Kagan, Lacey and Moss (1963) suggest that this variability can be explained by determining the individual's orientation towards the experimental situation (i.e., whether he finds it anxiety-provoking or interesting and responds in a defensive or orienting fashion, respectively), and the autonomic responses that are associated with this orientation.

## Adaptation to Physiological Recording

It may be argued that the obtrusiveness of psychophysiological measures is controlled for in psychophysiological stress studies by having the subject adapt to the measure during extended baseline periods. Adaptation is usually defined here as the wanning of investigatory responses to a more reduced or stable level for a certain assigned period of time. It is after the adaptation period that stimuli such as white noise, intense lights or mechanical stimulation are applied to the individual and his reaction or habituation to them recorded. However, a confound may exist in the results obtained in this manner. More precisely, the argument that researchers usually allow subjects to adapt to the instruments by repeated applications or by taking extended baselines can be questioned on several counts. While this procedure may decrease the obtrusive effects at the time of experimental manipulation, most studies do not empirically determine whether habituation to the measure has taken place. Also, the investigator who empirically ascertains that his subjects have habituated to the psychophysiological measure is in essence having the subjects habituate to both a novel situation (the experimental laboratory) and the monitoring device. Failure to discover the reactive effects of the measuring instrument itself has implications for experiments where the measure is applied several times to the individual and at prolonged interstimulus intervals. Here the subject may adapt to the novel situation but not the instrument, or adapt at greatly discrepant rates so that at subsequent applications of the index the obtrusiveness factor would be significantly present. Knowledge of the instrument's relative obtrusiveness would allow the researcher to use it as a correction factor for any trial using the physiological index in his data analysis. In addition, when autonomic indices are used in field studies the need to examine the reactive effects of measurement is particularly important since in these situations there are usually limitations in time and instrumentation that prevent an accurate determination of adaptation. Therefore, the obtrusiveness of psychophysiological measures must be taken into account if the data obtained by these means are to be interpreted with any degree of accuracy.

A Psychophysiological Framework for Obtrusiveness

The reactive effects of measurement in the psychophysiological experiment can be conceptualized within a psychophysiological framework and analyzed in terms of phenomena like orienting responses and habituation. The application of any of the myriad of autonomic measures may be considered as the introduction of a novel stimulus to the experimental subject. The significance of this stimulus is that it is the first one presented in the experimental situation and may affect reactions to subsequent stimulus presentations to a greater or lesser degree. In the same context, the continuous nature of the majority of these devices implies that the subject is repeatedly, if not constantly, exposed to them.

Sockolov (1963) has developed a neuronal model describing three major classes of response which may be elicited by applying a neutral (unconditioned) stimulus to an individual. These are orientation, defense and adaptation. The orientation class (OR) is a system of unconditioned motor, autonomic and central responses elicited by any change in stimulation independent of stimulus quality. For example, both heat and cold evoke an OR on the first presentation although, upon repetition, each evokes a distinctive adaptation pattern. The result of the orienting reaction is to make the individual more sensitive to stimulation and peripheral receptor input. The second system of unconditioned responses is the defense reaction which is also nonspecific with respect to the quality of the eliciting stimulus but does depend upon stimulus intensity. It is evoked by strong stimuli and its purpose is to limit stimulus action and to reduce the possibility of overexcitation in the organism. In addition, certain criteria are available which distinguish an OR from a defense reaction. These are (a) an OR is elicited by stimuli of low or moderate intensity while defense responses occur when the stimulus intensity is relatively high; (b) the OR is associated with reciprocal responses of peripheral vasoconstriction and cephalic vasodialation, while with the defense response there are concomitant responses of constriction in both head and periphery; (c) an OR pattern, unlike that of adaptation or defense responses, has the same response pattern to both stimulus onset and offset, since both are changes in stimulation; and (d) unlike adaptation and defense responses, which tend to be intensified by stimulus repetition, the OR diminishes rapidly (habituates) when a stimulus is repeated.

Lacey (see Lacey, 1959, 1967; Lacey et al., 1963) proposed a similar system pertaining to heart rate (HR) changes associated with complex situations involving attention and internal problem-solving. More precisely, he has stated that an organism exhibits HR deceleration in situations where "environmental intake" is present. That is, where the organism is required to attend to his environment. He also believes that HR deceleration facilitates the process of reacting to one's surroundings by creating a somatic readiness which enhances actual behavioral activity. On the other hand, HR increases lead to inhibition of cortical activity and hence to a reduction in sensitivity to stimulation. Consequently, Lacey postulates that HR acceleration should facilitate "rejection of the environment" and should occur in situations where stimulation is painful or unpleasant and in situations where external distractions would interfere with internal problem-solving. These findings have been replicated with adults by Lacey (Lacey, 1967;

Lacey & Lacey, 1970) and other researchers (Obrist, 1963; Obrist, Webb, Sutterer, & Howard, 1970) and with children as experimental subjects (Kagan & Lewis, 1965; Kagan & Rosman, 1964).

In comparing Lacey's hypotheses and findings regarding the relationship between changes in HR activity and situational demands to Sockolov's neuronal model, it would seem that orienting reactions would be associated with HR deceleration and defensive behaviors with HR acceleration. This contention has been borne out by Graham and Clifton (1966) in a review of the literature on the orienting response and by investigators manipulating situations to create either an orienting or defensive context (Hare, 1972, 1973; Hare, Wood, Britain, & Frazella, 1971; Jackson, 1974). The fact that HR responds to the above situations in a particular manner does not imply that all autonomic systems will respond in the same fashion. Lacey (1967) has pointed out the discrepancy between HR and skin conductance (SC) in situations involving environmental intake, rejection, or both. Namely, while the former results in HR deceleration and the latter in HR acceleration, SC increases on both occasions. He termed this discrepancy in autonomic indices as "directional fractionation" and considered it to be an illustration of the differential reaction of certain physiological systems. This pattern between SC and HR has been found to be fairly consistent across situations dealing with environmental intake or rejection (Blaylock, 1972; Edwards & Alsip, 1969; Lacey, 1967) and hence provides the investigator with useful knowledge pertaining to the covariance of these two autonomic systems when they are used as indices of arousal.

It is within the general models proposed by Sockolov and Lacey and their implications for HR and SC responses that an empirical definition for the reactive nature of psychophysiological measures should be formulated. Whether the application of these devices themselves produce a defensive or orienting reaction is an empirical question that must be answered due to its effects on the experiment as a whole. The answer to the preceeding question may also depend upon the psychological make-up of the individual experiencing the situation. The next section describes some research dealing with how different types of individuals respond to such circumstances (i.e., the presentation of novel stimuli).

Habituation, Obtrusiveness and Anxiety

A subject's reaction to the application of a novel stimulus, like a physiological instrument, may differ according to their present emotional state, personality structure or both. It was mentioned above that anxious subjects react to the application of a stimulus with greater activity than normals (Davis et al., 1954; Martin, 1961). Other researchers have found that anxious subjects take longer to return to pre-stimulation levels of arousal than controls (Kelly, 1966; Malmo & Shagass, 1952; Malmo, Shagass, & Helsam, 1951; Wing, 1964). Lader and Wing (1964, 1966) and Lader and Mathews (1968) have proposed a model for anxiety focusing on the degree to which an individual's autonomic responses habituate to the presentation of a series of stimuli. Essentially, they believe that anxious individuals have a greater tonic arousal level and that this elevated basal arousal hinders habituation to new stimuli since the presentation of these stimuli will maintain or add to the extant arousal state, and make the organism more sensitive to receptor input for longer periods of time. On the other hand, normals have a lower basal level of arousal which allows the presentation of stimuli to cause transient increases in CNS activity followed by rapid habituation. The fact that anxious subjects are initially at high levels of arousal suggests that their "reactivity" to subsequent stimuli will be somewhat attenuated. Several researchers state that the concept of "reactivity" be abandoned as a means of differentiating normal and anxious populations (Lader, 1969; Lader & Wing, 1966). Lader and Wing (1966) found that in comparison to normal control subjects, anxious patients exhibited impaired habituation to a series of tonal stimuli and elevated levels of heart rate (HR) and skin conductance (SC). Other investigators have shown that anxious subjects and phobics take longer to habituate to the orienting response than normals (Davis et al., 1954; Hare, 1973; Howe, 1958; Lader, 1969) and other psychiatric populations (Lader, 1969; Stewart et al., 1959). Lader (1969) has been able to successfully classify patients with various types of anxiety-based problems by determining their habituation rates.

In terms of the models concerning the reaction to neutral stimuli propounded by Sockolov and Lacey (discussed above), one would expect anxious subjects to exhibit more defensive responses (DR) rather than orienting reactions (OR). Hart (1974) found that anxious persons show a deficit in ORs and have a greater tendency to respond with DRs when stimuli are presented. Hare (1973) discovered that individuals with a spider phobia reacted to pictures of spiders with DRs, while the non-phobic group exhibited ORs. Neary and Zuckerman (1976) found "state anxious" individuals to have a significantly lower number of ORs to repeated tones than subjects who were not anxious.

Some researchers have approached Lader and Mathews' (1968) model of habituation and anxiety from a different angle. They determine whether habituation to various stimulus presentations is impaired by inducing anxiety in normal subjects prior to stimulation. Maltzman, Smith, Kantor and Mandell (1971) illustrated that graduate students with much experimental and laboratory experience habituated more rapidly than undergraduates lacking such experience. In a second experiment the postgraduates entered the experiment prior to an important examination and showed slower habituation rates than their undergraduate counterparts. Watts (1975) allowed subjects to experience two experimental conditions, threat of shock and no threat. In the former condition delayed habituation was present, whereas in the latter condition habituation was rapid.

It seems from the evidence presented that delayed habituation to a series of stimuli is a good index of anxiety and a characteristic of anxious individuals. This has important implications for the obtrusiveness of psychophysiological measures. Anxious subjects may display impaired habituation to the instrument and hence give responses during the experimental manipulation that are greatly confounded. Thus, while the reactive effects of measurement must in general be ascertained in the experimental context, it is important that these effects be quantified in situations that are anxiety-provoking or where anxious individuals are being studied. On the other side of the coin, a subject's reaction and adaptation to the experimental instrumentation may in itself provide an especially sensitive index of anxiety since this is a response to the first series of stimuli to which the subject is exposed, to a situation identical in design to the habituation studies described above, and free from some of the confounds that exist in such experiments (i.e., adaptation to a novel situation and the reaction to being monitored). Therefore, the effects of anxiety on obtrusiveness must be investigated.

The effects of anxiety on the habituation process and the reactivity of the subject in the experimental situation may be viewed in another context. According to modified versions of the Hullian drive theory (Spence, 1956, 1958; Taylor, 1956) anxiety can be seen as an acquired drive which has the capacity to generally energize the organism. This increase in drive then has a tendency to facilitate performance and increase the speed of learning. The degree of facilitation depends on the habit strength of the response to be learned and the number and strength of competing responses. That is, facilitation will occur when the response to be learned is of higher strength than other competing responses in the habit-hierarchy, and impairment will be evident when the response to be acquired is of lower strength.

There has been much experimental support for the theory that increases in arousal will facilitate learning. Individuals designated as high in anxiety by their scores on the Taylor Manifest Anxiety Scale (TMAS) have been shown to condition more rapidly and exhibit stronger responses than subjects having lower anxiety scores (Spence, 1964; Spence & Spence, 1966). The experimental situation in these studies primarily dealt with eyelid conditioning. Further support is gained from evidence for the related phenomena of increased stimulus generalization (Mednick, 1957) and resistance to extinction (Spence, 1964) under conditions of increased arousal. While these studies concentrated on a simple conditioning and performance situation, similar results have been obtained with GSR conditioning (Mednick, 1957) and paired-associates learning (Spence, 1958; Taylor, 1958). Also, other indices of arousal besides scores on the TMAS have been used in the eyelid conditioning procedure, namely heart rate and skin conductance. These experiments produced evidence consistent with the aforementioned theory (Rinquist & Ross, 1959; Rinquist & Spence, 1959). Other researchers manipulated the arousal levels of subjects by the use of shock and found again that anxious individuals in comparison to nonanxious persons conditioned faster (Spence, 1958; Spence, Faber, & Taylor, 1954). In addition, the effects of anxiety on more complex tasks like discriminative learning have been examined. The theory predicts that in this situation anxiety will impair learning at first due to the inclusion of task-irrelevant responses, but will later improve performance as the correct habit moves up the hierarchy. Experimental data has supported this contention (see Spence & Spence, 1966).

The fact that anxiety affects conditioning, stimulus generalization, and extinction has implications for any psychological experiment, since the experimental setting is usually anxiety-provoking and hence the procedures and instrumentation themselves can readily become conditioned stimuli which may interfere with subsequent experimental manipulations. Spence (1964) has mentioned that in terms of eyelid conditioning, there is evidence that more satisfactory results are obtained when experimentally naive subjects are used and experimental arrangements are such that subjects become somewhat fearful and uneasy.

Induction of Anxiety: Threat of Shock

The effects of anxiety on the performance of certain tasks and the reaction to various stimuli have been studied in several ways. Averill and Opton (1968) outline three techniques used to assess underlying dispositional characteristics like anxiety and their effects on behavior and physiological responding, namely the reduction, the correlative and the elicitation methods. The reduction approach examines a microproperty of a (macro) theory and makes inferences from the identified property about the corresponding theory. For example, an indication of a substance's solubility may be determined from a knowledge of its molecular structure. The aforementioned authors indicate that psychology has not reached the point where psychological constructs such as anxiety can be reduced to a particular physiological substrate. The second method deals with the empirical correlation between variables, using the more readily measured variable to estimate the value of the other. This approach has several disadvantages: correlation does not imply causation, it is purely descriptive, and its data source is based on the unlikely tenet of normal variations in personality being dependent upon gross constitutional differences in physiological responding. Averill and Opton cite the low correlations between trait and physiological variables as being evidence of the ineffectiveness of this method. The third technique, the elicitation approach, is seen as the most fruitful means of examining the characteristics and effects of dispositional variables. This method creates appropriate test conditions that will elicit the reaction under study and illustrate its effects. Its advantage is that it allows the investigator to control the presentation and analysis of the variable being examined. However, Averill and Opton state that the researcher must control for other dispositional variables that covary with the variable under study if results are not to be confounded. Other investigators also support the use of laboratory induced stress to study an individual's reaction under such situations and how it may be generalized to real-life circumstances (Lazarus, 1966, 1967). Bohlin (1973) states that the evidence from studies dealing with the effects of increased arousal or phenomenon like the orienting response is weakened since experimental manipulations of arousal are not implemented. He believes that active manipulations of arousal must be implemented if less equivocal results are to be obtained.

A variety of techniques have been used to increase anxiety levels in experimental subjects. These have ranged from frightening films (Alfert, 1966; Lazarus, 1967) to the injection of adrenalin (Schacter & Singer, 1962). A very popular method is the threat of shock. Several researchers see the potency of this technique as being derived from its direct implication of harm for the individual rather than more vicarious or cognitive approaches (Alfert, 1966, 1967; Opton & Lazarus, 1967). In a well controlled study Averill, Olbrich and Lazarus (1972) found that a threat of shock group produced significantly greater elevations in HR and self-reported anxiety than a vicarious condition where a model was shocked. Katkin (1965) used the threat of shock to induce stress and examine its relationship to autonomic responding and trait anxiety.

Threat of shock has successfully been used to increase anxiety in several studies examining the habituation characteristics of the orienting response (OR). Gatchel and Gaas (1976) found that subjects in the threat condition had increased tonic levels of SC and exhibited decreased short and long-term habituation of the OR. Carroll and Pokova (1976) showed that threatened subjects demonstrated slow SC habituation and a tonic SC that was resistant to decline compared to nonthreat subjects. Bohlin (1976) used threat of shock and performing arithmetic tasks as means of inducing arousal in two experimental groups and compared their responses with a group told to relax. He found that subjects in the shock-threat condition exhibited the slowest habituation to repeated presentations of an auditory stimulus, followed by the task and relaxation conditions, respectively. Finally, Watts (1975) in a study testing the hypotheses about anxiety delaying habituation proposed by Lader and Mathews (1968), observed that threat of shock increased SC and HR during a period when subjects believed shock to be imminent.

Several aspects of shock-induced threat, such as probability of occurrence and intensity, have been investigated. Niemela (1969a, 1969b) showed that HR and SC increased as a function of shock probability. Snortum and Wilding (1971) found that increments in the probability of shock produced statistically discrete increments in ratings of discomfort. In terms of intensity of threat, Deane (1961) observed that cardiac acceleration was greater for subjects told to expect strong shock than those told to expect weak shock. Epstein and Clarke (1970) found that HR and SC followed an order of increase related to whether the intensity of threat was low, medium or high. They concluded that a direct relationship exists between the expected magnitude of threat and psychological arousal during the anticipatory period.

Some interesting response patterns pertaining to subjects' physiological reactions to threat of shock have been observed. Deane (1966, 1969) found that in the beginning of the anticipation period subjects exhibited an acceleration in HR followed by a deceleration as the time for shock was approached and after it was actually applied. He believes that deceleration does not occur unless the subject has a knowledge of the time when shock will be given. Elliot (1966) observed that HR continues to accelerate throughout an experiment where the exact time of the shock was not given to the subject. Other researchers have examined how the threat of shock affects HR responding in situations demanding environmental intake or rejection. Blaylock (1972) suggests that threat and tasks involving intake or rejection may have an additive effect on HR. That is, threat may further accentuate the acceleration involved in mental tasks or offset the deceleration present in situations demanding attention. However, while some of her results demonstrated this finding, further research is needed. Niemela (1969b) found that HR responses were related to the degree to which an individual attends to the probability of receiving a shock and that the pattern of these responses resembled those observed during attention tasks.

It seems that the threat of shock is a very effective means of inducing anxiety and determining how increased levels of arousal affect habituation to stimuli like a psychophysiological instrument. However, the warnings of Averill and Opton (1968) concerning the control of other confounding dispositional variables must be heeded if accurate results are to be obtained. More precisely, the fact that individuals cope with stressful or threatening situations in different ways must be taken into account. Most persons have developed through experience a repertoire of specific defensive maneuvers to deal with different types of threat. Two general defensive styles, repression and sensitization, have been identified from research on adaptation to threat. Repressors tend to use avoidance mechanisms such as withdrawal and denial in response to threat, while sensitizers manage to over-interpret threat and utilize approach strategies like obsessive rumination and intellectualization as a response (Altrocci, Parsons, & Dickoff, 1960). Several researchers have shown that in threatening situations individuals labelled as "repressors" according to the Byrne R-S Scale (Byrne, 1961), in comparison to persons identified as "sensitizers", are less likely to verbalize anxiety or disturbance (Byrne, 1964; Lazarus & Alfert, 1964). On the other hand, while repressors report less anxiety, they exhibit significantly greater physiological reactivity to stress conditions like threat of shock, than sensitizers (Hare, 1966; Scarpetti, 1973).

Another variable that may confound experiments employing the elicitation method is the degree of trait anxiety present in the members of the elicitation and control groups. That is, the differences between the threat and nonthreat conditions may be obfuscated by the degree to which individuals in both groups are predisposed to threat. Watts (1975) in his study of the effects of increased arousal on habituation, matched his threat and non-threat groups on their scores on the Taylor Manifest Anxiety Scale (Taylor, 1953). Therefore, studies using the elicitation method to induce anxiety should consider the stress coping styles and trait or dispositional anxiety of their subjects.

## Skin Potential in Psychophysiological Research

Skin resistance measures have for the most part been the primary means of monitoring electrodermal activity in psychological research, the major reason being the fact that this technique presents the least amount of technical difficulty in terms of recording (Venables & Sawyer, 1963). However, recently this method has been shown to have several disadvantages that question its utility, such as polarization effects due to current passage and artifacts due to electrode size and current frequency (Montagu & Coles, 1966). Forbes (1964) points out that resistance and impedance changes are not clearly differentiated and may mask some of the electrodermal responses that may actually occur. He states that skin potential differences and the two potential wave responses (negative and positive fluctuations) are the most direct indicators of electrodermal activity, and yield qualitative (direction of potential change) as well as quantitative information (amplitude). He recommends that for the analysis of specific responses of the sympathetic and non-sympathetic type, magnitude of response and basal levels of electrodermal phenomena, skin potential is the method of choice. In addition, the invention of high gain, high input impedance, d.c. amplifiers has made skin potential a more viable technique and as easy to record as skin resistance.

Several advantages are conferred to skin potential (SP) as a measure of electrodermal activity. First, it is not affected by electrode size and does not need the passage of a current in the recording process, thus alleviating the problems associated with external polarization. Second, the effects of initial values on SP change and amplitude scores have been found to be negligible (Gaviria, Coyne, & Thetford, 1969) and the distribution of SP level is normal across subjects (O'Connell, Tursky, & Evans, 1967; Shapiro & Leiderman, 1964). Also, SP scores can be subjected to parametric as well as non-parametric statistics (Shapiro & Leiderman, 1964). Third, SP has been shown to be highly related to sweating ($r = .80$), and the negative component of the SP response has a high correlation with skin resistance and has a similar physiological basis in sweat gland activity (Martin & Venables, 1966). Fourth, as mentioned above, SP gives the researcher more information due to its diphasic nature and may be a potentially less ambiguous measure which may readily differentiate various psychological states (Burstein, Fenz, Bergeron, & Epstein, 1965; Hupka & Levinger, 1967). In terms of the present study, the qualitative distinctions that have been imputed to the positive and negative components of SP make it of special interest.

The positive and negative waves have been imbued with representing a variety of psychological phenomena such as orienting and defensive responses. Several researchers have shown that high intensity stimulation like shock or loud noise more readily evokes the positive wave of the SP response than low level stimulation (Forbes & Bolles, 1936; Shmavonian, Miller, & Cohen, 1968; Uno & Grings, 1965). They have concluded that the positive wave is a defensive reaction to a stimulus while the negative wave is related to the orienting response. Raskin, Kotses and Bever (1969) found that a monotonic relationship exists between stimulus intensity and the magnitude of the positive wave. At high levels of stimulation (120 db) the positive wave does not habituate, supporting the view that the positive SP component is related to a defensive response. On the other hand, some investigators claim that the positive wave is associated with an orienting rather than a defensive response (Loveless & Thetford, 1966; Yamazaki, Watanabe, & Niimi, 1969), or that both waves can be associated with orienting reactions depending on an individual's idiosyncratic pattern of autonomic responding (Glaus & Kotses, 1974). However, these studies have primarily been concerned with the conditioning of SP components, have utilized low to moderate intensity CSs, and have derived their findings from the conditionability of a wave form and its rate of habituation to the CS. In the Loveless and Thetford study both wave forms could not be conditioned, however, the positive wave habituated more rapidly. Yamazaki et al. also found that the positive component habituated more rapidly, but were able to condition the negative wave. Glaus and Kotses showed that both waves can be conditioned and that the positive wave was slightly faster in habituating. In another conditioning study Shmavonian et al. (1968) demonstrated that positive waves can be conditioned and that the negative component corresponds to the orienting response. Therefore, the roles that the negative and positive components play in distinguishing psychological phenomena are to say the least equivocal. Some of this confusion may be attributed to the fact that some of the aforementioned studies were lacking in appropriate experimental design (Yamazaki et al., 1969), differed in adaptation levels to the experimental setting (Shmavonian et al., 1968), and dealt with a variety of CSs and UCSs.

Skin potential levels have been shown to exhibit some consistent characteristics. Skin potential levels have been shown to be good indices of arousal for both normal (Christie & Venables, 1971; Leiderman & Shapiro, 1964; Lyken, Miller, & Strahan, 1968; Lyken, Rose, Luther, & Maley, 1966), and psychiatric populations (Venables, 1963; Venables & Wing, 1962). Essentially, skin potential levels reduce in negativity as the subject becomes more relaxed. Similarly, the rate at which SP levels return to values obtained during relaxation is a good indicator of the degree of stress produced in an individual by a particular task or stimulus (Christie, Cort, & Venables, 1976; Christie & Venables, 1964). In addition, researchers have found that cognitive tasks and threat conditions can be differentiated by the patterns of skin potential activity they elicit in subjects (Kaiser & Sandman, 1974; Miller, 1970). These studies indicated that tonic negative SP responses accompanied cognitive activity and phasic and biphasic SP responses were associated with stressful situations.

Therefore, it seems that SP is an appropriate measure for determining the autonomic characteristics of obtrusiveness since it conveys a multitude of information and is sensitive to both orienting and defensive types of responding.

The Palmar Sweat Index

An increasing number of field studies in psychological stress evaluation are using autonomic indices. Unfortunately, in these situations limitations in time, experimental setting, and instrumentation usually preclude investigators from obtaining adequate measures of adaptation to the experimental situation and the recording instrument being employed. Thus, in this context it is necessary for the researcher to obtain a general idea of the obtrusive nature of his recording device prior to implementation so that he can apply appropriate corrections to his results if warranted. One psychophysiological measure which is especially popular in field studies using autonomic indices is the Palmer Sweat Index (PSI) (Dabbs, Johnson, & Leventhal, 1968; Harrison, MacKinnon, & Monk-Jones, 1962; Kaoukis, 1976; Melamed, Hawes, Hutcherson, & Fleece, 1977). The PSI consists of taking a plastic impression of the skin at several intervals to enumerate the number of active sweat glands on the skin's volar surfaces (Sutarman & Thomson, 1952; Thomson & Sutarman, 1953). The technique is primarily affected by changes in sensory or psychological stimulation but is not altered by ambient temperature, thermoregulatory processes within the body, or muscular exercise (Kuno, 1956; MacKinnon, MacKinnon, & Williams, 1959; MacKinnon, Monk-Jones, & Fotherby, 1963).

This method has been shown to have several advantages: accuracy, simplicity, clarity (Venables & Martin, 1967), portability (Dabbs et al., 1968; King, 1975), reliability (King, 1975; Lore, 1966), and sensitivity (Haywood & Spielberger, 1966; Lore, 1966). Haywood and Spielberger (1966) showed how the device could differentiate between high and low anxious subjects in a mild stress situation. Lore (1966) obtained the same results with elementary school children. Other researchers were able to differentiate psychiatric patients with anxiety disorders from normals using the PSI (Beam, 1955). The method has also been shown to vary as a function of different types of stress (Johnson & Dabbs, 1967). Increases in the PSI from baseline have been noted with interactions external to the organism, like flight in a light aircraft (Dabbs et al., 1968), whereas decreases from baseline activity have been observed in situations which tended to direct an individual's attention towards his own thoughts and feelings (Harrison, 1964; Harrison et al., 1962; Johnson & Dabbs, 1967). Dabbs et al. (1968) suggested that this differential responding is dependent on whether the individual perceives the stressor as having internal (problem-solving tasks, anticipating surgery) or an external (actually experiencing the feared event) connotation. However, this interpretation of palmar sweat prints has recently been questioned. Weisenberg, Kreindler, Schachat and Werboff (1976) have stated that there is no direct empirical evidence suggesting that directional changes in the PSI were due to the external versus the internal connotation of a stressor. They recommend that the experimental situation be manipulated to promote either an internal or external connotation, and that the PSI be examined in terms of its changes during these experimental manipulations. Another way of approaching this problem would be to compare PSI results to heart rate changes and the proposed theory (Lacey, 1967; Lacey et al., 1963) that accounts for this system's directional tendencies. Thus, the PSI may be interpreted by examining whether an individual perceives the experimental situation as facilitating either environmental "intake" or "rejection", and by evaluating his concomitant heart rate activity under these conditions.

Summary

The preceeding sections raised several issues that have not been adequately investigated in psychophysiological research. They may be summarized as follows: a) the obtrusiveness of psychophysiological instruments has not been satisfactorily determined; b) the effects of anxiety on the obtrusiveness of autonomic measures have not been investigated; and c) studies dealing with habituation to novel stimuli and the effects of arousal on habituation have not been related to the reactive effects of measurement.

The present study was designed to examine these issues on an empirical basis. The obtrusiveness of the PSI and the effects of anxiety on the reactive effects of measurement were investigated. Also, the factors that predict the degree to which an individual will habituate to the PSI were studied. Two groups of subjects were randomly selected. The first group was assigned to an induced anxiety condition, threat of shock, and the second to a nonanxious control situation. Both groups were exposed to eight presentations of the PSI. Subjects' reactions to the application of this device were evaluated by using heart rate and skin potential activity as dependent measures. In addition, a state anxiety measure, the Multiple Affect Adjective Check List (MAACL) (Zuckerman &

Lubin, 1965) was administered to determine individuals' subjective ratings of the experimental situation.

## Hypotheses

Several specific hypotheses were formulated and investigated in this study. A list is provided below:

1) It was hypothesized that individuals in the threat of shock condition, in comparison to those in the control group, would exhibit greater autonomic responding on the HR and SP measures and would verbally report more anxiety.

2) It was postulated that anxious subjects would give quantitatively as well as qualitatively different responses to the initial presentation of the PSI than nonanxious subjects. Individuals in the anxiety condition were expected to show a greater amount of autonomic responding to this first presentation and have a tendency to exhibit more defensive reactions such as cardiac acceleration and the positive wave of the SP response.

3) It was hypothesized that persons in the induced anxiety group would take longer to habituate to presentations of the PSI than individuals in the control condition.

# METHOD

## Subjects

Sixty-two undergraduate students were obtained from the subject pool at the University of Manitoba. The subjects were 17 to 33 years old, with a mean age of 19.8 years. Thirty-one matched pairs of subjects were randomly assigned to each of two experimental groups, a shock-threat condition and a no-threat control group. The pairs were matched in terms of their scores on the trait anxiety measure, the TMAS. There were 15 males and 16 females in the induced anxiety condition and 16 males and 15 females in the control group. In addition, individuals were screened with regard to cardiovascular and respiratory problems. Two subjects were excluded from the study because of these criteria.

## Apparatus

Skin potential was monitored by a Cyborg Model BL505 SPR unit, with a differential input impedance of 2 megaohms. Cyborg spring-loaded, hand-clip electrodes were used with Hewitt Packard conductive electrolyte as the electrode paste. Heart rate was measured by a Whittacker Pulsewatch peripheral pulse sensor. Both the SPR unit and the peripheral pulse sensor were connected to a Harvard Apparatus Model 350 recording module and chart recorder. Heart rate and skin potential data were recorded on separate channels. Paper speed was set at .5 cm/sec.

Palmar sweat prints were obtained by applying a contrasting solution (Appendix A) to subjects' fingers and removing the dried prints with cellotape. The prints were permanently recorded by mounting the tape on 75 x 25 mm microscope slides.

Procedure

Subjects were asked to attend two experimental sessions. The first session was used to help individuals adapt to the laboratory setting and instrumentation. The laboratory setting consisted of a dimly lit soundproofed room with a large reclining chair and a table on which the electrodes for the recording equipment and the solution for the PSI were placed. The room was kept at a constant temperature of 21°C. In this session the subject entered the laboratory, was seated in a comfortable chair, and asked by the experimenter to fill out a pre-experimental questionnaire (Appendix B) consisting of the TMAS (Taylor, 1953) and R-S (Byrne, Barry, & Nelson, 1963) scales. After completion of this questionnaire the experimenter gave a brief explanation of the recording procedure (Appendix C) and interviewed each individual for health problems. Then he informed the subject to place his arms on the padded armrests and wait for the laboratory assistant while he left the room to monitor the recording equipment and observe the experimental situation through a one-way screen in an adjacent chamber.

At this point a trained male laboratory assistant (Appendix D), blind to the experimental paradigm, entered the experimental chamber and inspected the volar surface of the subject's hands for tissue damage, so that appropriate sites could be chosen for the placement of electrodes and the application of the PSI. Then the assistant prepared the subject's dominant hand for electrode placement by abrading the dorsal portion with a rough cloth (moistened with ethanol) and gently cleaning the palmar surface. Electrode paste was applied to both areas of skin and to the electrode cups. Subsequently, the hand-clip electrodes were fitted onto the hand, the reference electrode being placed on the abraded dorsal surface. A peripheral pulse sensor was placed on the index finger of the dominant hand and a copper electrode was taped to the individual's right ankle.

Once the recording equipment had been attached the assistant asked the subject to fill out the Today form of the MAACL (Appendix E). After completion of the check list the subject was reminded to keep as still and quiet as possible throughout the experimental procedure. Then the subject was told to relax, take a deep breath, hold it, and slowly release it. These instructions were repeated three times to help the individual relax.[1] Subjects were then allowed to rest for a period of 10 minutes. After this rest period baseline readings of heart rate and skin potential were taken for a period of 3 minutes.

At the end of the baseline period the laboratory assistant left the experimental chamber and the experimenter returned to explain the study in more detail (Appendix F). Subjects were also told that at the next session they would go through the same recording procedure except that an additional measure, a chemical fingerprint, would be taken to facilitate the analysis of resting states. Questions were answered for both groups and a second session scheduled. The second session was conducted within 72 hours from the first one.

In session two, subjects entered the same laboratory and were seated in a comfortable chair. At this time subjects in the induced anxiety condition (Appendix Ga) were informed by the experimenter that a painful shock may be applied to their right ankle at some unsignalled time during the experiment and that they have the option of not

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[1] It has been suggested that relaxation procedures stabilize electrodermal measures and minimize initial value effects (Haney & Euse, 1976).

participating in this portion of the study. Individuals in the non-anxious group were told (Appendix Gb) that the procedures would be essentially the same as those carried out during the first meeting except for the recording of sweat prints. Also, both experimental groups were reminded to remain as still and quiet as possible during the monitoring procedure. The experimenter then left the room and the laboratory assistant entered to attach the recording equipment. Subjects were again asked to fill out the MAACL and allowed to rest for 10 minutes. After the rest period, heart rate and skin potential measures were taken for three minutes. Following the three-minute monitoring period, individuals were informed by the assistant that chemical prints would be taken from their nondominant hand in one minute.[2] The PSI was then applied to the volar surface of the index finger of the nondominant hand at eight random intervals ranging from 50 to 80 seconds (Appendix H).[3] Unequal intervals were employed to prevent subjects from being conditioned to the time of presentation. Heart rate and skin potential responses were monitored throughout this procedure. In addition, the laboratory assistant made note of any movement or abnormal breathing patterns and gave a global rating of the subject's anxiety level (Appendix I).

After the PSI presentations a three-minute rest period was instituted. Then the recording equipment was disconnected and the experimenter returned (the laboratory assistant left at this point) and asked

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[2]These instructions were given to minimize startle responses during the first print.

[3]Eight PSI presentations were used because Kaoukis (1976) in a pilot study found that subjects usually stabilize their readings within 10 presentations and usually by the seventh. Most studies using the PSI take from six to eight prints.

subjects to fill out a post-experimental questionnaire (Appendix J) dealing with their feelings and reactions toward the experiment. After the completion of the questionnaire, the rationale for the study was given (Appendix K) and questions answered.

Dependent Measures

1) Heart Rate: Heart rate was computed as the number of beats per minute (bpm).

2) Heart Rate Change Score: This variable was computed as the HR during a specific time period minus the HR value obtained during the baseline interval in session one.

3) Frequency of Negative SP Waves: A negative wave was considered to be a negative deflection from a zero millivolt baseline, with a slope greater than or equal to 10 degrees, that returned to this baseline and did not result in a positive deflection.

4) Frequency of Positive SP Waves: A positive wave was considered to be a positive deflection from a zero millivolt baseline, with a slope greater than or equal to 10 degrees, that returned to this baseline and did not result in a negative deflection.

5) Total Frequency of SP Responses: This variable consisted of the arithmetic sum of the number of negative, positive, and biphasic SP responses. A biphasic response was defined as a negative wave that continued into a positive deflection.

6) Average Negative Wave Potential: This variable consisted of the average potential magnitude of all negative deflections within an observation period. The potential magnitude was calculated from the amplitude of negative waves.

7) Average Positive Wave Potential: This variable consisted of the

average potential magnitude of all positive deflections within an observation period. The potential magnitude was computed from the amplitude of positive waves.

8) MAACL Score: This score was derived from subjects' responses to the check list.

All of the dependent measures except for the MAACL were monitored during three observation periods. The MAACL was given during the first two periods but not the third. The first period consisted of the three-minute period following the rest interval in the first session. HR and SP responses were averaged to give beats per minute and number of waves per 20-second interval, respectively. The second period comprised the three-minute interval following the rest time given in the second session. Heart rate and SP responses were averaged as in the first period. The third monitoring time involved eight 20-second intervals, with each interval corresponding to an application of the PSI. The beginning of the interval was defined as stimulus onset, that is, the administration of the PSI solution to the subject's finger.

# RESULTS

Several different types of analytic procedures were utilized to test the hypotheses investigated in this study. The techniques used to analyze the data for each hypothesis and the results of the analyses are presented below.

## Analysis of Anxiety Condition

The hypothesis that individuals in the induced anxiety condition would exhibit greater autonomic responding and report more anxiety than persons in the no-threat control group, was examined by comparing the means of the two experimental groups at the second baseline period for each of the response systems (verbal, heart rate, skin potential). The results of the t-tests performed on these means are presented in Table 1. The two groups failed to differ significantly ($p > .05$) on any of the autonomic measures. However, individuals in the threat group did report a significantly higher level of anxiety than persons in the control condition ($p < .01$). Thus, it seems that while individuals in the anxiety condition subjectively felt more anxious, they did not physiologically respond in a manner that differentiated them from control subjects reporting less anxiety.

## Analysis of Subjects' Reactivity to the PSI

The hypothesis that anxious subjects, in comparison to individuals in the control group, would give quantitatively as well as qualitatively different responses to the initial presentation of the PSI was investigated by performing a 2x2 Analysis of Variance (ANOVA) on each of the HR and SP measures for the first trial. The two between factors were experimental condition and sex. While individuals in the two groups did not differ significantly in terms of their HR and SP activity, they

TABLE 1: Results of the analyses used to determine the experimental groups' different patterns of responding during the baseline period.

| Variable | Group | N | Mean | SD | t | DF[1] | p |
|---|---|---|---|---|---|---|---|
| MAACL | High Anx. | 31 | 11.35 | 2.63 | 4.62 | 56.24 | .01 |
| | Low Anx. | 31 | 7.77 | 3.42 | | | |
| HR | High Anx. | 31 | 84.10 | 14.06 | 0.72 | 57.81 | .47 |
| | Low Anx. | 31 | 81.23 | 17.12 | | | |
| Av. positive potential | High Anx. | 31 | 0.31 | 0.57 | 0.30 | 50.78 | .77 |
| | Low Anx. | 31 | 0.28 | 0.36 | | | |
| Av. negative potential | High Anx. | 31 | 0.41 | 0.63 | -0.20 | 53.60 | .85 |
| | Low Anx. | 31 | 0.44 | 0.44 | | | |
| Freq. of positive waves | High Anx. | 31 | 0.38 | 0.40 | 0.41 | 56.17 | .68 |
| | Low Anx. | 31 | 0.33 | 0.30 | | | |
| Freq. of negative waves | High Anx. | 31 | 0.48 | 0.43 | 0.59 | 59.96 | .55 |
| | Low Anx. | 31 | 0.44 | 0.42 | | | |

[1] Separate variance estimate was used in degrees of freedom calculation.

did exhibit significantly different autonomic patterns when their sex as well as their experimental assignment was taken into account. That is, significant interaction effects were found for sex by anxiety condition when the frequency of positive ($p < .01$) (Table 2) and the frequency of negative ($p < .03$) (Table 3) waves were examined as dependent variables. With respect to the frequency of positive waves, anxious females seemed to show the greatest number of defensive responses, followed by nonanxious males (Figure 1). Nonanxious females had a higher frequency of positive wave responses than anxious males, who had the least number of defensive reactions. On the other hand, when the frequency of negative waves was considered, anxious males tended to exhibit the greatest number of orienting responses, followed by nonanxious and anxious females, respectively (Figure 2). Nonanxious males showed the least number of negative waves. Therefore, it seems that females in the threat condition had a greater tendency to react to the first PSI application with a defensive reaction, than females in the nonanxious control group. Anxious males seemed to react to the PSI with more orienting responses than males in a nonanxious state, who for the most part exhibited a pattern of responding very similar to that shown by anxious females.

<u>Analysis of Habituation to the PSI</u>

The hypothesis that individuals in the induced anxiety condition would take longer to habituate to the PSI than persons in the nonanxious control group was examined in two ways. The first approach dealt with the computation of a habituation score for each individual on each of the dependent variables. This is a technique that is frequently used in studies on habituation and is especially present in research that investigates the effects of anxiety on this phenomenon (Lader &

TABLE 2: Reactivity of subjects to the first presentation of the PSI using frequency of positive waves as the dependent variable.

| | | Male | | Female | | Total |
|---|---|---|---|---|---|---|
| | | $\bar{x}$ | SD | $\bar{x}$ | SD | $\bar{x}$ |
| | High | 0.53 | 0.64 | 1.44 | 0.96 | 1.00 |
| Anxiety | Low | 1.19 | 1.28 | 0.67 | 0.72 | 0.94 |
| | Total | 0.87 | | 1.06 | | |

| Source | Mean Square | DF | F | p |
|---|---|---|---|---|
| Sex | 0.57 | 1 | 0.64 | .43 |
| Anxiety | 0.05 | 1 | 0.06 | .81 |
| Sex x Anxiety | 7.86 | 1 | 8.66 | .01 |
| Error | 0.89 | 58 | | |

TABLE 3: Reactivity of subjects to the first presentation of the PSI using frequency of negative waves as a dependent variable.

| | | Male | | Female | | Total |
|---|---|---|---|---|---|---|
| | | $\bar{x}$ | SD | $\bar{x}$ | SD | $\bar{x}$ |
| | High | 0.93 | 0.88 | 0.56 | 0.51 | 0.74 |
| Anxiety | Low | 0.25 | 0.58 | 0.67 | 0.72 | 0.45 |
| | Total | 0.58 | | 0.61 | | |

| Source | Mean Square | DF | F | p |
|---|---|---|---|---|
| Sex | 0.01 | 1 | 0.02 | .89 |
| Anxiety | 1.30 | 1 | 2.77 | .10 |
| Sex x Anxiety | 2.40 | 1 | 5.12 | .03 |
| Error | 0.47 | 58 | | |

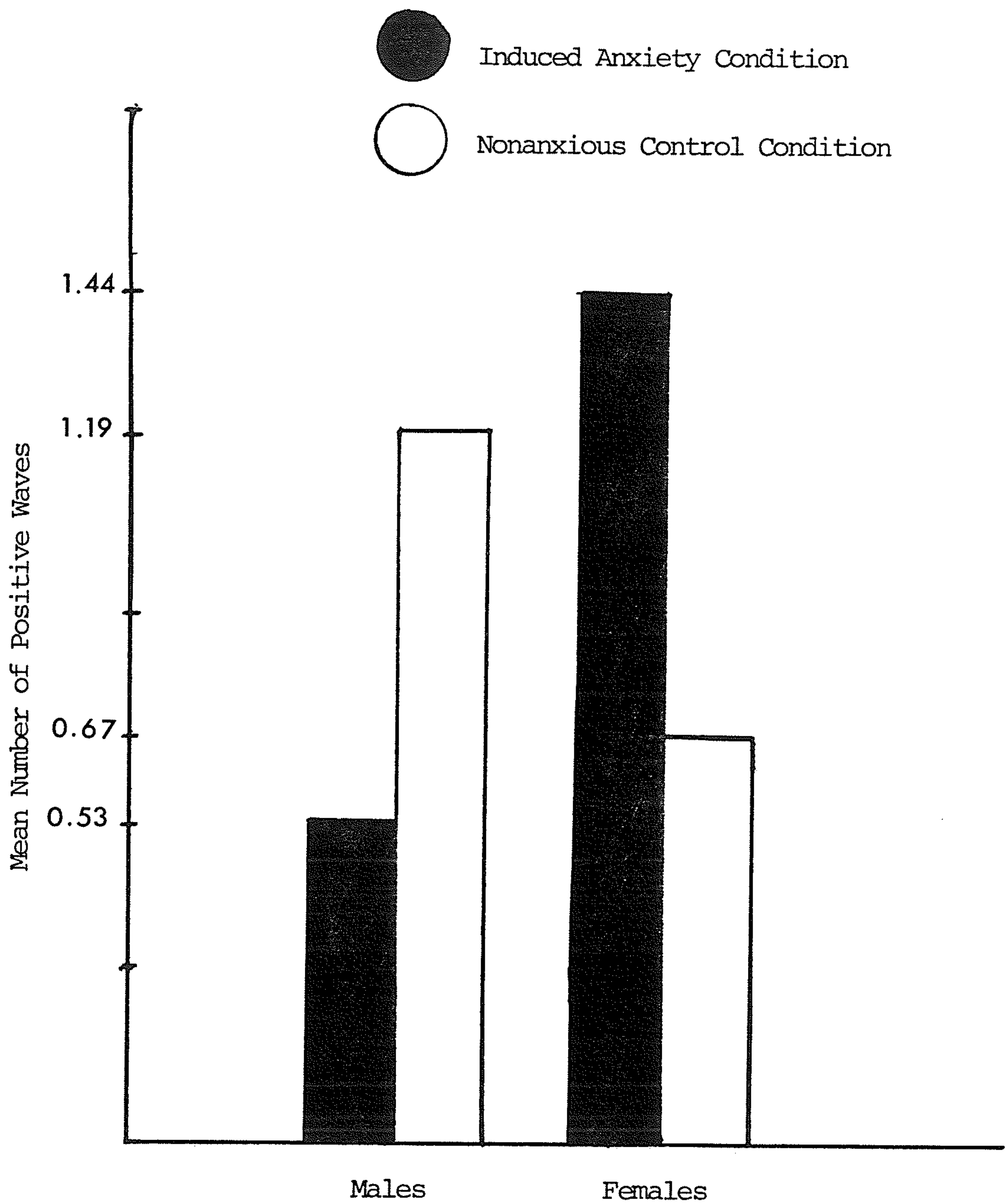


Figure 1: Graph of the sex by anxiety condition interaction for subjects' reactivity to the PSI using the frequency of positive waves as a dependent variable.

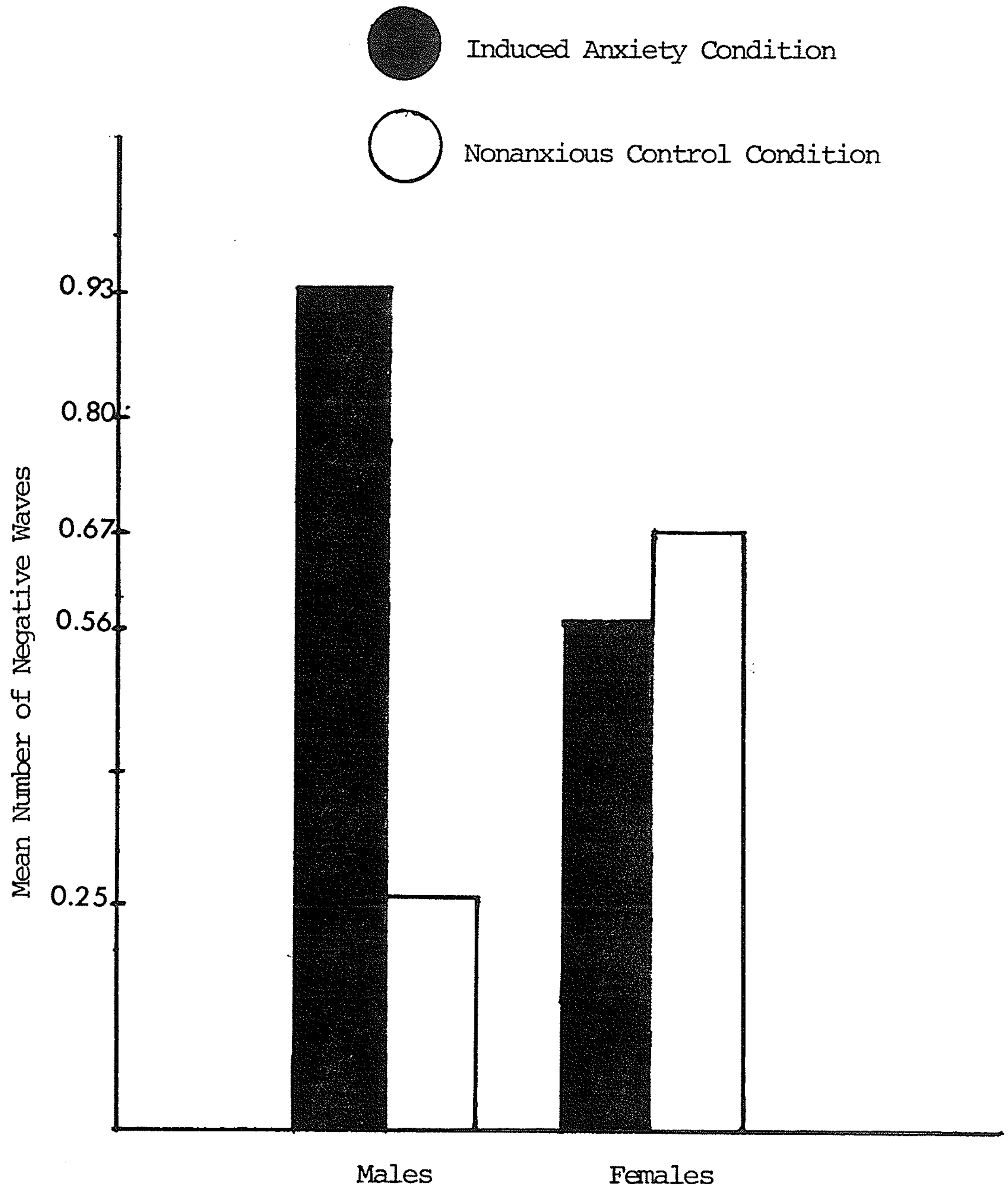


Figure 2: Graph of the sex by anxiety condition interaction for subjects' reactivity to the PSI using the frequency of negative waves as a dependent variable.

Wing, 1966). Also, it provides a means of describing an individual's habituation to the eight stimulus presentations with a single score. The habituation score in the present analysis consisted of the unadjusted beta weight or slope of the regression line of each dependent variable on the eight trial periods. Once these weights were calculated, individuals were classified as "habituators" or "nonhabituators" by performing a median split on these values. That is, those persons exhibiting more negative beta values on a particular variable were classified as "habituators", while those obtaining more positive scores were labelled "nonhabituators". To test the hypothesis that anxious individuals tend to be nonhabituators and nonanxious subjects habituators, a 2x2 Chi-Square analysis was performed on each dependent variable, with anxiety condition and habituation assignment being the independent variables. Only the Chi-Square analysis for the average negative potential indicated that a significant relationship ($p < .04$) exists between anxiety condition and habituation (Table 4). Here 68% of the subjects in the anxiety condition were labelled as "nonhabituators" and 32% identified as "habituators". Also, a significant positive correlation was observed between anxiety condition and habituation classification ($r = .29$; $p < .02$).

In the second procedure a 2x2x(7) repeated measures Analysis of Covariance (ANCOVA), sex by experimental group by trials, was performed on each of the HR and SP measures. The purpose of this analysis was to determine whether an anxiety condition by trials interaction was present in any of the dependent variables. That is, whether persons in the threat group, in comparison to individuals in the control group, would exhibit less of a decreasing trend in HR and SP activity over trials. Subjects'

TABLE 4: Chi-Square analysis for determining the relationship between habituation classification and experimental assignment using the median splits of the beta values for the average negative wave potential as the criterion.

| | | Nonhabituators | Habituators |
|---|---|---|---|
| Anxiety | High | 68% n=21 | 32% n=10 |
| | Low | 32% n=10 | 68% n=21 |

Chi-Square= 6.67 df= 2 p= .035

reaction to the first period was used as a covariate for all analyses to control for initial value effects. In all of the analyses this was found to be a significant contributor to the individual differences between the independent variables ($p < .005$). Also, scores on the R-S scale were employed as a second covariate. However, these scores failed to significantly account for any individual differences between the independent variables.

There were no significant interaction effects for anxiety condition by trials. However, when the average positive potential was examined as a dependent variable, it was shown that individuals in general responded differently ($p < .01$) over PSI presentations (Table 5). More precisely, subjects exhibited a significantly decreasing linear trend ($p < .01$) over PSI applications. This trend was also indicated when sex was taken into account ($p < .02$). In addition, females tended to have a greater average positive wave potential than males ($p < .02$), and in comparison to males, their responses over PSI presentations had greater amplitudes ($p < .04$).

The two experimental conditions were shown to be significantly different ($p < .03$) in terms of their average negative potential change scores (see Table 6). That is, when baseline responding was taken into account, individuals in the anxiety condition had significantly greater potentials than persons in the control group. Therefore, when baseline values are considered, anxious subjects seem to react to the PSI across trials and sex with orienting responses of greater amplitude than individuals in a nonanxious state.

A significant difference was found in individuals' reactions to the PSI over time ($F=2.18$; $df=6,348$; $p < .05$) when the frequency of positive waves was used as a dependent variable. However, no definite trends

TABLE 5: Analysis of PSI data over trials: 2x2x(7) repeated ANCOVA on average positive potential as a dependent variable.

| | | | Trial 1 | | Trial 2 | | Trial 3 | | Trial 4 | | Trial 5 | | Trial 6 | | Trial 7 | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\bar{x}$ | SD | $\bar{x}$ | SD | $\bar{x}$ | SD | $\bar{x}$ | SD | $\bar{x}$ | SD | $\bar{x}$ | SD | $\bar{x}$ | SD | $\bar{x}$ |
| Anxiety | High | Male | 0.34 | 0.58 | 0.31 | 0.57 | 0.16 | 0.27 | 0.40 | 0.67 | 0.29 | 0.54 | 0.28 | 0.51 | 0.17 | 0.27 | 0.53 |
| | | Female | 0.96 | 1.35 | 0.91 | 1.30 | 0.95 | 1.35 | 0.67 | 0.86 | 0.81 | 1.21 | 0.63 | 0.79 | 0.56 | 0.59 | |
| | Low | Male | 0.49 | 0.56 | 0.33 | 0.51 | 0.30 | 0.30 | 0.27 | 0.27 | 0.42 | 0.56 | 0.18 | 0.15 | 0.22 | 0.18 | 0.37 |
| | | Female | 1.06 | 1.05 | 0.36 | 0.40 | 0.50 | 0.70 | 0.30 | 0.40 | 0.18 | 0.17 | 0.34 | 0.58 | 0.11 | 0.13 | |
| | Total | Male | 0.42 | | 0.32 | | 0.23 | | 0.33 | | 0.36 | | 0.23 | | 0.20 | | 0.30 |
| | | Female | 1.01 | | 0.65 | | 0.73 | | 0.49 | | 0.50 | | 0.49 | | 0.33 | | 0.65 |
| | Grand Total | | 0.72 | | 0.49 | | 0.48 | | 0.41 | | 0.43 | | 0.36 | | 0.27 | | |

TABLE 5: continued

| Source | Mean Square | DF | F | p |
|---|---|---|---|---|
| **Between** | | | | |
| Sex | 9.59 | 1 | 6.47 | .02 |
| Anxiety | 3.09 | 1 | 2.08 | .15 |
| Sex x Anxiety | 4.52 | 1 | 3.05 | .09 |
| R-S Covariate | 1.13 | 1 | 0.76 | .39 |
| Trial 1 Covariate | 32.11 | 1 | 21.67 | .01 |
| Error | 1.48 | 56 | | |
| **Within** | | | | |
| Trials | 1.20 | 6 | 4.91 | .01 |
| Trials x Sex | 0.53 | 6 | 2.18 | .04 |
| Trials x Anxiety | 0.29 | 6 | 1.16 | .33 |
| Trials x Sex x Anx. | 0.26 | 6 | 1.06 | .39 |
| Error | 0.25 | 348 | | |
| **Linear Trend** | | | | |
| Trials | 5.95 | 1 | 17.16 | .01 |
| Trials x Sex | 1.95 | 1 | 5.61 | .02 |
| Trials x Anxiety | 0.48 | 1 | 1.39 | .24 |
| Trials x Sex x Anx. | 0.03 | 1 | 0.24 | .63 |
| Error | 0.35 | 58 | | |

TABLE 6: Analysis of PSI data over trials: 2x2x(7) ANCOVA on average negative potential change scores as a dependent variable.

| | | | Trial 1 | | Trial 2 | | Trial 3 | | Trial 4 | | Trial 5 | | Trial 6 | | Trial 7 | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\bar{x}$ | SD | $\bar{x}$ | SD | $\bar{x}$ | SD | $\bar{x}$ | SD | $\bar{x}$ | SD | $\bar{x}$ | SD | $\bar{x}$ | SD | $\bar{x}$ |
| Anxiety | High | Male | 0.31 | 0.63 | 0.37 | 0.77 | 0.21 | 0.42 | 0.36 | 0.61 | 0.21 | 0.39 | 0.37 | 0.58 | 0.18 | 0.27 | 0.51 |
| | | Female | 0.67 | 1.24 | 0.71 | 1.07 | 0.81 | 1.07 | 0.66 | 1.23 | 0.86 | 1.50 | 0.76 | 1.23 | 0.73 | 1.33 | |
| | Low | Male | 0.29 | 0.84 | 0.18 | 0.72 | 0.38 | 0.69 | 0.10 | 0.52 | 0.15 | 0.57 | 0.14 | 0.46 | 0.14 | 0.61 | 0.18 |
| | | Female | 0.97 | 1.36 | 0.10 | 0.49 | 0.14 | 0.75 | -0.00 | 0.50 | -0.03 | 0.53 | 0.14 | 0.78 | -0.13 | 0.33 | |
| | Grand Total | | 0.56 | | 0.34 | | 0.39 | | 0.28 | | 0.30 | | 0.35 | | 0.23 | | |

TABLE 6: continued

| Source | Mean Square | DF | F | p |
|---|---|---|---|---|
| Between | | | | |
| Sex | 4.97 | 1 | 2.10 | .15 |
| Anxiety | 11.72 | 1 | 4.94 | .03 |
| Sex x Anxiety | 6.43 | 1 | 2.71 | .11 |
| Trial Covariate | 28.06 | 1 | 11.82 | .01 |
| Error | 2.37 | 57 | | |
| Within | | | | |
| Trials | 0.69 | 6 | 1.91 | .08 |
| Trials x Sex | 0.31 | 6 | 0.86 | .52 |
| Trials x Anxiety | 0.76 | 6 | 2.09 | .06 |
| Trials x Sex x Anx. | 0.67 | 6 | 1.84 | .09 |
| Error | 0.36 | 348 | | |

could be identified for subjects' reactions over time.

Prediction of Habituation to the PSI

In order to determine the degree to which an investigator can predict whether an individual will habituate rapidly to PSI presentations, a series of multiple regression analyses (simultaneous solution) were performed on the data. For these analyses the criterion variable was the habituation-nonhabituation dichotomy obtained from a median split of the physiological variables' beta values (described above). Six criterion variables were established. These were the dichotomous splits for: HR values, average positive wave potential, average negative wave potential, frequency of negative SP responses, frequency of positive SP responses, and the total number of SP responses. Fourteen predictor variables were used in each of the regression analyses (see Table 7). A step-down regression procedure was also employed for each criterion variable to reduce the predictor set to the most discriminative combination. The results of both sets of regression techniques are presented in Table 9. Multiple correlation coefficients from the regression analyses using all fourteen predictors in a simultaneous solution are reported. In addition, the significant predictors and variables in the final equation of the step-down procedure are indicated.

A multiple regression analysis was also performed to determine the variables that best predicted an individual's anxiety level in the experiment. The criterion here was the subject's assignment to either the threat of shock or control condition. Again fourteen predictor variables were employed and are described in Table 8. A stepwise analysis was carried out to reduce this set to a more parsimonious combination. The results of both analyses are presented in Table 9.

TABLE 7: Definitions of the predictor set used in differentiating "habituators" from "nonhabituators" for each of the dependent variables.

| PREDICTORS | DEFINITION |
|---|---|
| SEX | male/female |
| TMAS | score on the Taylor Manifest Anxiety Scale |
| R-S | score on the R-S Scale |
| MACL1 | first baseline score on the MAACL check list |
| HRB1 | first baseline score for heart rate |
| PB1 | first baseline positive potential value |
| MB1 | first baseline negative potential value |
| FPB1 | first baseline frequency of positive waves |
| FTB | first baseline frequency of total SP responses |
| FMB1 | first baseline frequency of negative waves |
| Q3 | subject's global anxiety rating |
| RA1 | laboratory assistant's rating of subjects' anxiety level prior to PSI prints |
| RA2 | laboratory assistant's rating of subjects' anxiety level during PSI prints |
| RA5 | laboratory assistant's global rating of subjects' anxiety |

TABLE 8: Definitions of the predictor set for the analyses using anxiety assignment as the criterion variable.

| PREDICTORS | DEFINITION |
|---|---|
| SEX | * |
| TMAS | * |
| R-S | * |
| MACL1 | * |
| MACL2 | second baseline score on the MAACL check list |
| Q3 | * |
| RA1 | * |
| RA5 | * |
| HR | beta weight for heart rate scores |
| PP | beta weight for positive potential value |
| M | beta weight for negative potential value |
| FP | beta weight for frequency of positive waves |
| FM | beta weight for frequency of negative waves |
| FT | beta weight for total frequency of SP responses |

*See Table 7 for definition

TABLE 9: Results of the simultaneous and stepwise regression analyses used to determine the variables that best differentiated "habituators" from "nonhabituators" and subjects in the anxiety condition versus the control group.

| Criterion | Variables in the final equation of the stepwise analysis |
|---|---|
| HR Score | |
| R=.58 $R^2$=.34 $R^2$adj.=.15 | Sex, R-S, HRB1, PB1*, MB1*, Q3 |
| Average positive potential | |
| R=.46 $R^2$=.21 $R^2$adj.=.03 | Sex, R-S, FMB1, TMAS |
| Average negative potential | |
| R=.44 $R^2$=.20 $R^2$adj.=.04 | Sex*, R-S, FPB1*, FTB, RA2, RA5 |
| Frequency of positive waves | |
| R=.54 $R^2$=.29 $R^2$adj.=.08 | TMAS, R-S*, PB1, FPB1, FTB*, Q3, RA1* |
| Frequency of negative waves | |
| R=.58 $R^2$=.34 $R^2$adj.=.15 | R-S*, MACL1, MB1, FTB*, RA1*, RA2* |
| Frequency of total SPRs | |
| R=.49 $R^2$=.22 $R^2$adj.=.02 | TMAS, MACL1, HRB1, FPB1, RA1*, RA5 |
| Anxiety Assignment | |
| R=.76 $R^2$=.58 $R^2$adj.=.44 | Sex, MACL1*, MACL2*, RA1*, RA5*, HR, FP, FM*, FT, TMAS* |

*$p < .05$

Procedural Checks

A 2x2 ANOVA, sex by anxiety condition, was carried out to determine whether subjects were appropriately matched in terms of their trait anxiety scores on the TMAS. There were no significant differences between anxiety conditions and the sexes (Table 10a), and hence the matching procedure appeared to have been appropriately conducted. Also, a 2x2 ANOVA was performed on individuals' R-S scores to ascertain whether the experimental groups and the sexes differed in terms of their tendency to respond in a "repressive" or "sensitized" manner. Again no significant differences were observed (Table 10b).

In order to determine the degree to which the anxiety manipulation, threat of shock, was effective in inducing anxiety a series of 2x2x(2) repeated measures ANOVAs, sex by anxiety condition by baseline period, was performed on the variables for each of the response systems (verbal, heart rate, skin potential). The ANOVA carried out on the self-report measure of anxiety (MAACL) showed that individuals in the anxiety condition obtained higher anxiety scores ($p < .05$) than persons in the control group (Table 11a). Similarly, subjects in general had a tendency to rate their anxiety as being higher during the second baseline than during the first period ($p < .01$). Moreover, there tended to be a significant interaction ($p < .01$) between baseline periods and anxiety conditions. That is, persons in the threat group tended to feel more anxious during the second baseline period than persons in the control condition. The ANOVA carried out on HR scores indicated that subjects in general had significantly higher heart rates ($p < .01$) during the second baseline period (Table 11b). However, no other significant effects were observed for this variable. When the average negative wave potential was

TABLE 10a: Analysis for the procedural check on the matching of subjects using TMAS scores as a dependent variable.

| | | Male | | Female | | Total |
|---|---|---|---|---|---|---|
| | | $\bar{x}$ | SD | $\bar{x}$ | SD | $\bar{x}$ |
| | High | 15.67 | 8.29 | 16.82 | 8.28 | 16.25 |
| Anxiety | Low | 16.44 | 7.55 | 19.33 | 8.71 | 17.89 |
| | Total | 16.06 | | 18.08 | | |

| Source | Mean Square | DF | F | p |
|---|---|---|---|---|
| Sex | 63.23 | 1 | 0.94 | .34 |
| Anxiety | 41.94 | 1 | 0.62 | .43 |
| Sex x Anxiety | 11.86 | 1 | 0.18 | .68 |
| Error | 67.33 | 58 | | |

TABLE 10b: Analysis for the procedural check on the matching of subjects using R-S scores as a dependent variable.

| | | Male | | Female | | Total |
|---|---|---|---|---|---|---|
| | | $\bar{x}$ | SD | $\bar{x}$ | SD | $\bar{x}$ |
| | High | 43.60 | 17.87 | 40.19 | 16.69 | 41.90 |
| Anxiety | Low | 42.31 | 17.47 | 47.87 | 15.59 | 45.09 |
| | Total | 42.96 | | 44.03 | | |

| Source | Mean Square | DF | F | p |
|---|---|---|---|---|
| Sex | 17.76 | 1 | 0.06 | .81 |
| Anxiety | 158.14 | 1 | 0.54 | .47 |
| Sex x Anxiety | 311.23 | 1 | 1.06 | .31 |
| Error | 294.50 | 58 | | |

TABLE 11a: Analysis for the procedural check on the effectiveness of anxiety induction using scores on the MAACL as a dependent variable.

| | | | Baseline 1 | | Baseline 2 | | Total |
|---|---|---|---|---|---|---|---|
| | | | $\bar{x}$ | SD | $\bar{x}$ | SD | $\bar{x}$ |
| Anxiety | High | Male | 7.87 | 2.90 | 10.60 | 2.56 | |
| | | Female | 7.75 | 3.17 | 12.06 | 2.57 | 9.57 |
| | | Total | 7.81 | | 11.33 | | |
| | Low | Male | 8.19 | 3.92 | 7.13 | 3.86 | |
| | | Female | 8.60 | 3.99 | 8.47 | 2.85 | 8.10 |
| | | Total | 8.40 | | 7.80 | | |
| | Grand Total | | 8.10 | | 9.57 | | |

| Source | Mean Square | DF | F | p |
|---|---|---|---|---|
| Between | | | | |
| Sex | 18.60 | 1 | 1.18 | .28 |
| Anxiety | 67.37 | 1 | 4.26 | .04 |
| Sex x Anxiety | 0.32 | 1 | 0.02 | .88 |
| Error | 15.82 | 58 | | |
| Within | | | | |
| Trials | 66.24 | 1 | 11.52 | .01 |
| Trials x Sex | 12.18 | 1 | 2.12 | .15 |
| Trials x Anxiety | 131.47 | 1 | 22.86 | .01 |
| Trials x Sex x Anx. | 0.82 | 1 | 0.14 | .71 |
| Error | 5.75 | 58 | | |

TABLE 11b: Analysis for the procedural check on the effectiveness of anxiety induction using heart rate as a dependent variable.

| | | Baseline 1 | | Baseline 2 | | Total |
|---|---|---|---|---|---|---|
| | | $\bar{x}$ | SD | $\bar{x}$ | SD | $\bar{x}$ |
| Anxiety High | Male | 71.80 | 8.25 | 81.60 | 16.53 | 78.63 |
| | Female | 74.69 | 11.41 | 86.44 | 11.33 | |
| Anxiety Low | Male | 73.06 | 14.51 | 81.94 | 18.22 | 78.69 |
| | Female | 79.27 | 11.96 | 80.47 | 16.47 | |
| Total | | 74.68 | | 82.67 | | |

| Source | Mean Square | DF | F | p |
|---|---|---|---|---|
| Between | | | | |
| Sex | 300.40 | 1 | 1.04 | .31 |
| Anxiety | 0.08 | 1 | 0.00 | .98 |
| Sex x Anxiety | 17.32 | 1 | 0.06 | .81 |
| Error | 286.97 | 58 | | |
| Within | | | | |
| Trials | 1935.76 | 1 | 19.46 | .01 |
| Trials x Sex | 63.44 | 1 | 0.64 | .43 |
| Trials x Anxiety | 254.86 | 1 | 2.56 | .11 |
| Trials x Sex x Anx | 179.30 | 1 | 1.86 | .18 |
| Error | 99.48 | 58 | | |

examined (Table 11c), it was found that subjects in general tended to exhibit negative SP responses with greater amplitude during the second as opposed to the first baseline period ($p < .03$). The baseline sessions did not differ from each other when sex and/or experimental assignment were considered. The analyses carried out on the ratio of the average positive potential to the average negative potential, illustrated that males, in comparison to females, tended to have positive wave responses of greater amplitude than negative wave responses, across baseline periods and experimental conditions ($F=6.30$, $df=1,58$; $p < .02$). Thus, males appear to exhibit greater amplitude in their "defensive reactions" during baseline states than females.

A series of 2x2 ANOVAs, sex by anxiety condition, was also performed on the questionnaire data dealing with subjects' global rating of anxiety, rating of anxiety during the application of chemical prints, the laboratory assistant's rating of the subjects' anxiety during the experiment in general and during the application of the chemical prints. Subjects in the anxiety condition, in comparison to individuals in the control group, reported greater levels of anxiety throughout the experiment in general and during the application of the chemical prints in particular ($F=6.80$; $df=1,58$; $p < .01$; and $F=5.40$; $df=1,58$; $p < .02$, respectively). Similarly, the laboratory assistant rated subjects in the anxiety group as being significantly more anxious just before the application of the prints than individuals in the control condition ($F=4.85$; $df=1,58$; $p < .04$). However, the experimental groups did not differ significantly when the assistant's global rating of anxiety was considered as a dependent variable ($F=1.26$; $df=1,58$; $p < .27$).

TABLE 11c: Analysis for the procedural check on the effectiveness of anxiety induction using the average negative potential as a dependent variable.

| | | Baseline 1 | | Baseline 2 | | Total |
|---|---|---|---|---|---|---|
| | | $\bar{x}$ | SD | $\bar{x}$ | SD | $\bar{x}$ |
| High | Male | 0.16 | 0.19 | 0.21 | 0.26 | 0.29 |
| | Female | 0.19 | 0.13 | 0.60 | 0.81 | |
| Anxiety | | | | | | |
| Low | Male | 0.37 | 0.36 | 0.40 | 0.39 | 0.39 |
| | Female | 0.33 | 0.41 | 0.47 | 0.51 | |
| Total | | 0.26 | | 0.42 | | |

| Source | Mean Square | DF | F | p |
|---|---|---|---|---|
| Between | | | | |
| Sex | 0.40 | 1 | 1.83 | .18 |
| Anxiety | 0.36 | 1 | 1.67 | .20 |
| Sex x Anxiety | 0.31 | 1 | 1.46 | .23 |
| Error | 0.21 | 58 | | |
| Within | | | | |
| Trials | 0.77 | 1 | 4.82 | .03 |
| Trials x Sex | 0.42 | 1 | 2.61 | .11 |
| Trials x Anxiety | 0.16 | 1 | 1.01 | .32 |
| Trials x Sex x Anx. | 0.13 | 1 | 0.80 | .37 |
| Error | 0.16 | 58 | | |

Ancillary Analyses

Subjects' reactivity to the first presentation of the PSI was further investigated by performing a series of analyses on variables derived from the study's main dependent measures. When a 2x2 ANOVA was carried out on the ratio of positive wave frequency to negative wave frequency, significant differences between males and females across anxiety conditions were observed ($F=6.04$; $df=1,58$; $p<.02$). More precisely, females in comparison to males, exhibited a greater number of "defensive" reactions in relation to orienting responses for the first trial. ANOVAs performed on the ratio of average positive wave potential to average negative wave potential and HR change scores, showed that there was a tendency for individuals in the anxiety group to exhibit greater HR increases from baseline and a higher average potential ratio than persons in the control condition ($F=3.89$; $df=1,58$; $p<.06$; and $F=3.88$; $df=1,58$; $p<.06$, respectively).

An ANOVA was also performed on the post-experimental questionnaire data dealing with the degree to which subjects rated the experiment as interesting (see Table 12). A significant sex by anxiety condition interaction was found ($p<.03$). Anxious males were most interested in the experiment followed by nonanxious females. On the other hand, nonanxious males were least interested in the study.

TABLE 12: Analysis performed on the post-experimental data dealing with subjects' interest in the experiment.

| | | Males | | Females | | Total |
|---|---|---|---|---|---|---|
| | | $\bar{x}$ | SD | $\bar{x}$ | SD | $\bar{x}$ |
| | High | 5.73 | 0.88 | 4.50 | 1.46 | 5.10 |
| Anxiety | Low | 4.38 | 1.71 | 4.87 | 1.64 | 4.61 |
| | Total | 5.03 | | 4.68 | | |

| Source | Mean Square | DF | F | p |
|---|---|---|---|---|
| Sex | 2.13 | 1 | 0.99 | .32 |
| Anxiety | 3.81 | 1 | 1.78 | .19 |
| Sex x Anxiety | 11.52 | 1 | 5.37 | .02 |
| Error | 2.15 | 58 | | |

# DISCUSSION

The finding that individuals in the anxiety condition reported more anxiety and were observed to be more anxious than persons in the control group, but did not differ from this group in terms of their autonomic responding during pre-stimulation periods, can be explained in two ways. First, many researchers (Katkin, 1965; Leitenberg et al., 1971) have found low correlations between autonomic indices, behavioral observations and self-report measures of anxiety. Thus, while persons may subjectively feel more anxious, their feelings are not necessarily accompanied by physiological arousal, and vice versa. Also, the three aforementioned response systems are considered to be relatively independent and indicate response characteristics of the subject that are autonomous from each other (see Hersen & Bellack, 1976). In the present study it appears that individuals' reactions to anxiety were more apparent in their verbal and behavioral repertoires than in their autonomic systems. Second, the second session of the study in itself appeared to be quite anxiety-provoking for individuals. Subjects in general reported more anxiety, had higher heart rates and had negative SP responses of greater amplitude during this period. These increases in autonomic responding during the second baseline may have attenuated any differential response patterns between the two experimental groups. However, persons in the threat condition did increase their subjective feelings of anxiety to such an extent that they could be distinguished from individuals in the control condition. This provides further support for the contention that subjects in this study had a propensity to respond to the experimental situation with their verbal and behavioral systems. Therefore, the preceeding results may somewhat be attributed to subjects' predisposition to react to the threat situation with their verbal/ cognitive and behavioral systems, and the general elevation of autonomic activity in the second session causing an attenuation of the differences between the experimental groups.

Subjects' reaction to the first presentation of the PSI was observed to be quite a complex phenomenon. While it was hypothesized that anxious individuals would react to the first PSI trial in a manner that was qualitatively as well as quantitatively diffeernt from the control group, it was found that a person's sex in addition to their anxiety level determined his/her pattern of responding. Anxious females had a tendency to react to the measure with more "defensive" responses than nonanxious females. This finding is in agreement with other studies that have found that phobics (Hare, 1972) and anxious persons in general (Hart, 1974; Neary & Zuckerman, 1976) give more defensive responses and less orienting reactions to stimuli than nonanxious individuals. These studies have primarily used heart rate as a dependent measure. However, there is some evidence suggesting that an increase in the number of positive SP waves is associated with increased levels of arousal. Several researchers (Forbes & Bolles, 1936; Shmavonian et al., 1968; Uno & Grings, 1965) have shown that high intensity auditory stimulation or shock evokes more positive waves in subjects. Similarly, Raskin et al. (1969) found that a monotonic relationship exists between the intensity of stimulation and the elicitation of positive SP waves. Therefore, it appears that anxious females exhibit a pattern and degree of autonomic responding that is indicative of high physiological arousal and a defensive orientation.

On the other hand, anxious males responded to the PSI by exhibiting an increase in orienting responses, and nonanxious males showed a defensive pattern of responding similar to anxious females. These results appear to contradict the general belief that anxious individuals emit more defensive reactions and show a deficit in orienting responses. Moreover, nonanxious persons are usually seen as having a propensity to respond in an orienting fashion. These discrepancies may be attributed to some other factors that may have been operating during the experiment which may have affected subjects' initial reactions to the stimulus, namely sex differences in electrodermal responding, subjects' interest in the study's procedures, and the demand characteristics imposed by having a male laboratory assistant.

Anxious males' tendency to react to the first stimulus presentation in an orienting as opposed to a defensive manner may be due to the degree to which they found the study interesting. These individuals reported the most interest in the experiment. This interest in the study may be indicative of subjects' predisposition to respond to the experimental situation or stimuli with a particular pattern of autonomic activity. Lacey (Lacey, 1967; Lacey & Lacey, 1958b) has suggested that situations or stimuli that are interesting to an individual are conducive to environmental "intake". That is, in these instances persons have a tendency to respond in an orienting fashion so that they can gain more information about their surroundings. Thus, since anxious males in the study found the experimental procedures most interesting, it is plausible that they were more prone to react to the experimental environment and stimuli in an orienting fashion. Furthermore, the pre-PSI warning given by the laboratory assistant may have enhanced this pattern of responding in these individuals since it has been shown that the orienting response can be accentuated by having subjects attend to the test stimulus (Korn & Moyer, 1968; Razran, 1961).

Research in the area of sex differences in electrodermal responding has for the most part yielded equivocal results (Fisher & Kotses, 1974; Kopacz & Smith, 1971). Furthermore, this research has only concentrated on skin resistance measures as dependent variables and has neglected skin potential phenomena. In studies using skin conductance response (SCR) as a measure, males have been found to exhibit higher basal conductance levels in non-stressful situations than females (Fisher & Kotses, 1974; Graham, Cohen, & Shmavonian, 1966; Kopacz & Smith, 1971). However, the results are more variable when stress conditions and SCR reactivity measures are employed. Some researchers have found that males show greater reactivity in stress situations (Graham et al., 1966; Kimmel & Kimmel, 1965). Others observed females to be more reactive (Berry & Martin, 1957; Kopacz & Smith, 1971). Thus, it appears that while the results are considerably variable in this area of research, there does seem to be some consistency in the finding that males tend to have higher basal levels of electrodermal activity and arousal than females. Also, this pattern of responding exhibited by males was observed in the present investigation where nonanxious males emitted more defensive reactions than nonanxious females. Moreover, the finding that anxious females have a tendency to show more defensive responses lends support to studies that have found females to be more reactive in stress situations (Berry & Martin, 1957; Kopacz & Smith, 1971). Therefore, the patterns of reactivity shown by anxious females and nonanxious males in the present study may be partially imputed to the sex differences found in research utilizing electrodermal indices.

There has been a paucity of research investigating experimenter and subject sex effects in studies of electrical skin phenomena. Fisher and Kotses (1974) conducted one of the first and most comprehensive studies of this problem. They found that male and female subjects emitted significantly more spontaneous skin resistence responses in the other-sex experimenter condition. Also, males in the female experimenter condition gave more spontaneous GSR fluctuations than any of the other experimental groups. These authors attributed the results to a combination of stimulus novelty effects (i.e., female experimenter in a male role) and an individual's history of social role learning. They recommend that further research be conducted to elucidate the complex factors in the experimenter-subject relationship that affect electrodermal activity. In terms of the present study, anxious females' defensive responding may have been due to the presence of a male laboratory assistant, but nonanxious males' activity did not fit the pattern observed by Fisher and Kotses. However, the sex of the experimenter is only one aspect of the constellation of experimenter characteristics that affect electrodermal phenomena. Physical attractiveness, mannerisms, and style of dress may be other salient variables that interact with the experimenter's sex to alter skin potential activity. Therefore, any one or combination of these other variables may have influenced individuals' SP responses in the present investigation and illustrates the need for further research to ascertain the degree to which these processes operate to affect electrodermal responding.

While the two experimental groups did not differ significantly in terms of their response to the first PSI presentation, they did differ across PSI applications. That is, when average negative potential change scores were examined, anxious individuals exhibited responses of greater magnitude than nonanxious control subjects. This indicates that anxious persons find the PSI more obtrusive across presentations than individuals in a more relaxed state and hence underscores the need to investigate the obtrusiveness of autonomic indices. Similar findings have been reported in other studies using skin resistance measures (Beam, 1955; Haywood & Spielberger, 1966). However, in these investigations subjects' reactivity was measured in terms of their response to an initial stimulus presentation. The fact that anxious persons differed from nonanxious individuals across PSI trials suggests that this may be another method, in addition to reactivity and habituation scores, of differentiating these two populations. This approach of examining individuals' responses across a series of stimulus presentations may provide a more stable measure of responding in stress situations, since it takes into account increases, decreases, and prolonged periods of activity without the difficulties of identifying trends or dealing with nonlinear relationships. Furthermore, it is based on several stimulus applications rather than the response to a single trial, as is the case with a reactivity index.

The Chi-Square analysis of individuals' habituation to the PSI indicated that nonanxious persons had a tendency to habituate at a faster rate than anxious individuals in terms of the magnitude of their orienting responses. This finding is in agreement with Lader and Mathews' (1968) model of evaluating anxiety and is supported by other studies that have indicated that anxious subjects and phobics take longer to habituate to the orienting response than normals (Davis et al., 1954; Hare, 1973; Lader, 1969; Lader & Wing, 1966). Moreover, it has serious implications for the obtrusiveness of this device, namely that anxious persons continue to react to this instrument over time and take longer to adapt. Therefore, longer adaptation periods to the experimental instrumentation should be implemented in situations where the experimenter is dealing with anxious subjects, since these individuals' prolonged reactions to the device may confound the evaluation of the psychological constructs under investigation.

When the more discriminative method of evaluating habituation was employed, the repeated measures Analysis of Covariance (ANCOVA) (covarying the first trial), no significant anxiety condition by trials interactions were found. However, a sex by trials effect was present. Females, in comparison to males, took longer to habituate to the PSI and tended to exhibit defensive responses of greater magnitude over PSI presentations. Berry and Martin (1957) also found females to be slow habituators, but other researchers have found them be be faster than males (Kopacz & Smith, 1971; Korn & Moyer, 1968). The fact that females were slow habituators in the present study may be attributed to their tendency to exhibit more positive waves on the first PSI trial than males and thus they had a higher probability of emitting positive SP responses of greater amplitude on subsequent presentations. In addition, the positive wave response has been shown to be slow to habituate (Raskin et al., 1969) and thus any trend initiated on the first trial could be continued over time. Therefore, the sex of the subject has to be taken into account when ascertaining an individual's reactivity and habituation to an autonomic index.

The discrepancy in findings between the two techniques of determining a subject's habituation to the PSI may be attributed to certain methodological differences and inadequacies. First, in the Chi-Square analysis adjusted beta weights should have been computed to correct for initial value effects. However, even the procedure of utilizing adjusted beta weights has some short-comings. The procedure only adjusts the intercept and does not partial out the variance associated with the first trial from the remaining data points on the regression line. The repeated ANCOVA adjusts all trials and should be the method of choice in these situations.

The fact that subjects in this study responded to the PSI with changes in their skin potential rather than their heart rate activity may be seen as an example of "directional fractionation" (Lacey & Lacey, 1958a, 1970). That is, individuals have a propensity to analyze and respond to stimulus situations with specific autonomic systems and not others. McGuinness (1973) obtained similar results in a habituation study using blood volume and heart rate as dependent variables. She found no differences in heart rate for anxious and nonanxious subjects during a habituation series and in an orienting situation. She suggests that heart rate may not be an appropriate measure for differentiating individuals with different levels of anxiety in studies using stimuli of moderate intensity, since there is no sympathetic arousal effect for heart rate under these circumstances. She recommends that heart rate recovery time be used in habituation studies. Thus, if this type of variable was employed it may have provided the present investigation with a more sensitive measure for examining heart rate during a habituation series.

Even though skin potential activity appeared to be the physiological system that was most sensitive to presentations of the PSI, there was some variation in the characteristics of skin potential activity present at a certain point in time. The frequency of SP responses seemed most sensitive to change on the first PSI trial, while the magnitude of positive and negative waves exhibited differential patterns over and across PSI applications. Glaus and Kotses (1974) suggest that skin potential phenomena, not unlike autonomic systems in general, are quite complex and that individuals have an idiosyncratic pattern of skin potential activity. Thus, not only will a person have a propensity to respond with a particular autonomic system, but will also exhibit a predisposition to react with a certain characteristic of that system, such as negative as opposed to positive SP waves. Therefore, it may be more appropriate to use single organism designs instead of the group approach in research employing electrodermal measures. In fact, Glaus and Kotses recommend that alternatives to group designs be used in skin potential studies if less equivocal results are to be obtained.

In terms of elucidating the variables that best predict[4] habituators from nonhabituators, four types of variables were found to distinguish these two groups. The first type dealt with a subject's dispositional characteristics: whether he/she is an anxious person in general (trait anxiety) and whether he/she is a "repressor" or "sensitizer". The second area dealt with the person's sex. This is not surprising since males and females responded to the first PSI trial and subsequent presentations in a different fashion. The third group of variables were concerned with subjects' behavioral manifestations of anxiety as measured by the laboratory assistant's behavioral check list. Individuals rated as being anxious during the experiment were more likely to be

[4]The variables selected were those that were present in the final solution of the stepwise regression procedure on four or more criterion variables.

classified as nonhabituators. Finally, the frequency of positive waves and the total frequency of SP responses distinguished habituators from nonhabituators. The fact that the positive wave is slow to habituate and was found to be a salient variable in differentiating the electrodermal activity of males and females probably influenced its importance as a predictor variable. However, the low values of the adjusted multiple correlation coefficients (adjusted for shrinkage) suggest that these results be viewed with caution and that further research be carried out to determine these variables' predictive utility.

Summary and Recommendations

The obtrusiveness of autonomic measures was found to be a salient factor in psychophysiological research and could confound the evaluation of the theoretical constructs being investigated in a particular study. More precisely, the PSI was observed to be an intrusive instrument which affected subjects' electrodermal responding. Also, the obtrusiveness of this device was found to be a complex phenomenon in that it was affected by an individual's sex and anxiety level. Anxious males and females exhibited their own specific pattern of responding on the first PSI trial and over PSI presentations.

The results of this study illustrate that further research needs to be carried out on the obtrusiveness of psychophysiological measures. Other devides besides the PSI should be investigated. Also, the effects of variables like subjects' sex, experimenter characteristics, anxiety level, and nature of the experimental situation on obtrusiveness must be researched. Furthermore, skin potential phenomena in general must be studied in more detail. The effects of sex and anxiety level on skin potential characteristics should be ascertained. In addition, studies should be designed which can determine the types of skin potential responses that are present in situations demanding environmental "intake" or "rejection". Finally, more sensitive dependent variables and more appropriate experimental designs should be employed to clarify some of the ambiguities in the results of electrodermal research.

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# APPENDIX A

## Palmar Sweat Technique

The Palmar Sweat Technique depends on the emission of sweat from active glands into a solidifying plastic film. The plastic substance used is immiscible with moisture and consequently leaves bubbles or holes in the print which mark the sites of active sweat glands. After thoroughly drying the skin with absorbent tissue, the following solution is applied to the finger with a single dab of a cork stopper or brush:

| | |
|---|---|
| Polyvinyl formal (Forvar 15/95E: Monsanto Chemicals) | 5 gm. |
| Butyl phthalate | 10 ml. |
| Semi-colloidal dispersion of graphite in trichloethylene (dag 155: Acheson Colloids Co.) | 20 gm. |
| Ethylene dichloride | 100 ml. |

Butyl phthalate is used to strengthen the print whereas graphite provides greater visual contrast.

When the solvent has evaporated (within 10-30 seconds), the print is covered with a piece of Scotch "Magic" transparent tape and lifted off the finger. The tape and film are then mounted on a microscope slide.

For scoring, the print is enlarged 10 diameters with a microscope and the active sweat glands simply counted. These glands appear as holes along the ridges of the print. Scoring is facilitated by using a template covering the appropriate area, in this case, $2mm^2$ . The same area on an individual's finger is easily located in subsequent prints by reference to skin landmarks visible on the print.

# APPENDIX B

## Pre-Experiment Questionnaire

Health and Opinion Survey

This survey consists of numbered statements. Read each statement and decide whether it is true as applied to you or false as applied to you.

You are to mark your answers on the answer sheet you have. If a statement is TRUE or MOSTLY TRUE as applied to you, blacken between the lines in the column headed T. If a statement is FALSE or NOT USUALLY TRUE as applied to you, blacken between the lines in the column headed F. If a statement does not apply to you or if it is something that you don't know about, make no mark on the answer sheet.

Remember to give YOUR OWN opinion of yourself. Do not leave any blank spaces if you can avoid it.

In marking your answers on the answer sheet be sure that the number of the statement agrees with the number on the answer sheet. Make your marks heavy and black. Erase completely any answer you wish to change. Do not make any marks on the question sheets.

Remember to try to make some answer to every statement.

NOW TURN THE PAGE AND GO AHEAD

1. I have a good appetite.
2. I wake up fresh and rested most mornings.
3. I am easily awakened by noise.
4. I like to read newspaper articles on crime.
5. My hands and feet are usually warm enough.
6. My daily life is full of things that keep me interested.
7. I am about as able to work as I ever was.
8. There seems to be a lump in my throat much of the time.
9. I enjoy detective or mystery stories.
10. Once in a while I think of things too bad to talk about.
11. I am very seldom troubled by constipation.
12. At times I have fits of laughing and crying that I cannot control.
13. I am troubled by attacks of nausea and vomiting.
14. I feel that it is certainly best to keep my mouth shut when I'm in trouble.
15. At times I feel like swearing.
16. I find it hard to keep my mind on a task or job.
17. I seldom worry about my health.
18. At times I feel like smashing things.
19. I have had periods of days, weeks, or months when I couldn't take care of things because I couldn't get going.
20. My sleep is fitful and disturbed.
21. Much of the time my head seems to hurt all over.
22. I do not always tell the truth.
23. My judgement is better than it ever was.
24. Once a week or oftener I feel suddenly hot all over, without apparent cause.
25. I am in just as good physical health as most of my friends.
26. I prefer to pass by school friends, or people I know but have not seen for a long time, unless they speak to me first.
27. I am almost never bothered by pains over the heart or in my chest.
28. I am a good mixer.
29. Everything is turning out just like the prophets of the Bible said it would.
30. I do not read every editorial in the newspaper every day.
31. I sometimes keep on at a thing until others lose their patience with me.
32. I wish I could be as happy as others seem to be.

33. I think a great many people exaggerate their misfortunes in order to gain the sympathy and help of other.
34. I get angry sometimes.
35. Most of the time I feel blue.
36. I sometimes tease animals.
37. I am certainly lacking in self-confidence.
38. I usually feel that life is worthwhile.
39. It takes a lot of argument to convince most people of the truth.
40. Once in a while I put off until tomorrow what I ought to do today.
41. I think most people would lie to get ahead.
42. I do many things which I regret afterwards (I regret things more often than others seem to).
43. I go to church almost every week.
44. I have very few quarrels with members of my family.
45. I believe in the second coming of Christ.
46. My hardest battles are with myself.
47. I have little or no trouble with my muscles twitching or jumping.
48. I don't seem to care what happens to me.
49. Sometimes when I am not feeling well I am cross.
50. Much of the time I feel as if I have done something wrong or evil.
51. I am happy most of the time.
52. Some people are so bossy that I feel like doing the opposite of what they request, even though I know they are right.
53. Often I feel as if there were a tight band about my head.
54. My table manners are not quite as good at home as when I am out in company.
55. I seem to be about as capable and smart as most others around me.
56. Most people will use somewhat unfair means to gain profit or an advantage rather than to lose it.
57. The sight of blood neither frightens me nor makes me sick.
58. Often I can't understand why I have been so cross and grouchy.
59. I have never vomited blood or coughed up blood.
60. I do not worry about catching disease.
61. At times my thoughts have raced ahead faster than I could speak them.
62. If I could get into a movie without paying and be sure I was not seen I would probably do it.

63. I commonly wonder what hidden reason another person may have for doing something nice for me.
64. I believe that my home life is as pleasant as that of most people I know.
65. Criticism or scolding hurts me terribly.
66. My conduct is largely controlled by the customs of those about me.
67. I certainly feel useless at times.
68. At times I feel like picking a fist fight with someone.
69. I have often lost out on things because I can't make up my mind soon enough.
70. It makes me impatient to have people ask my advice or otherwise interrupt me.
71. I would rather win than lose in a game.
72. Most nights I go to sleep without thoughts or ideas bothering me.
73. During the past few years I have been well most of the time.
74. I have never had a fit or convulsion.
75. I am neither gaining nor losing weight.
76. I cry easily.
77. I cannot understand what I read as well as I used to.
78. I have never felt better in my life than I do now.
79. I resent having anyone take me in so cleverly that I have had to admit that it was one on me.
80. I do not tire quickly.
81. I like to study and read about things that I am working at.
82. I like to know some important people because it makes me feel important.
83. What others think of me does not bother me.
84. It makes me uncomfortable to put on a stunt at a party even when others are doing the same sort of things.
85. I frequently have to fight against showing that I am bashful.
86. I have never had a fainting spell.
87. I seldom or never have dizzy spells.
88. My memory seems to be all right.
89. I am worried about sex matters.
90. I find it hard to make talk when I meet new people.
91. I am afraid of losing my mind.
92. I am against giving money to beggars.
93. I frequently notice my hand shakes when I try to do something.
94. I can read a long while without tiring my eyes.

95. I feel weak all over much of the time.
96. I have very few headaches.
97. Sometimes, when embarrassed, I break out in a sweat which annoys me greatly.
98. I have had no difficulty in keeping my balance in walking.
99. I do not have spells of hay fever or asthma.
100. I do not like anyone I know.
101. I wish I were not so shy.
102. I enjoy many different kinds of play and recreation.
103. I like to flirt.
104. In walking I am very careful to step over side walk cracks.
105. I frequently find myself worrying about something.
106. I gossip a little at times.
107. I hardly ever notice my heart pounding and I am seldom short of breath.
108. I have at times stood in the way of people who were trying to do something, not because it amounted to much but because of the principle of the thing.
109. I get mad easily and then get over it soon.
110. I brood a great deal.
111. I have periods of such great restlessness that I cannot sit long in a chair.
112. I dream frequently about things that are best kept to myself.
113. I believe I am no more nervous than most others.
114. I have few or no pains.
115. Sometimes without any reason or even when things are going wrong I feel excitedly happy, "on top of the world".
116. I can be friendly with people who do things which I consider wrong.
117. Sometimes at elections I vote for men about whom I know very little.
118. I have difficulty in starting to do things.
119. I sweat very easily even on cool days.
120. It is safer to trust nobody.
121. Once a week or oftener I become very excited.
122. When in a group of people I have trouble thinking of the right things to talk about.
123. When I leave home I do not worry about whether the door is locked and the windows closed.
124. I do not blame a person for taking advantage of someone who lays himself open to it.
125. At times I am all full of energy.
126. My eyesight is as good as it has been for years.

127. I have often felt that strangers were looking at me critically.
128. I drink an unusually large amount of water every day.
129. Once in a while I laugh at a dirty joke.
130. I am always disgusted with the law when a criminal is freed through the arguments of a smart lawyer.
131. I work under a great deal of tension.
132. I am likely not to speak to people until they speak to me.
133. I have periods in which I feel unusually cheerful without any special reason.
134. Life is a strain for me much of the time.
135. In school I found it very hard to talk before the class.
136. Even when I am with people I feel lonely much of the time.
137. I think nearly anyone would tell a lie to keep out of trouble.
138. I am easily embarrassed.
139. I worry over money and business.
140. I almost never dream.
141. I easily become impatient with people.
142. I feel anxiety about something or someone almost all the time.
143. Sometimes I become so excited that I find it hard to get to sleep.
144. I forget right away what people say to me.
145. I usually have to stop and think before I act even in trifling matters.
146. Often I cross the street in order not to meet someone I see.
147. I often feel as if things were not real.
148. I have a habit of counting things that are not important such as bulbs on electric signs, and so forth.
149. I have strange and peculiar thoughts.
150. I get anxious and upset when I have to make a short trip away from home.
151. I have been afraid of things or people that I knew could not hurt me.
152. I have no dread of going into a room by myself where other people have already gathered and are talking.
153. I have more trouble concentrating than others seem to have.
154. I have several times given up doing a thing because I thought to little of my ability.

155. Bad words, often terrible words, come into my mind and I cannot get rid of them.
156. Sometimes some unimportant thought will run through my mind and bother me for days.
157. Almost every day something happens to frighten me.
158. I am inclined to take things hard.
159. I am more sensitive than most other people.
160. At periods my mind seems to work more slowly than usual.
161. I very sledom have spells of the blues.
162. I wish I could get over worrying about things I have said that may have injured other people's feelings.
163. People often disappoint me.
164. I feel unable to tell anyone all about myself.
165. My plans have frequently seemed so full of difficulties that I have had to give them up.
166. Often, even though everything is going fine for me, I feel that I don't care about anything.
167. I have sometimes felt that difficulties were piling up so high that I could not overcome them.
168. I often think, "I wish I were a child again."
169. I have often met people who were supposed to be experts who were no better than I.
170. It makes me feel like a failure when I hear of the success of someone I know well.
171. I am apt to take disappointments so keenly that I can't put them out of my mind.
172. At times I think I am no good at all.
173. I worry quite a bit over possible misfortunes.
174. I am apt to pass up something I want to do because others feel that I am not going about it in the right way.
175. I find it hard to set aside a task that I have undertaken, even for a short time.
176. I have several times had a change of heart about my life work.
177. I must admit that I have at times been worried beyond reason over something that really did not matter.
178. I like to let people know where I stand on things.
179. I have a daydream life about which I do not tell other people.

180. I have often felt guilty because I have pretended to feel more sorry about something than I really was.
181. I feel tired a good deal of the time.
182. I sometimes feel that I am about to go to pieces.
183. I cannot keep my mind on one thing.
184. I blush as often as others.
185. I have diarrhea ("the runs") once a month or more.
186. I worry quite a bit over possible troubles.
187. I practically never blush.
188. I am often afraid that I am going to blush.
189. I have nightmares every few nights.
190. I feel hungry almost all of the time.
191. I have a great deal of stomach trouble.
192. At times I lose sleep over worry.
193. I am usually calm and not easily upset.
194. It makes me nervous to have to wait.
195. I have often felt that I faced so many difficulties I could not overcome them.
196. I do not have as many fears as my friends.
197. I am more self-conscious than most people.
198. I am a very nervous person.
199. I don't like to face a difficulty or make an important decision.
200. I am very confident of myself.

# APPENDIX C

## Explanation given to subjects at the beginning of Session I

The present experiment deals with determining how young adults physically react to a restful situation. To determine how you react to such circumstances we are recording various physiological indices like body temperature. The devices that I am going to place on the fingers of your nondominant hand and your right ankle (show electrodes and sensor) will help us find out about these factors. The procedure will last approximately 20 minutes after which I will tell you more about the study. Try to relax and remain as still as possible while you are connected to the instruments so that we can obtain accurate recordings. Also, do not talk while you are being monitored since this affects your breathing patterns and hence our recordings. Save any questions or comments for the end of the session when you will be disconnected from the apparatus. I will be happy to discuss the experiment with you then. Do you have any questions?

# APPENDIX D

## Description of Laboratory Assistants

Both laboratory assistants were male undergraduate, psychology students. They were trained in applying the PSI to the volar surface of the skin using a high quality artist's brush. Also, they were instructed in attaching the electrodes and in carrying out the relaxation procedure. They were not informed about the two experimental conditions but were told that the study concentrated on the monitoring of heart rate and skin potential responses during resting states. Finally, they were offered acknowledgement in any ensuing publications resulting from the study and a research fee for their services in the experiment.

APPENDIX E

# MULTIPLE AFFECT ADJECTIVE CHECK LIST

TODAY FORM

By Marvin Zuckerman
and
Bernard Lubin

Name.......................................... Age........ Sex......

Date....................... Highest grade completed in school......

DIRECTIONS: On this sheet you will find words which describe different kinds of moods and feelings. Mark an ☒ in the boxes beside the words which describe how you feel now - today. Some of the words may sound alike, but we want you to check all the words that describe your feelings. Work rapidly.

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A D H

1 ☐ active
2 ☐ adventurous
3 ☐ affectionate
4 ☐ afraid
5 ☐ agitated
6 ☐ agreeable
7 ☐ aggressive
8 ☐ alive
9 ☐ alone
10 ☐ amiable
11 ☐ amused
12 ☐ angry
13 ☐ annoyed
14 ☐ awful
15 ☐ bashful
16 ☐ bitter
17 ☐ blue
18 ☐ bored
19 ☐ calm
20 ☐ cautious
21 ☐ cheerful
22 ☐ clean
23 ☐ complaining
24 ☐ contented
25 ☐ contrary
26 ☐ cool
27 ☐ cooperative
28 ☐ critical
29 ☐ cross
30 ☐ cruel
31 ☐ daring
32 ☐ desperate
33 ☐ destroyed
34 ☐ devoted
35 ☐ disagreeable
36 ☐ discontented
37 ☐ discouraged
38 ☐ disgusted
39 ☐ displeased
40 ☐ energetic
41 ☐ enraged
42 ☐ enthusiastic
43 ☐ fearful
44 ☐ fine
45 ☐ fit
46 ☐ forlorn
47 ☐ frank
48 ☐ free
49 ☐ friendly
50 ☐ frightened
51 ☐ furious
52 ☐ gay
53 ☐ gentle
54 ☐ glad
55 ☐ gloomy
56 ☐ good
57 ☐ good-natured
58 ☐ grim
59 ☐ happy
60 ☐ healthy
61 ☐ hopeless
62 ☐ hostile
63 ☐ impatient
64 ☐ incensed
65 ☐ indignant
66 ☐ inspired
67 ☐ interested
68 ☐ irritated
69 ☐ jealous
70 ☐ joyful
71 ☐ kindly
72 ☐ lonely
73 ☐ lost
74 ☐ loving
75 ☐ low
76 ☐ lucky
77 ☐ mad
78 ☐ mean
79 ☐ meek
80 ☐ merry
81 ☐ mild
82 ☐ miserable
83 ☐ nervous
84 ☐ obliging
85 ☐ offended
86 ☐ outraged
87 ☐ panicky
88 ☐ patient
89 ☐ peaceful
90 ☐ pleased
91 ☐ pleasant
92 ☐ polite
93 ☐ powerful
94 ☐ quiet
95 ☐ reckless
96 ☐ rejected
97 ☐ rough
98 ☐ sad
99 ☐ safe
100 ☐ satisfied
101 ☐ secure
102 ☐ shaky
103 ☐ shy
104 ☐ soothed
105 ☐ steady
106 ☐ stubborn
107 ☐ stormy
108 ☐ strong
109 ☐ suffering
110 ☐ sullen
111 ☐ sunk
112 ☐ sympathetic
113 ☐ tame
114 ☐ tender
115 ☐ tense
116 ☐ terrible
117 ☐ terrified
118 ☐ thoughtful
119 ☐ timid
120 ☐ tormented
121 ☐ understanding
122 ☐ unhappy
123 ☐ unsociable
124 ☐ upset
125 ☐ vexed
126 ☐ warm
127 ☐ whole
128 ☐ wild
129 ☐ willful
130 ☐ wilted
131 ☐ worrying
132 ☐ young

# APPENDIX F

## Explanation given to subjects after Session I

As I mentioned before, the study is trying to determine how students respond to restful situations. To check the reliability of the results we obtained during this session and to see how consistent resting states are, we need to hold another session where we can monitor your responses under similar conditions. The recording procedures will be the same as they were today except that in the next session several chemical prints will be taken from your hand. These prints consist of ink being applied to your fingers by brush at several intervals. It is just another technique that will help show us what is involved when the student is at rest and in a comfortable position. We didn't use this instrument today because it is very reliable , and the prints provide a discrete permanent record which only need to be taken once. Do you have any questions? Lets schedule the next session for...

# APPENDIX G

## A) Instructions for Induced Anxiety Condition

As I mentioned in the last session, we would like to have another recording of how you respond to restful situations. However, we are also interested in seeing how students react to stressful stimuli, so you may receive a moderately painful shock to your right ankle through the electrode attached to it. The probability that you will receive a shock depends on whether the random number generator we are using to select students for shock assigns you a value that results in shock within the next 30 minutes. There will be no warning or signal suggesting when the shock will occur. It could happen at the very beginning of the experiment or just before the equipment is disconnected from your body. The chemical prints do not signal the shock, there is no warning. If you wish to withdraw from the study at this point you have the option of doing so and will receive credit for the first session. The monitoring procedure will be identical to the last session except for the application of the sweat prints. Again, please remain as still and quiet as possible. Save any questions or comments for after the experiment.

## B) Instructions for Nonanxious Control Condition

Today we will hook you up again to the equipment to get a second record of your responses while you are resting. Remember that fingerprints will be taken during this session. Again, remain as still and quiet as possible. Save any questions or comments until after the experiment.

# APPENDIX H

Experimental Outline for Session II

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| REST | BASELINE | PSI1 | PSI2 | PSI3 | PSI4 | PSI5 | PSI6 | PSI7 | PSI8 | REST |
| 10min. | 3min. | 50s | 60s | 70s | 80s | 70s | 60s | 50s | | 5min. |

s=seconds

# APPENDIX I

## Assistant's Behavioral Rating Form

Subject's Name__________________

Assistant's Rating Form

1) Rate how anxious the subject was during the 10 min. rest period.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| indifferent | | | | | | very anxious |

2) Rate how anxious the subject was during the last 3 min. before PSI.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| indifferent | | | | | | very anxious |

3) Rate how anxious the subject was when the electrodes were applied.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| indifferent | | | | | | very anxious |

4) Rate how anxious the subject was when the sweat prints were taken.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| indifferent | | | | | | very anxious |

5) Give an overall rating of this individual in terms of anxiety.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| relaxed | | | | | | very anxious |

For the following items place a 1,2 or 4 next to the appropriate category to indicate whether the event occurred during the periods described in items 1,2 and 4, respectively.

Movement Check: a) no movement____ b) some movement____ c) extreme movement____

Movement Area: a) head____ b) torso____ c) arms-shoulders____ d) hands____ e) legs____ f) other______________________

Breathing Check: a) normal____ b) somewhat abnormal____ c) very abnormal____

Breathing Type: a) shallow-rapid____ b) shallow-slow____ c) deep-rapid___ d) deep-slow____

Comments: ____________________________________________

____________________________________________________

APPENDIX J

Post-Experiment Questionnaire

(Nonanxious Control Condition)

Name:____________________

Post-Experiment Questionnaire

Circle the choice that best decribes how you feel.

1) Rate the degree to which you found the experiment interesting.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| boring | | | | | | very interesting |

2) Rate how alert and attentive you were during the experiment.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| indifferent | | | | | | very alert & attentive |

3) Rate how anxious you were during the experiment.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| indifferent | | | | | | very anxious |

4) Rate how anxious the application of the electrodes made you feel.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| indifferent | | | | | | very anxious |

5) Rate how anxious the application of chemical prints made you feel.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| indifferent | | | | | | very anxious |

6) Did your heart rate change during the experiment? 1) yes 2) no
If yes, did it: 1) increase 2) decrease 3) change more than once________
When did your heart rate change? 1) when you entered the laboratory 2) when the electrodes were attached 3) when the chemical prints were taken 4) after the chemical prints 5) other (specify)__________________

7) Did the amount you sweat change during the experiment? 1) yes 2) no
If yes, did it: 1) increase 2) decrease 3) change more than once__________
When did your sweating change? 1) when you entered the laboratory 2) when the electrodes were attached 3) when the chemical prints were taken 4) after the chemical prints 5) other (specify)__________________

8) Were you startled by the application of the chemical prints?
1) yes 2) no

9) Rate the degree to which the application of the chemical prints made you feel uncomfortable.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| indifferent | | | | | | very uncomfortable |

10) Rate the degree to which you believed the explanation of the purpose of the experiment.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| did not believe it | | suspicious | | believed it for the most part | | believed it totally |

11) Rate the degree to which you found the laboratory assistant a source of support during the experiment.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| anxiety-provoking | | | | | | very supportive |

12) Did you think that the laboratory assistant or experimenter would harm you in any way? 1) yes 2) no Comment:____________________

______________________________________________________________________

What did you think the experiment was about? ____________________________

______________________________________________________________________

Comments:_____________________________________________________________

______________________________________________________________________

# APPENDIX J

## Post-Experiment Questionnaire

(Induced Anxiety Condition)

Name:____________________

Post-Experiment Questionnaire

Circle the choice that best decribes how you feel.

1) Rate the degree to which you found the experiment interesting.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| boring | | | | | | very interesting |

2) Rate how alert and attentive you were during the experiment.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| indifferent | | | | | | very alert & attentive |

3) Rate how anxious you were during the experiment.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| indifferent | | | | | | very anxious |

4) Rate how anxious the application of the electrodes made you feel.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| indifferent | | | | | | very anxious |

5) Rate how anxious the application of chemical prints made you feel.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| indifferent | | | | | | very anxious |

6) Did your heart rate change during the experiment? 1) yes 2) no

If yes, did it: 1) increase 2) decrease 3) change more than once________

When did your heart rate change? 1) when you entered the laboratory 2) when the electrodes were attached 3) when the chemical prints were taken 4) after the chemical prints 5) other (specify)__________________

7) Did the amount you sweat change during the experiment? 1) yes 2) no

If yes,did it: 1) increase 2) decrease 3) change more than once_________

When did your sweating change? 1) when you entered the laboratory 2) when the electrodes were attached 3) when the chemical prints were taken 4) after the chemical prints 5) other (specify)__________________

8) Were you startled by the application of the chemical prints?

1) yes 2) no

9) Rate the degree to which the application of the chemical prints made you feel uncomfortable.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| indifferent | | | | | | very uncomfortable |

10) Rate how anxious the threat of shock made you feel.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| indifferent | | | | | | very anxious |

11) Indicate the period where you anticipated receiving the shock.

a) throughout the experiment___
b) when the chemical prints were taken___
c) after the chemical prints___
d) other (specify)______________________________

12) Rate the degree to which you believed that you would receive a shock.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| did not believe it | | suspicious | | believed it for the most part | | believed it totally |

13) Rate the degree to which you believed the explanation of the purpose of the experiment.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| did not believe it | | suspicious | | believed it for the most part | | believed it totally |

14) Rate the degree to which you found the laboratory assistant a source of support during the experiment.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| anxiety-provoking | | | | | | very supportive |

15) Did you think that the laboratory assistant or experimenter would harm you in any way? 1) yes 2) no Comment:______________________

______________________________________________

16) What did you think the experiment was about?______________________

______________________________________________

Comments:______________________________________

______________________________________________

## APPENDIX K

### A) Rationale for Experiment- Induced Anxiety Condition

You were assigned a number from the number generator which did not result in the application of an electric shock. The purpose of introducing a shock was to increase your level of arousal while you were being monitored and to see how your responses changed in comparison to when you were more relaxed. In addition, we wanted to see how you reacted to the application of the chemical prints under stressful conditions. Another group was not threatened with shock but was given the chemical prints. We want to determine whether individuals under stress react differently to these prints than persons in a more relaxed state. Do you have any questions? We would greatly appreciate it if you would not tell your fellow students about the purpose of this study since they may be used as subjects. Thank you for participating.

### B) Rationale for Experiment- Nonanxious Control Condition

Essentially, we wanted to determine your reaction to the chemical prints taken from your nondominant hand. Another group was threatened with shock as well as being given the chemical prints. We want to find out whether individuals under stress react differently to these prints in comparison to persons like yourself, who were in a more relaxed state. Do you have any questions? We would greatly appreciate it if you would not tell your fellow students about the purpose of this study since they may be used as subjects. Thank you for participating.