THE UNIVERSITY OF MANITOBA

THE EFFECT OF ANALOGUE STRESS AND VOLUNTARY CONTROL PROCEDURES ON SELF-REPORTED ANXIETY, HEART RATE, AND ELECTROMYOGRAPHIC RESPONSE

by

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A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE

DOCTOR OF PHILOSOPHY

DEPARTMENT OF PSYCHOLOGY

WINNIPEG, MANITOBA

August, 1979

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A dissertation submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of

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Acknowledgements

The completion of this dissertation has been facilitated by the help of many people. I would especially like to thank John Schallow, my advisor, not only for his expert assistance at every phase of the dissertation but also for his being there to share with me both the good and difficult times throughout my years of graduate school. Having John as an advisor and friend I count among my best fortunes.

Each of the members of my committee provided examples of scholarship and personal concern that contributed greatly to my progress. In particular I thank Michel Janisse for his assistance with equipment and his skillful attention to detail, Ken Hughes for his suggestions at the proposal stage, and Ross Hartsough for his good humor, his thoughtfulness, and his helping to put the whole thing in perspective. I also thank Dr. Johann Stoyva for consenting to be the External Examiner for this project at a very busy time for him and for his very helpful remarks and suggestions.

Special thanks are also extended to Jennifer Clinch who provided me with her considerable expertise in statistical procedures, her friendship, and lots of cups of tea. Thanks, too to Dave Martin for his generosity with his laboratory and his time in helping to set up the equipment.

Thanks to Dot McLeod for typing well in a hurry and for breaking her custom of not typing dissertations.

Larry and Caleb Jordan were especially important to the completion of this project. In their various ways, they provided welcome diversions and helped me to stay happy.

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Abstract

The purpose of the present investigation was to examine the effects of two kinds of stress situations (test anxiety and threat of shock) and diverse treatment procedures on three responses frequently associated with the presence of anxiety (HR, frontalis EMG, and self-reported anxiety). The treatment conditions were EMG feedback, HR feedback, Combined (HR & EMG) feedback and an abbreviated progressive relaxation procedure; control conditions included false-feedback and instructions to rest. Eighty-two female undergraduate subjects attended two experimental sessions, the first consisting of the administration of self-report measures (STAI, Spielberger, 1970; SR-GTA, Endler & Okada, 1975) and physiological monitoring, and the second consisting of two analogue stress phrases interspersed by the treatment phase. Results from Session I indicated that state anxiety (STAI-State) immediately preceding this adaptation period was related to the three measures of trait anxiety (STAI-Trait, SRGTA-Evaluation and SRGTA-Physical Danger), with the unique proportion of the variance among the intercorrelations accounted for by the SR-GTA Physical Danger scale. A significant relationship also was observed between self-report measures (STAI-State and SRGTA-Evaluation) and physiological responses (EMG and HR), with each pairing accounting for a meaningful proportion of the variance in the other. Results from Session II demonstrated that the test anxiety condition was effective in increasing both HR and EMG while the threat of shock condition increased only EMG. Consistent with the situation-specific approach to trait anxiety, evidence was provided of a significant correlation in the predicted direction between physiological variables (postmanipulation EMG, HR reactivity) and the congruent trait anxiety measure (SRGTA-E) that was greater than the correlation between these variables and the incongruent measure (SRGTA-PD). Multivariate analyses of covariance indicated a significant difference among the treatment groups accounted for by differences in HR and state anxiety reductions. No significant differences were observed in EMG reduction. Ranging from the most to least effective the groups were: Progressive Relaxation, False-Feedback, HR-Feedback, Combined-Feedback, Rest-Control and EMG-Feedback. Significant differences were observed between the EMG-Feedback group and Progressive Relaxation and False-Feedback, respectively, with the latter groups exceeding the former in both HR and state anxiety reduction. As anticipated, HR-Feedback subjects were more successful in reducing their HR's than EMG-Feedback subjects. The overall performance of the experimental groups did not exceed that of the control groups. While the correlation of HR and EMG treatment residuals was moderately positive for the Combined-Feedback group, the coupling was nonsignificant and did not differ from that of the other feedback or control groups. Across all groups, however, EMG and HR reduction during treatment were negatively correlated. The reduction of combined physiological activity was not found to be related to reductions in state anxiety; but the posttreatment levels of EMG and state anxiety were found to be significantly correlated. No differences related to treatment group membership were observed in responses to the posttreatment applications of stress. However, it was observed that subjects who reduced their state anxiety most effectively during treatment reported decreased anxiety to the posttreatment test anxiety condition. The inverse relationship was demon-

strated between HR reduction during treatment and HR reactivity to posttreatment test anxiety. Similarly, for the threat of shock manipulation, EMG reduction during treatment was found to be negatively associated with EMG posttreatment reactivity. Two significant patternings of relationships among the treatment and test anxiety reactivity variables were described, and one significant pattern was described for the threat of shock condition. Results were interpreted as being generally consistent with a multivariate approach to the study of anxiety: the interrelationships among psychological and physiological indices were discussed in the context of both individual and situational differences.

THE EFFECT OF ANALOGUE STRESS AND VOLUNTARY CONTROL PROCEDURES ON SELF-REPORTED ANXIETY, HEART RATE, AND ELECTROMYOGRAPHIC RESPONSE

According to advocates of divergent theoretical perspectives, the principal problems in the study of human behavior do not lie in the observation of events, which are relatively slow and macroscopic compared to those of other sciences, but in "how you slice the pie" (Skinner, 1953, Meehl, 1973). The analyses, or pie-slicing, of behavior in the last half-century have evolved into a debate regarding the selection of important responses, the meaningful level of inference, and the functional significance of the environmental complex. In the study of emotion, it is essential to recognize response complexity with regard to both intra-individual variables and stimulus conditions. How these variables interact, or how the sliced pie might fit back together, also emerges as an important focus of investigation. The purpose of the present study was to examine the interrelationships among two physiological variables (frontalis muscle tension and heart rate) and self-reported anxiety (STAI, Spielberger, Gorsuch & Lushene, 1970; SR-GTA, Endler & Okada, 1974) under two kinds of analogue stress conditions (test anxiety and threat of shock) and procedures for modifying psychophysiological activity. These procedures include three biofeedback conditions (EMG, HR, and Combined EMG and HR) and an abbreviated progressive relaxation technique as well as the two control conditions of the false-feedback of a "successful" subject and simple "rest" instructions.

In spite of its ubiquity in psychological theory and popular expression, the construct of anxiety has no widely agreed upon operational definition. Drawing from an earlier distinction (Cattel &

Scheier, 1958, 1961), Spielberger (1972) described state anxiety A-State) as an emotional reaction "consisting of unpleasant, consciously-perceived feelings of tension and apprehension, with associated activation of the autonomic nervous system (ANS)" (p. 29) and trait anxiety (A-Trait) as the tendency to respond with A-State under stress. Endler and his associates (Endler, Hunt & Rosenstein, 1962, Endler & Hunt, 1969) have asserted that a number of factors, including the kinds of evocative situations, affect the expression of anxiety. In pursuing a multidimensional approach to anxiety, they introduced the S-R Inventory of General Trait Anxiousness (SR-GTA) (Endler & Okada, 1974) as a self-report instrument consisting of four general situations (interpersonal, physical danger, ambiguous and innocuous) and nine modes of response. A scale in which the individual responds to the situation of being evaluated by others was also included for research purposes. Factor analyses have pointed to the existence of two situational factors (interpersonal and physical danger) and two response mode factors (physiological-distress and approach). In the initial study using populations of normal adults and youths as well as psychiatric patients (neurotics and psychotics), the construct validity of anxiety as measured by the SR-GTA was generally supported (Endler & Okada, 1974).

The major prediction arising from Endler's person-by-situation approach to anxiety is that the trait anxiety measure corresponding to the situation would be the best index of the state anxiety evoked in that situation. This hypothesis was recently tested by Kendall (1978) using 96 male college student subjects preselected on the basis of high or low scores on the A-Trait portion of the STAI, the Physical

Danger scale of the SR-GTA (SRGTA-PD), and the Evaluation scale of the SR-GTA (SRGTA-E), respectively. The subjects were exposed to two analogue stress situations: a short film graphically illustrating automobile crashes and an exceedingly difficult decoding task. As expected, a triple interaction of type of stress, trait level, and trait measure emerged. That is, the high trait anxious individuals reported greater state reactions when the trait measure corresponded with the kind of stress. This effect was not found, however, when subjects were divided into high and low anxious groups according to the STAI-Trait. Therefore, at least in its early tests, the situation scales of the SR-GTA have been demonstrated to be useful in the investigation of a multidimensional approach to anxiety.

Research guided by the state-trait distinction in anxiety has responded to the need to investigate and specify the stimuli that evoke different levels of state anxiety for high and low trait anxious individuals. Conflicting results may be attributable to an incongruence between the self-report measure and the experimental stressor (Shedletsky & Endler, 1974). One purpose of the present study is to evaluate the situational specificity of trait anxiety, employing the Evaluation scale and the Physical Danger scale of the SR-GTA to correspond to a text anxiety and threat of shock situation, respectively. It is expected that each SR-GTA measure will be more closely associated with physiological and subjective indices of anxiety under the congruent situation than under the incongruent situation.

Early work in the area of the psychophysiology of emotion emphasized a general arousal concept which presumed unified and relatively invariate responses to stimulation (e.g., Cannon, 1936; Selye, 1946). The idea that a subjectively experienced emotion is paralleled by a particular physiological state, equivalently measured by one of a number of indicators, has met with important qualifications. More current opinion (Lang, Rice & Stermbach, 1972) has pointed to a concept of emotion defined simultaneously by verbal (cognitive-affective), overt motor, and covert physiological responses. However, not only are the relationships among these behavioral systems and the situation frequently complex and idiosyncratic (Bowers, 1973; Endler, 1975), the patterning of physiological responses also may be specific both to stimuli and individual differences (Lacey, 1962, 1967; Davidson & Schwartz, 1976). For the study of anxiety, the selection of responses and response parameters in situations of rest, stress, and voluntary control has become increasingly important.

Although the nature of the association between physiological and psychological variables in anxiety has been the frequent subject of theory, investigation of this interrelation has been largely atheoretical (Alexander, 1972). Studies conducted with greatly varying subject groups and numerous operational definitions of anxiety suggest that subjective anxiety may be reflected in both skeletal tension and autonomic reactivity, particularly heart rate (Buss, 1962; Eysenck, 1971). Accelerated heart rate and large increases under stressful conditions have been considered among the more reliable correlates of anxiety (Cattell & Scheier, 1961, p. 208; Goldstein, 1964; Shipman, Oken & Heath, 1970; Martin, 1971; Alexander, 1972), and a number of studies (Malmo & Shagass, 1949; Sainsbury & Gibson, 1954; Williams & Williams, 1967; Smity, 1973; Stoyva & Budzynski, 1974) have observed increased muscle tension to be related to the presence of anxiety or anxiety-related symptoms. However, the nature of the relationships within (Lacey, 1967; B.A. Alexander, 1972, 1977) and between (Jacobson, 1938; Obrist, 1970; Williamson & Blanchard, 1979b) these physiological systems are far from clear as responses often fail to correlate with each other (Johnson & Lubin, 1972) and physiologically similar reponses have been reported as different emotions because of cognitive-affective influences (Schachter & Singer, 1962, Lazarus, 1967). It is one purpose of the present study to assess anxiety with a multivariate approach with reference to skeletal, autonomic, and subjective responses. It is expected that an individual's initial response to a psychophysiological monitoring situation will be reflected in measures of both trait and state anxiety and these will be associated with her level of skeletal and autonomic activity as measured by frontalis EMG and HR, respectively. In addition, different stressors are expected to elicit differential patterns of physiological and subjective responsitivity from individuals (e.g. Gang & Teft, 1975; Barrell & Price, 1977; Obrist, Gaebelin, Teller, Langer, Grignolo, Light & McCubbin, 1978).

The association between skeletal muscle and autonomic response is central to an understanding of anxiety from the perspectives of both reactivity and control. Mowrer (1947) posited a two-factor learning theory in which somatic and visceral events were viewed as autonomous processes subject to modification by different learning processes. While more current work on emotional behavior has also tended to assume that heart rate changes can become independent from other biological processes in the manner of a spontaneous response, somatic responses (e.g. respiration rate) have been described as the most important mediators in learned cardiovascular response, particularly heart rate increase, thus far (Williamson & Blanchard, 1979a).

In a psychotherapeutic context, the association among response systems becomes particularly important: it determines which factors are the appropriate targets for modification. While the relaxation response has been characterized by a number of investigators (e.g. Hess, 1957; Gellhorn, 1967; Bensen, Beary & Carol, 1974; Stoyva & Budzynski, 1974) as an antistress response involving low physiological arousal, a diversity of opinion exists regarding the most effective use of input variables to induce a relaxed state.

Two physiologically oriented techniques that have demonstrated potential utility are progressive relaxation instructions (Jacobson, 1938; Paul, 1969) and biofeedback procedures (Stoyva & Budzynski, 1974). In a recent review of studies comparing relaxation procedures, Tarler-Benlolo (1978) outlined the difficulties which made the evaluation of these investigations difficult: number of subjects, matching of subjects, control groups, number of training sessions, delivery of instructions (live vs. taped), home practice, tests for generalization, and follow-up data. (See also Appendix A for a detailed review of treatment studies.) She concluded, however, that present evidence demonstrated generally that verbal relaxation procedures (such as progressive relaxation) and biofeedback (EMG) are equivalent in producing positive results. In considering specifically the reduction of anxiety using these procedures, efficacy is dependent on the degree of generalization to other physiological and to cognitive-affective responses. Using a multivariate approach, the present study examined the relative effectiveness of an abbreviated progressive relaxation procedure and biofeedback procedures aimed at modifying frontalis EMG and HR, respectively. The potential synergistic effect of presenting simultaneous feedback of both frontalis tension and HR to the subject was also investigated. Because studies reporting positive results for their experimental groups have been criticized for not maximizing expectancies for gain in control conditions (e.g. Blanchard & Epstein, 1977), the false feedback of a "successful" subject as well as an instructions-to-rest control condition will be included. In general, was expected that reduction in anxiety was most clearly reflected in the response modalities specifically modified in the treatment procedures but that generalization across response systems would be greater in the experimental than in the control groups.

While considerable research attention has been focused on the psychophysiology of the anxiety construct under conditions of stress and voluntary control, the relationship between the two is only beginning to be addressed. Several recent studies (e.g. Lott & Gatchel, 1978; Victor, Mainardi & Shapiro, 1978) using cold pressor stress tests and feedback-assisted HR conditioning have pointed to conflicting results concerning the efficacy of biofeedback in the clinical management of stressful stimuli. However, interesting response patterns, including a possible "crossover" phenomenon (Connor, 1974) on the inverse association between responsitivity and control, have emerged. The present study will investigate the effects of diverse voluntary control procedures on responses to two kinds of posttreatment stress, relative to their pretreatment levels. In general, it is expected that reductions in the physiological activity and state anxiety exhibited during treatment will be maintained in the posttreatment stress phase.

For a more detailed review of the literature, see Appendix A.

Summary and Hypotheses

The present investigation was designed as a multivariate approach to the construct of anxiety. The effect of analogue stress conditions and diverse voluntary control procedures on self-reported anxiety, heart rate, and frontalis muscle tension will be examined. The nature of the evocative stimulus is an important determinant of the anxiety response. State or transient anxiety, for example, may be provoked by some "stress" situations and not by others, making it imperative that any A-Trait measure be congruent with the threatening situation (Shedletsky & Endler, 1974). Because previous investigations have frequently employed self-report instruments that were incongruent with the experimental stressors, it is one purpose of the present study to investigate the construct of trait anxiety and state anxiety with regard to specific analogue stress situations. The SR-GTA (Endler & Okada, 1975) was used to predict responses in a test anxiety and threat of shock condition. Although therapies of anxiety related problems frequently have focused on altering a single response system, there is only qualified evidence that meaningful generalization occurs or that simple unidimensional treatments are efficacious. In addition to the focus on psychophysiological reactivity and anxiety, the relative effectiveness of various treatment procedures -- EMG feedback, HR feedback, Combined (HR and EMG) feedback, Progressive Relaxation, False-Feedback, and a Rest Control -- will be explored on dimensions of level, change, and subsequent influence on reactivity. Specific hypotheses are as follows:

Hypothesis I. Because of the novelty and perhaps consequent stress of the psychophysiological monitoring situation, it was expected that persons who report higher levels of state anxiety (STAI-State) at that time and higher scores on the SR-GTA Evaluation dimension would exhibit a higher baseline of frontalis tension (EMG) and hart rate (HR).

Hypothesis II. It was anticipated that the physiological measures of HR and frontalis EMG and state anxiety would be greater under analogue stress conditions corresponding to trait measures on the SR-GTA than to incongruent measures and situations. More specifically, the correlation between reactivity (HR, EMG, STAI-State) under threat of shock and the SR-GTA Physical Danger scores was expected to exceed that between the former and the SR-GTA Evaluation scores. Conversely, it was also expected that the correlation between each indicator of reactivity under the test anxiety condition and the SR-GTA Evaluation score would be greater than the correlation between the indices under this condition and the SR-GTA Physical Danger score.

Hypothesis III. Subjects in all training procedures -- EMG Feedback, HR Feedback, Combined HR and EMG Feedback, and Progressive Relaxation -- were expected to exhibit greater reductions in EMG and HR activity and in state anxiety than individuals in the False-Feedback and Rest-Control conditions.

Hypothesis IV. The EMG and HR feedback procedures were expected to be specific to the response for which the individual received feedback; progressive relaxation was expected to exert an influence on both physiological measures. Therefore, subjects in the EMG feedback group were expected to decrease their frontalis tension to a greater degree than subjects in either the progressive relaxation or HR feedback conditions. Similarly, it was anticipated that HR feedback subjects would more successfully decrease their HR than persons in the progressive relaxation and EMG feedback groups. The performance of individuals receiving progressive relaxation instructions was also expected to exceed that of EMG feedback subjects and HR feedback subjects on measures of HR and frontalis tension, respectively.

Hypothesis V. Persons in the combined (HR and EMG) feedback group were expected to exhibit a stronger coupling of HR and EMG reductions than individuals in the EMG feedback and HR feedback conditions. Heart rate and frontalis EMG also were expected to vary together to a greater extent in subjects in the three feedback procedures than in subjects in both control groups.

Hypothesis VI. It was anticipated that persons who exhibited greater combined decreases in physiological activity between pre- and posttraining would report greater reductions in state anxiety.

Hypothesis VII. It was anticipated that the degree of specificity in reductions of EMG, HR, and state anxiety due to treatment would be maintained in the second reactivity phase. Subjects who have exhibited greater decreases in combined physiological response levels (EMG and HR) and state anxiety following treatment were expected to demonstrate lowered physiological reactivity and state anxiety to the posttreatment experimental stressors, relative to the initial application.

Method

Subjects

The sample consisted of 82 female undergraduates enrolled in Summer and Evening psychology courses at the University of Manitoba (Mean age= 25.5). The subjects volunteered for a study on "Emotional Response and Relaxation Training" and had no previous experience in a psychophysiological experiment. Each subject was assigned randomly to one of six groups (four experimental and two control).

Self-report Measures

Prior to physiological recording in Session I, subjects responded to a brief screening questionnaire concerning drug use (including coffee and cigarettes), medical history (particularly cardiovascular complaints), and menstrual cycle (Appendix B-1). They were administered the S-R-Inventory of General Trait Anxiousness (SR-GTA) (Endler & Okada, 1975) and the State-Trait Anxiety Inventory (STAI) (Spielberger et al., 1970) (Appendices B-2 and B-3, respectively). The former scale consists of five situations in which trait anxiety was assessed. The two situations used in the present study were (a) "You are in situations where you are being evaluated by other people" (SRGTA-Evaluation) and (b) "You are in situations where you are about to, or may encounter physical danger" (SRGTA-Physical Danger). Because the SR-GTA is a relatively new instrument, the widely used A-Trait measure of the STAI (STAI-Trait) was included to further explore the role situation specificity in anxiety. The subjects responded to the A-State section of the STAI (STAI-State) after preparing for the physiological recording in Session I and before the recording itself. During Session II, selected items of the STAI-State (O'Neil, Spielberger, & Hansen, 1969) were administered via a two-way speaker preceding and following treatment as well as following each experimental stress condition. Using a scale ranging from one to four identical to that on the paper and pencil instrument, the subjects responded verbally to each taped item (Appendix B-4).

Apparatus

The experiment was conducted in two adjacent rooms housing, respectively, the subject and the physiological recording instruments. The sound-proofed and electrically shielded experimental chamber was equipped with a semi-reclining chair having an adjustable arm and head rest and was illuminated by a low-intensity lamp. Subjects in all conditions received tape-recorded instructions and could respond orally through a two-way speaker in the room.

Beckman surface EMG electrodes were applied to the prepared skin (Basmajian, 1967) over the frontalis muscle in the manner described by Tippold (1967, pp. 294-295). DC resistance between action and reference electrodes was maintained between two thousand and ten thousand ohms. Auditory analogue feedback and integrated EMG recordings were made using a Feedback Myograph BFT 401. The output was illustrated through a BFT 231 optical isolater and on a BFT Integrator over 20 sec. intervals.

Heart rate (HR) data was collected using a Whittaker Pulse-Watch which measures beat-by-beat pulse by means of a photo-electric cell placed on the center finger of the left hand. The visual HR feedback meter was zero-centered at 90 bpm, with a full scale deflection range of 50-130 bpm (Bell & Schwartz, 1975). The output was recorded on a MFE 5-channel strip-chart recorder. The utility of the full-scale meter feedback system without supplemental reinforcement has been demonstrated (Blanchard et al., 1972; Stephans et al., 1972; Finley, 1970).

In order to lend authenticity to the threat of shock experimental stress condition (described below) a shock-delivery machine was placed slightly to the right of the subject within her peripheral vision. A small red light on the machine was illuminated at the beginning of Session II, and surface electrodes were attached to the right forearm of the subject.

Procedure

Subjects participated individually in two separate sessions no more than five days apart. Session I consisted of responding to self-report instruments and a 20-min. adaptation period during which the subject was asked to relax as thoroughly as possible without sleeping. This period was designed both to accustom the subject to the laboratory and physiological recording and to collect data during the initial period. See Figure I for a graphic representation of the design.

Place Figure I about here

Session II consisted of six phases: Prestimulus Rest (4 min.); Reactivity I (6 min.); Treatment (25 min.); Transfer Rest (2 min.); Reactivity II (6 min.); and Poststimulus Rest (4 min.). They are described below.

I. Prestimulus Rest consisted of 4 unsignalled 1 min. trials immediately following electrode placement. Subjects were asked to rest, and no external stimuli were presented.

II. The two Reactivity phases established the elicited HR and EMG response range for each subject before and after treatment, Reactivity I and Reactivity II, respectively. Prior to each of two counterbalanced tasks in Reactivity I and Reactivity II, the subjects were informed of

Figure 1. Experimental Design

SESSION I	Baseline (20 min.)	
SESSION II	Prestimulus Rest (4 min.)	
	Reactivity I (6 min) Task A (1 min.)-Rest (1 min.)-Task B (1 min.)-Rest (3 min.)	
	Treatment (25 min.)	EMG Feedback (EMG-FB)
		HR Feedback (HR-FB)
		Combined (EMG & HR) Feedback (Combined-FB)
		Progressive Relaxation (PR)
		False Feedback (False-FB)
		Rest-Control (R-Control)
	Transfer Rest (2 min.)	
	Reactivity II (3 min.)[1] Task A (1 min.) -Rest (1 min.) -Task B (1 min.)	
	Poststimulus Rest (4 min.)	

[1]Tasks A and B were presented in counterbalanced order across subjects.

the nature of the stress condition. The tasks were presented for a duration of 1 min. followed by 1 min. rest periods. Subjects were instructed to relax during all rest trials. The stress conditions are described below.

a. Threat of Shock task was included to simulate a physical danger situation. The subject was told that a "small but substantial" shock might be delivered to her right forearm during the following 1 min. period on the basis of a random probability formula. She was informed that the chances for shock presentation were 50% for all subjects throughout the experiment (i.e., Reactivity I and Reactivity II) and that the experimenter would indicate the period during which shock was imminent.

b. Test Anxiety Scene was selected to simulate a situation in which one is being evaluated by other persons. Although the data from systematic desensitization research is far from conclusive, the imagining of unpleasant scenes has been associated with an elevation of physiological indicators (e.g., Gelder & Matthews, 1968). The scene of the few moments preceding an exam for which the subject is uncertainly prepared was selected for several reasons. Whereas the threat of shock task was analogous to a physical danger situation, no task has regularly appeared in the psychophysiological literature to evaluate physiological response to a task threatening self-esteem. Not only are "exam jitters" a phenomenon almost universally experienced at one time or another by college students, but Janisse and Palys (1976) reported that items referring to evaluation and test anxiety ("Writing exams"; "Speaking in class or in public"; "Before taking an exam") were the most frequently reported anxiety-evoking situations for both males and females.

III. Tape-recorded Treatment instructions for each of four experimental and two control conditions were delivered in the experimental chamber after completion of Reactivity I. See Appendices C-1, C-2, C-3, C-4, C-5, and C-6 for transcripts of instructions.

a. EMG Feedback (EMG-FB). Subjects received continuous auditory feedback regarding the level of their frontalis muscle tension. They were instructed that the pitch of the tone would vary directly with changes in EMG level, a lower pitch denoting reduced muscle tonus. Subjects were instructed to relax by lowering the tone for a 25 min. period.

b. Heart Rate Feedback (HR-FB). Subjects received full meter visual feedback regarding their heart rates. Subjects were asked to lower their HR for 25 min. by attending to the visual meter.

c. Combined Feedback (Combined-FB). Subjects in this combined feedback group were instructed as the subjects in the two previous conditions. They received simultaneous visual and auditory feedback regarding HR and frontalis EMG, respectively, for 25 min.

d. Progressive Relaxation (PR). The subjects received taped progressive relaxation instructions in an abbreviated version (Paul, 1966). In brief, they were asked to alternately tense and relax each of the major muscle groups, concentrating on the feeling of relaxation. The 25 min. procedure involved a brief review of the muscle groups together with general relaxation induction it culminated with specific suggestions of total body relaxation (last 3 min.).

e. False Feedback (False-FB). Control subjects in this condition received identical instructions to those given to EMG feedback subjects except that they were referred to "physiological activity level" instead of muscle tension level. Instead of their own feedback, however, they heard a tape-recorded 25 min. noncontingent tone connoting successful relaxation. The purpose of this group was to control for possible "placebo" effects attributed to the belief that one was receiving highly technical treatment and, further, that one was effective in employing the procedure. On the postexperimental questionnaire, the item, "What percentage of time was the tone actually under your control?", yielded a median response of 30% for the False feedback subjects compared to a median of 50% for EMG feedback subjects and of 30% for the Combined feedback subjects.

f. Rest Control (R-Control). Subjects were instructed to relax deeply for the 25 min. period. Attention was directed to reducing muscle tension and breathing in a restful manner. They received neither feedback nor further instruction. The purpose of this group was to control for effects due to the passage of time and nonspecific aspects of the experimental situation.

IV. Transfer Rest was a period following Treatment and preceding Reactivity II in which subjects were asked to "remain deeply relaxed" for 2 min. This was to allow the subject an interval before the second presentation of reactivity tasks in Reactivity II.

V. Reactivity II was identical to Reactivity I for each subject, with the task being presented in the same order as in Reactivity I.

VI. Poststimulus Rest, like the prestimulus period, consisted of four 1 min. unsignalled trials during which the subjects were asked to relax.

The experiment was conducted by two female experimenters, each of whom conducted both sessions for one-half of the subjects across the six groups. In all phases of the experiment, the subject was asked to avoid excessive movement during trials. Session II experimental instructions were delivered and the subject could respond in a normal speaking voice through a two-way speaker in the subject chamber. Upon completion of both sessions, a postexperimental questionnaire (Appendix D) was administered, objectives of the study were briefly reviewed, and questions answered as fully as possible at that point. Results and further details of the study were made available to subjects upon request.

Results

Sampling of Physiological Data

The physiological data recorded throughout the experiment were sampled for analysis according to each experimental phase. For Session I, median EMG (amplitude) and mean HR (bpm) values for the first five minutes of the twenty minute habituation period were selected. Session II data yielded three main scores: Reactivity I, Treatment, and Reactivity II. Reaction to stress was initially represented by the simple differences between the median EMG and mean HR during the "rest" minute immediately preceding the onset of the analogue stress and those measures during the following minute. Residualized scores to account for initial differences were used to represent reactivity *per se*. Further reduction of these data to represent Reactivity II, relative to Reactivity I and to Treatment, is discussed where appropriate in the Results section. Effect of treatment was represented by the differences between the pretreatment values of median EMG and mean HR during the last minute of the three minute rest period preceding training instructions and those during the last three minutes of the 25 min. treatment period. The posttreatment values were regressed on the pretreatment value for analysis.

Relationships Among Trait Anxiety Measures and Session I State Anxiety

Intercorrelations were calculated among the three trait anxiety measures, SRGTA-E, SRGTA-PD, and STAI-Trait, and the state anxiety measure, STAI-State, administered at the beginning of Session I. (See Table I.) A family-wise error rate of .10 divided equally among the six correlations indicated that a probability of less than .0167 was required for significance. The correlation (r = .403) between the two

SRGTA scales of Evaluation and Physical Danger reflected a significantly positive association. Although the correlation of SRGTA-E and STAI-Trait approached significance (*r* = .269, p = .0192) according to the conservative criterion, the relationship between SRGTA-PD and STAI-Trait was nonsignificant.

State anxiety (STAI-State) reported at this initial phase of the experiment after preparing for physiological recording was significantly correlated with each of the three trait measures (SRGTA-E: *r* = .306, SRGTA-PD: *r* = .398, STAI-Trait: *r* .444), and no differences were found among these associations. In order to more closely investigate components of the SRGTA in predicting self-report in this adaptation situation, a multiple correlation among STAI-State, SRGTA-PD and SRGTA-E was calculated (*r* = .427). The simple differences between this value and those of SRGTA-PD and SRGTA-E with STAI-State (yielding .121 and .029 respectively) indicated considerable shared variance among the three variables, with the variance of the SRGTA-PD-- STAI-State relationship almost completely subsuming that of the SRGTA-E -- STAI-State relationship. Further examination of SRGTA measures versus STAI-Trait in relationship to STAI-State revealed a similar pattern. Multiple correlations of STAI-State and STAI-Trait with SRGTA-PD (*r* = .549) and SRGTA-E (*r* = .481) also pointed to the unique proportion of the variance in STAI-State being accounted for by the Physical Danger scale of the SRGTA.

Place Table I about here

Table I

Correlations Among Trait Anxiety Measures and

State Anxiety (Session I)

	SRGTA-E	SRGTA-PD	STAI-Trait	STAI-State
SRGTA-E	1.00			
SRGTA-PD	.403[a]	1.00		
STAI-Trait	.269	.167	1.00	
STAI-State	.306[b]	.398[a]	.444[a]	1.00

N = 77, one-tailed
(a) $p<.0005$
(b) $p<.005$

Relationships Among Self-Report Anxiety Measures and Physiological Variables During Session I

The extent of the association between the physiological variables and the self-report measures of anxiety was viewed to be of fundamental importance to the present research. This relationship was initially approached in the baseline session predicting that persons who reported higher levels of state anxiety (STAI) at that time and have higher scores on a trait anxiety measure (SRGTA-E) would exhibit higher levels of physiological responsivity (EMG and HR) (Hypothesis I).

Two canonical correlations were calculated between the set of self-reported anxiety scores and the set of physiological variables. The values of these (BMD·P6M) were R_{C1} = .45711 and R_{C2}= .10995: the first yielded a significant chi-square value of 18.58 (df = 78, $p < .001$), indicating that the first two canonical variables were significantly related. The means of the squared structure coefficients (zero-order correlations of the canonical variables with their constituent variables) were examined to determine the proportion of variance in each set present in the first canonical variables. The proportion of variance accounted for by the first canonical variable in the first (SRGTA-E, STAI-State) and the second (EMG, HR) sets were .6312 and .5953, respectively. Because a sizeable fraction of the variance in each set was present in the first canonical variables, further analysis to determine the proportion of variance accounted for in one set by the other via their canonical variables was conducted. The proportion of self-reported anxiety variance accounted for by the first canonical variable of the set of physiological measures was .1377; and the proportion of physiological variance accounted for by the first canonical variable of the set of self-report measures was .1299.

The structure coefficients for each set of variables was examined to determine the relative contribution of each measure to overall variance. For the first set, the structure coefficients were SRGTA-E: .629 and STAI-State: .931; and for the second set, the corresponding structure coefficients were EMG: .842 and HR: .694. Although state anxiety and EMG predominate on their respective sides, it is clear that the trait anxiety measure and heart rate also contribute considerably to the correlation. Therefore, at least during the initial period of Session I, it can be said that each of the self-report anxiety measures and the two physiological variables account for a meaningful proportion of the variance.

Relationships of SRGTA Trait Anxiety Measures with Physiological Variables and State Anxiety Under Analogue Stress Conditions

The association between two trait anxiety measures (SRGTA-E and SRGTA-PD) on the one hand and three reactivity measures (EMG, HR, STAI-State) under stress on the other was investigated in the second phase of the experiment, Reactivity I. It was anticipated that the reactivity variables would be greater under analogue stress conditions (test anxiety and threat of shock) corresponding to SR-GTA trait measures (SRGTA-E and SRGTA-PD, respectively) than to incongruent measures and situations (Hypothesis II).

An experimental manipulation check using the simple difference between pre- and postmanipulation values of the physiological variables was calculated for each of the stress conditions. For the test anxiety situation, both EMG and HR increased significantly, yielding correlated *t*-values of 3.08 ($p<.005$) and 2.20 ($p<.025$), respectively. Only EMG increased significantly ($\underline{t}$ = 4.25, p<.001) under the threat of shock condition. Seventy-six percent of the subjects reported in the post-experimental questionnaire the belief that they might actually be shocked. Two subjects spontaneously reported of having been shocked. Measures of state anxiety were taken at the end of each counterbalanced stress period (see Method). In order to check randomization of response across groups to Reactivity I, MANCOVA's using the premanipulation values of the physiological variables as covariates and postmanipulation state anxiety were performed. These were nonsignificant for each of the stress conditions: test anxiety - $\underline{F}$(15,199) = .979, p = .479; threat of shock - $\underline{F}$(15,199) = .790, p = .688.

Zero-order correlations among the trait measures and postmanipulation scores of state anxiety, EMG, and HR were examined to determine the degree of association between each of the pairs of variables under the two conditions. As was indicated previously (Table I), the correlation between the two self-report trait measures was significant ($\underline{r}$ = .403, p<.0005). The association between EMG and HR was also significant under each of the stress situations (test anxiety: $\underline{r}$ = .276, p<.05; threat of shock: $\underline{r}$ = .280, p<.05). However, EMG in the test anxiety condition provided the only significant correlation of a postmanipulation measure with a trait measure (SRGTA-E) ($\underline{r}$ = .23, p<.05). This correlation proved to be significantly greater ($\underline{Z}$ = 1.71 p<.05 1-t) than the correlation of EMG with SRGTA-PD under the test anxiety condition ($\underline{r}$ = .01). Differences between the correlations of the trait anxiety measures with postmanipulation HR and state anxiety, respectively, were nonsignificant in the test anxiety situation. No differences between postmanipulation values and trait anxiety scores reached significance in the threat of shock condition.

In order to more closely examine physiological reactivity *per se* and account for individual differences in the premanipulation measures, analyses were performed using the residual scores of each variable (EMG, HR), the postmanipulation scores regressed on the premanipulation values. Semipartial and multiple semipartial correlations were calculated to evaluate the relationship of these variables (singularly, together, and combined with STAI-State) to the situational trait anxiety measures under each of the conditions. A test for the difference between correlations (Glass, & Stanley, 1970) was then performed to determine whether physiological reactivity and state anxiety were greater under stressor conditions corresponding to congruent SR-GTA measures than to incongruent measures and situations.

Under the test anxiety condition, the semipartial correlation of heart rate reactivity with SRGTA-E was significant (r = .183, $p<.05$) and was found to be significantly greater (Z = 1.68, $p<.05$) than that of HR reactivity with SRGTA-PD (r = .002). Neither the semipartial correlations of the reactivity with the trait measures nor their difference reached significance. Therefore, when EMG reactivity was incrementally included with HR reactivity in multiple semipartial correlation with SRGTA-E and SRGTA-PD, the EMG did not significantly account for a greater degree of variance than did HR reactivity alone. The addition of postmanipulation state anxiety to the physiological measures in multiple semipartial correlation with the trait measure also did not yield significant results.

Under the threat of shock condition, neither HR reactivity nor EMG reactivity was significantly correlated with either situational trait anxiety measure. Multiple semipartial correlations of HR reactivity and EMG reactivity with SRGTA-E and SRGTA-PD, respectively, were nonsignificant. Including the postmanipulation measure of state anxiety also yielded nonsignificant multiple semipartial correlation. Differences of correlations were nonsignificant for each pair of semipartial and multiple semipartial correlations.

In summary, analyses indicated that the test anxiety manipulations was the more effective of the two regarding changes in both physiological measures. Furthermore, evidence was provided of a significant correlation in the predicted direction between physiological variables (postmanipulation EMG, HR reactivity) and the congruent trait anxiety measure (SRGTA-E) that was greater than the correlation between these variables and the incongruent measure (SRGTA-PD).

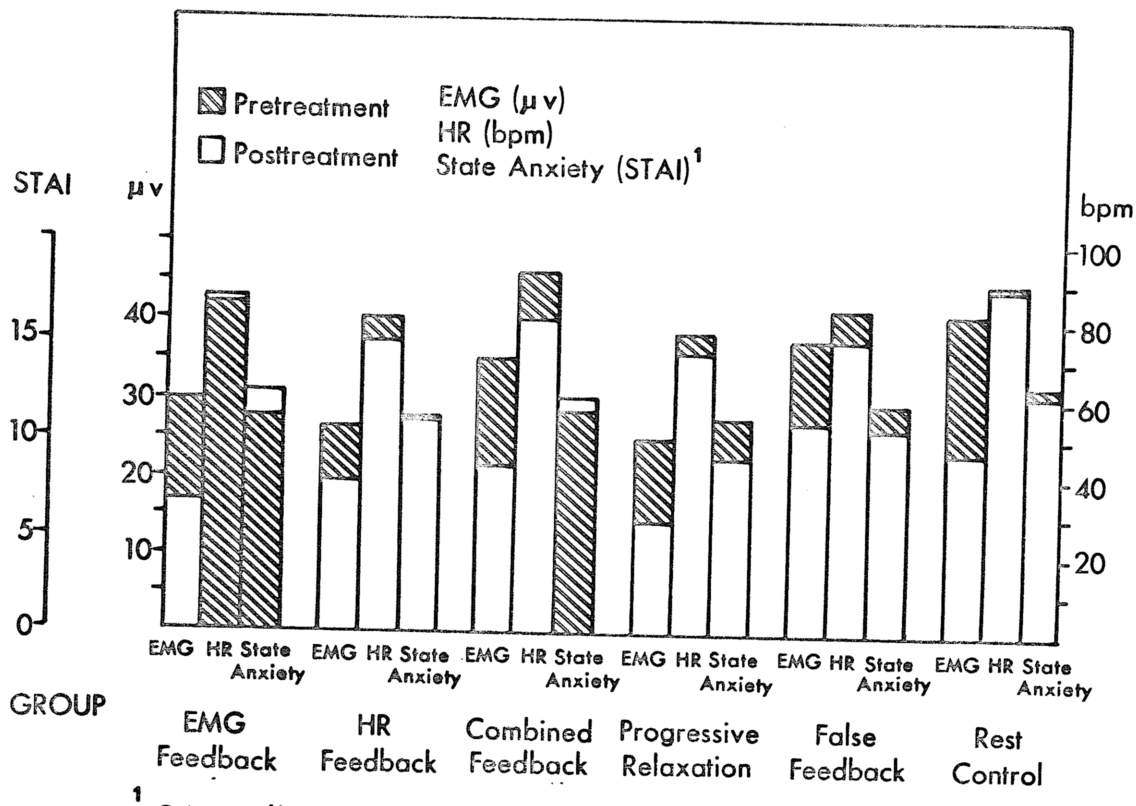
Effect of Treatment on Physiological Variables and State Anxiety

In order to evaluate the effect of treatment on the physiological variables and state anxiety, multivariate analyses of covariance (MANCOVA) (Finn, 1976) were calculated for all groups and for selected orthogonal comparisons. The pretreatment values, which had exhibited no group differences [$F(15,204) = .941$, $p<.52$], were used as covariates to the corresponding posttreatment values in the analyses. The nonsignificant test for regression of parallelism of hyperplanes [$F(45,167.1) = 1.15$, $p<.259$] indicated that covariance of these variables was appropriate. Pre- and posttreatment values for each group are illustrated in Figure 2.

Place Figure 2 about here

Figure 2. Observed group means:

Pre- and posttreatment



[1] Selected Items (See Method)

The MANCOVA performed across all groups yielded a significant F-ratio for the multivariate test of equality of mean vectors [F(15,196) = 2.171, $p<.0086$]. While reductions in EMG failed to discriminate among the treatment groups, [F(5,73) = .649, $p<.663$], reductions in HR and state anxiety yielded significant results [F(5,73) = 2.76, $p<.02$; F(5,73) = 3.56, $p<.006$, respectively]. Only the first discriminant function, or linear combination of dependent variables, was significant. The standardized discriminant function coefficients for each variable, or the weights maximally discriminating among the groups, were as follows: EMG = .239; HR = .557; STAI-State = .820. Group centroids calculated from the raw discriminant function coefficients and the means adjusted for covariates for each variable are represented in Table II. As demonstrated by the multivariate group centroids, the groups ranging from most to least effective in reducing the combination of the three dependent variables were as follows: PR, False-FB, HR-FB, Combined-FB, R-Control, and EMG-FB.

Place Table II about here

Exploratory multivariate analyses among the groups were conducted using a family-wise error rate of .10 divided among the fifteen possible comparisons; therefore, it was necessary that a comparison not exceed $p = .006$ to reach significance. MANCOVAs yielded a significant difference between the EMG-FB group and PR [F(3,71) = 6.16, $p<.0009$] and between the EMG-FB group and False-FB [F(3,712) = 5.16, $p<.002$]. The standardized discriminant functions for each variable illustrated that a relatively high proportion of the variance in the group differ-

Table II

Multivariate Treatment Group Centroids

Treatment Group	Adjusted Mean Scores[1]			Group Centroids
	EMG (μv)	HR (bpm)	STAI-State[2]	
EMG - FB	17.83	86.59	12.94	8.44
HR - FB	22.52	78.77	11.22	7.38
Combined - FB	21.54	74.83	12.38	7.55
PR	19.21	78.18	9.17	6.77
False - FB	24.67	76.44	10.30	6.93
Control	18.20	84.79	11.54	7.89

[1]Adjusted for covariates

[2]Selected Items (See Method)

ences was accounted for by greater reductions in HR and state anxiety in the PR group and in the False-FB group, respectively: EMG vs. PR (EMG = -.13, HR = .48, STAI-State = .89); EMG vs. False-FB (EMG = -.36, HR = .58, STAI-State = .74).

Treatment Groups Compared to Control Groups. It was anticipated in Hypothesis III that subjects in all training procedures -- EMG-FB, HR-FB, Combined-FB, and PR -- would exhibit greater reductions in physiological activity and in state anxiety than individuals under the False-FB and R-Control conditions. A MANCOVA calculated on this comparison failed to yield significant results. Because the False-FB contained a definite manipulation, the programmed reduction in tone possibly leading the subject to consider herself successful, this group was included with the four treatment groups in a second comparison. This MANCOVA was also nonsignificant.

Specificity of Treatment Effect. In Hypothesis IV, it was predicted that the EMG and HR feedback procedures would be specific to the response for which the individual received feedback and that PR would exert an influence on both physiological measures. As anticipated, HR-FB subjects were more successful in reducing their HR than were EMG individuals (t = 1.96, $p<.05$, 1-t) but no more so than persons in the PR group. Progressively relaxed individuals also reduced their HR's to a greater extent than those in the EMG-FB group (t = 2.09, $p<.02$, 1-t). No difference was observed among the three groups in the decrease of frontalis tension. (See Figure 2.)

Relationship of Physiological Variables in Combined Feedback Group versus Other Feedback and Control Groups. It was anticipated in Hypothesis V that persons in the Combined-FB group would exhibit a stronger coupling of HR and EMG reductions than individuals in the EMG-FB and HR-FB conditions. Heart rate and EMG were also expected to vary together to a greater extent in feedback subjects (EMG, HR, and Combined-FB groups) than in control subjects (False-FB, R-Control). While the correlation of HR and EMG treatment residuals was moderately positive ($\underline{r}$ = .313) in the Combined-FB group, this coupling failed to reach significance and did not significantly exceed that of either the EMG-FB or HR-FB group. The coupling of the physiological response reductions of the three feedback groups also did not exceed those of the control groups. Across all groups, EMG and HR reduction during treatment demonstrated a significantly negative relationship to each other ($\underline{r}$ = -.267, $p<.02$).

Relationship between Reductions in Physiological Activity and in State Anxiety. It was predicted that persons who exhibited greater combined decreases in physiological activity between pre- and posttraining would report greater reduction in state anxiety (Hypothesis VI). Multiple correlations of state anxiety treatment residuals calculated with pre- and posttreatment EMG and HR were nonsignificant. Zero-order correlations among the EMG, HR and STAI-State measures gathered pre- and posttreatment were inspected. While none of the three variables were found to be significantly related at pretraining, the posttraining levels of EMG and state anxiety yielded a significant correlation ($\underline{r}$ = .55, $p<.002$). Therefore, while the reduction of combined physiological activity (EMG and HR) was not found to be related to reductions in state anxiety, posttreatment state anxiety and EMG were found to be significantly correlated. This association between the magnitude of these two variables is consistent with their strong association exhibited during the baseline period.

Summary of Treatment Effect. Analyses of treatment effect on physiological activity and state anxiety pointed to a significant difference among the groups accounted for by decreases in HR and in state anxiety. No differences were observed in EMG reduction. When the three variables (EMG, HR, STAI-State) were combined to optimally discriminate among the groups, the most to least effective treatment conditions were as follows: PR, False-FB, HR-FB, Combined-FB, R-Control, and EMG-FB. The progressive relaxation group and the false-feedback group significantly differed from the EMG-FB condition, and these differences were attributable to differences in HR and state anxiety reduction. As anticipated, the HR-FB group decreased its HR to a greater extent than the EMG-FB group. The overall performance of the treatment groups did not exceed that of the control groups. Reduction of combined physiological activity was not related to decreases in state anxiety across groups, nor was the coupling of physiological activity (EMG, HR) greater in the Combined-FB group than in the other feedback or control groups.

Reactivity II: Relationship to Reactivity I and to Treatment

The posttreatment analogue stress phase, Reactivity II, was first examined for physiological response to the second application of the test anxiety and threat of shock stimuli. These responses and that of state anxiety were then compared to those exhibited in Reactivity I. The differential effect of treatment on subjects in Reactivity II, relative to Reactivity I, was evaluated (Hypotheses VII).

Relationship of Reactivity II to Reactivity I. Manipulation checks calculated to determine physiological response to the posttreatment application of the experimental stress conditions were consistent with those yielded from Reactivity I, the pretreatment phase. As in Reactivity I, both EMG (*t* = 5.708, p<.001) and HR (*t* = 2.302, p<.05) increased in response to the posttreatment test anxiety manipulation; and only EMG (*t* = 3.835, p<.003) increased in response to the second application of the threat of shock condition. Unexpectedly, EMG increase in Reactvity II was greater than that in Reactivity I (*t* = 3.003, p<.01) for the test anxiety situation.

The pre- and postmanipulation values of the physiological variables and the postmanipulation values of state anxiety in both Reactivity I and II were examined to determine differences in levels. (See Figure 3.) For the test anxiety condition, subjects exhibited a lower premanipulation level of EMG (*t* = 4.129 p<.001) and a lower postmanipulation of EMG (*t* = 1.75, p<.05, 1-t) and state anxiety (*t* = 3.80, p<.003) in Reactivity II than Reactivity I. Under the threat of shock condition, individuals manifested significantly lower EMG (*t* = 3.584, p<.0006) and HR premanipulation levels (*t* = 3.218, p<.002) in Reactivity II than in Reactivity I; and the postmanipulation value of HR in Reactivity II was also less than that in Reactivity I (*t* = 2.34, p<.05).

Therefore, in the test anxiety condition, while EMG responsitivity was greater in Reactivity II than in Reactivity I, both the pre- and postmanipulation EMG values were lower in Reactivity II than in Reactivity I. This pattern, together with differential pre- and postmanipulation levels for the two experimental stress phases, pointed to the necessity of employing residualized scores (Lacey, 1956) in order to accommodate Wilder's (1950) Law of Initial Values (see Introduction) in the following analyses.

Place Figure 3 about here

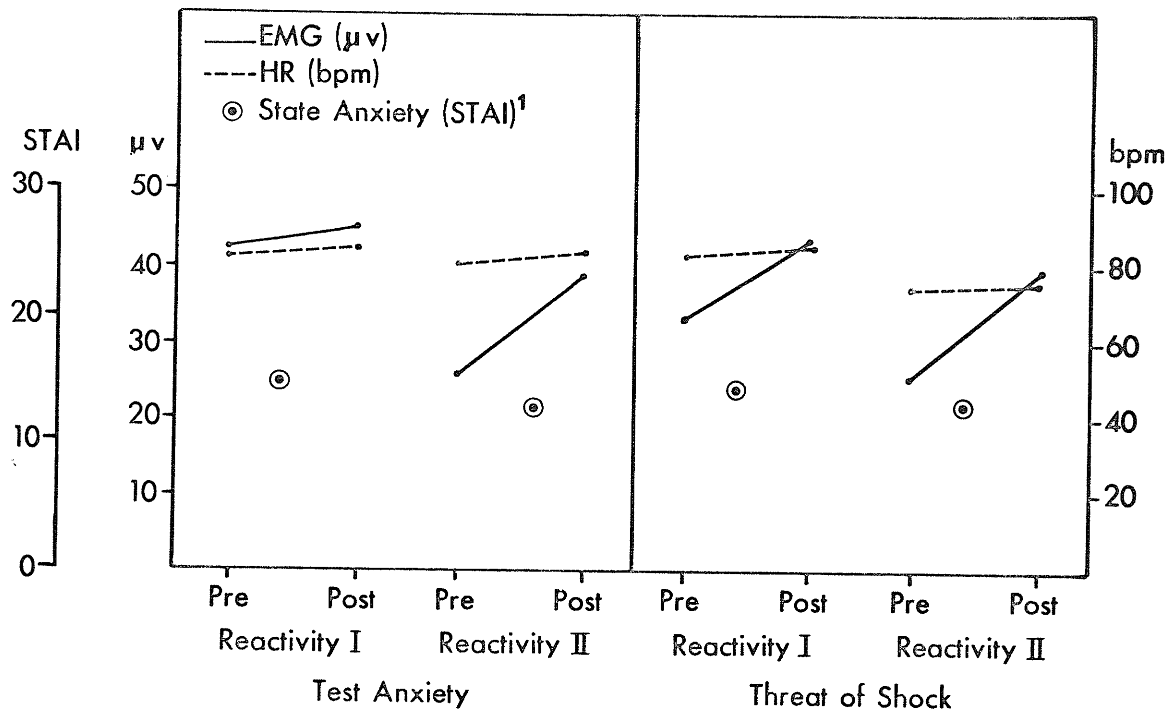
Relationship of Reactivity II to Treatment. It was predicted in Hypothesis VII that reductions in EMG, HR, and state anxiety due to treatment would be maintained in the posttreatment experimental stress phase. Those subjects who exhibited greater decreases in response levels following treatment were expected to demonstrate lowered physiological reactivity and state anxiety to Reactivity II, relative to the initial application of stimuli.

In order to determine differences in physiological reactivity between the two experimental stress phases, the residualized scores of Reactivity II were regressed on those of Reactivity I. The postmanipulation measure of state anxiety in Reactivity II was regressed on the corresponding measure in Reactivity I. These three sets of residualized scores (EMG, HR, STAI-State), representing Reactivity II relative to Reactivity I (RR scores), were placed in canonical correlation with the treatment residuals (TR scores).

Group differences in Reactivity II, relative to Reactivity I, were explored via MANCOVAs using the residualized scores of Reactivity I as covariates for those of the second application of analogue stress. As reported earlier, no group differences were observed in Reactivity I. Pair-wise comparisons were made. The test anxiety situation will be examined first.

A. Test anxiety - Reactivity II. An examination of the zero-order correlations of the test anxiety RR scores with TR scores yielded a significant result in the predicted direction for state anxiety (r = .308, $p<.005$). That is, those subjects who reduced their state

Figure 3. Responses to pre- and posttreatment analogue stress across groups.



1 Selected Items (See Method)

anxiety most effectively during treatment reported decreased anxiety to the posttreatment application of test anxiety. An inverse relationship was observed for HR in this situation: individuals who exhibited greater HR reductions during treatment demonstrated increased responsivity to Reactivity II test anxiety (r = .295, $p<.01$).

The patterns of the three response variables in relation to each other in Reactivity II and in treatment were examined via canonical correlations. The first two of the canonical correlations of test anxiety reactivity residuals (TA-RR scores/first set) with treatment residuals (TR-scores/second set) were significant (R_{C1} = .362, χ^2 = 20.84, df = 9, $p<.01$; R_{C2}= .314, χ^2 = 9.94, df = 4, $p<.04$). The proportion of variance in each set accounted for by the canonical variables was calculated for each correlation. In R_{C1}, the proportion of variance accounted for in the first set was .346 and in the second set, .339. Therefore, about one-third of the variance in each set appeared in the first canonical variables. For R_{C2}, a correlation orthogonal to R_{C1}, the proportion of variance accounted for by the second canonical variables was .312 and .408 for the first and second set, respectively. Thus, the first and second canonical variables together accounted for about two-thirds of the variance present in each of the two sets. For each of the canonical correlations, only about 4% of the variance in one set of variables (TA-RR: EMG, HR, STAI-State) was accounted for by the other (TR: EMG, HR, STAI-State) and vice-versa.

The structure coefficients in the two canonical correlations were examined to determine the relative importance of each variable. For R_{C1}, the structure coefficients for the first set of variables (TA-RR scores) were EMG: .282, HR: -.649, and STAI-State: .733; and those for the second set of variables (TR-scores) were EMG: .207, HR: .554, and STAI-State: .816. Therefore, the relative weighting in the TA-RR scores pointed to a strong directional difference between HR reactivity and state anxiety in the posttreatment test anxiety condition. In the second set of variables, the structure coefficients pointed to the sum of HR and state anxiety decrease in treatment as accounting for the majority of the variance. EMG accounts for very little of the variance in either canonical variable. The first canonical correlation, therefore, indicated that those persons who exhibited the greater combined reductions of HR and state anxiety with treatment were those subjects who demonstrated the greater differences between the two response indices, greater decreases in state anxiety and increases in HR reactivity, during posttreatment test anxiety.

In the second canonical correlation, R_{C2}, a different pattern emerged. The structure coefficients for the TA-RR scores were EMG: 0.079, HR: .684, STAI-State: .676 and for the TR scores were EMG: .632, HR: -.813, STAI-State: .408. The TA-RR canonical variable respresented a sum of HR reactivity and state anxiety, and the TR canonical variable represented the additive weighting of EMG and state anxiety minus that of HR. Therefore, a second patterning of responses may be described as illustrating individuals who reduce EMG and state anxiety while increasing HR during treatment being those to exhibit HR and state anxiety decreasing together during Reactivity II text anxiety.

Using a family-wise error rate of .10 for pair-wise comparisons (p .006), MANCOVAs calculated among groups yielded no signficiant differences.

B. <u>Threat of Shock-Reactivity II</u>. An examination of the zero-order correlations between Threat of Shock-RR scores and TR scores pointed to EMG reduction due to treatment being negatively correlated with posttreatment threat of shock EMG reactivity ($\underline{r}$ = -.348, $p<.005$). The first of the canonical correlations calculated to determine relationship patterns among the stress and treatment variables was significant, R_{C1}= .365, χ^2= 18.20, df - 9, $p<.03$. The sets of TS-RR scores and TR scores accounted for 36% and 35% of the variance of their respective canonical variables. The proportion of variance accounted for in one set by the other via their canonical variables was 5% in both cases.

The structure coefficients for the TA-RR scores were EMG: .889, HR: .464, STAI-State: -.288; and for the TR scores, EMG: 0.877, HR: .022, STAI-State: 0.547. Thus, the posttreatment threat of shock canonical variable was comprised largely of EMG and HR reactivity, in order, with a moderately negative association with state anxiety. The great majority of the variance in the treatment canonical variables was accounted for by the negative, additive association of EMG and state anxiety. The pattern of relationship between treatment and Reactivity II threat of shock represented by the canonical correlation, then, pointed to the following: individuals who concomitantly reduced their EMG and state anxiety during treatment exhibited heightened EMG and HR as well as moderately reduced state anxiety to posttreatment threat of shock, and vice versa. No group differences were observed.

<u>Summary of Reactivity II Relationships</u>. As in Reactivity I, test anxiety in Reactivity II was demonstrated to affect increases in both physiological variables while only EMG was increased by the threat of shock manipulation. Because evidence was presented for a negative relationship between prestimulus level and change based on simple differ-

ence, residualized scores were used to evaluate the response of individuals to posttreatment stress in relation to pretreatment stress and treatment. For the test anxiety condition, those individuals who reduced their state anxiety during treatment also demonstrated decreased state anxiety to Reactivity II relative to that in Reactivity I as predicted. However, HR treatment reduction was negatively associated with HR reactvity, and EMG and HR decreases due to treatment were also observed to be negatively correlated. Two patternings of relationships among the treatment and text anxiety reactivity variables were described. For the threat of shock manipulation, as HR for test anxiety, EMG reduction during treatment was found to be negatively associated with EMG posttreatment reactivity. One significant pattern of treatment and posttreatment response relationships was described for threat of shock. No significant differences were observed among the groups in either Reactivity I or Reactivity II according to a family-wise error rate of .10 for pairwise comparisons. Results of analysis, then, pointed in general to the complex patterning of response modes in treatment, in each reactivity condition, and in the relationship of the experimental phases to each other.

Discussion

Relationship Among Trait Anxiety Measures and Session I State Anxiety

Intercorrelations among the three trait anxiety measures and the Session I premonitoring state anxiety measure revealed an interesting pattern. The correlation between SRGTA-Evaluation and SRGTA-Physical Danger was significant and the value (r = .403) was close to that found by Kendall (1978) in his original pool of 198 male subjects (r = .38). The moderately positive correlation of the situations on the same instrument may be in part attributable to a response set or, indeed, may represent a commonality in the degree of anxiety experienced by a given individual perceiving herself either being evaluated by others or in physical danger. However, the situation-specific aspects of the SRGTA were sufficient to yield significantly different correlations with physiological indices in the analogue stress condition of Session II (see Results). That is, in the test anxiety situation, subjects exhibited a closer association between HR response and SRGTA-Evaluation and between EMG magnitude and SRGTA-Evaluation than between either of these physiological variables and SRGTA-Physical Danger.

The correlation between SRGTA-E and STAI-Trait approached significance, and that between SRGTA-PD and STAI-Trait was nonsignificant. While the latter correlation also failed to reach significance in Kendall's research, the former was strongly significant (r = .52, $p<.005$) and greater than the association (r = .269, $p=.0192$) observed in the present study ($Z = 2.19$, $p<.05$). Kendall argued that the STAI-Trait was heavily weighted with items concerning anxiety of being evaluated by others and reflected little relating to other situations, such as physical danger. It may be that somewhat older (Average Age = 25.5 yrs) female subjects, perhaps by virtue of their conditioning, perceive anxious situations as connoting physical danger more than do college-age males, or they generally distinguish less between evaluative situations and physically dangerous ones. Although the direction of the difference was similar in the two studies, it seems that for females the STAI-Trait instrument was no more geared to measuring anxiety evoked by evaluation than by physical danger.

State Anxiety (STAI-State) measured during Session I, following electrode placement and prior to monitoring, was significantly related to each of the trait measures. No difference was observed among the correlations. Initial reaction to the sound-proofed chamber varied widely, from a trembling subject who could not complete the experiment to a mother of five who wanted to "rent it out weekends." Clearly, the ambiance of the experimental chamber included elements of both physical danger and evaluation. The white lab coats, sophisticated equipment, one-way mirror, and nonspecific nature of Session I instructions speak to this. The fact that the STAI-State was no more closely associated with STAI-Trait than with either SRGTA-E and SRGTA-PD suggested that the evaluative and physical danger components present in the STAI-Trait were not additive. Further analyses pursued the relationship of the SR-GTA components. Pursuing the relationship of STAI-State to STAI-Trait and to each of the SR-GTA measures, analyses revealed considerable common variance between state anxiety in this ambiguous situation and its association to trait anxiety as evaluated by each of the three scales. The relationship between SRGTA-PD and STAI-State seemed to contribute the unique proportion of the variance to the overall multiple associations (STAI-State, STAI-Trait, SRGTA-E and SRGTA-PD). Therefore, in predicting an individual's first subjective reaction to psychophysiological monitoring, the possibility that physical danger may be perceived cannot be dismissed.

Relationships Among Self-Report Anxiety Measures and Physiological Variables During Session I

The associations among the self-report and physiological indices of anxiety were investigated during a period at the beginning of Session I in which subjects were instructed to rest without sleeping. It was predicted in Hypothesis I that individuals who reported higher levels of state anxiety (STAI-State) and had higher trait anxiety scores (SRGTA-E) would exhibit an elevated baseline of frontalis tension and heart rate. Analyses indicated that the subjective and physiological indices of anxiety were significantly related in a positive direction. A meaningful proportion of the variance in each of the two sets of variables (STAI-State and SRGTA-E; EMG and HR) was included in the overall association; and, further, within the context of the association, a sizeable fraction of the variance in one set was accounted for by the other, and vice-versa. Examination of the individual variables revealed that while EMG and state anxiety were more heavily weighted in the relationship between subjective and physiological indices of anxiety, HR and trait anxiety also contributed importantly to the response pattern.

The relationship between the sets of physiological and self-report variables was not only statistically significant but also relevant in accounting for a sizeable proportion of the variance. This cannot, however, be interpreted to support the idea of anxiety as a conjoint event that can be equivalently tapped through either self-report or physiological monitoring. On the contrary, it underlines the importance of viewing anxiety as a pattern of related responses, both between and among response modes. Because both EMG and HR contributed information of the overall pattern, the two-factor (skeletal musculature and ANS) theory (Eysenck, 1961; Buss, 1962) was supported to the extent that consideration of each modality was important to the description of a physiological response in anxiety. The correlational analyses employed in the present study dealt with the responses within individuals but may point to the need to investigate between individual patterns as well (e.g., Lacey, & Lacey, 1958). Other muscle groups and ANS responses, or parameters of responses such as variability, would also be profitable to investigate.

On the self-report side, the results indicated that the tendency to respond, or trait anxiety, provided related data additional to that provided by the subject's response in the actual situation, or her state anxiety. Because there was no experimental manipulation other than the novelty of the psychophysiological monitoring itself, the subjects were ostensibly "at rest." However, the SRGTA-E was selected as the appropriate trait anxiety measure on an a priori basis due to the pervasive evaluative components or "demands" experienced by many experimental subjects (e.g., Rosenthal and Jacobson, 1968). Therefore, the relation- found between self-report and physiological variables may be consistent with studies reporting such positive associations among normals at rest (Smith, 1973; Matus, 1974) or patients at rest (Oken, & Heath, 1970) or may be more broadly interpreted as a psychophysiological reaction to an evaluative situation.

In summary, the results of normal female subjects in an initial psychophysiological monitoring situation pointed to the appropriateness of viewing anxiety as involving a pattern of related psychophysiological responses.

Relationships of SRGTA Trait Anxiety Measures With Physiological Variables and State Anxiety Under Analogue Stress Condtions

The selection of situationally specific trait anxiety measures to evaluate anxiety under differing stressor conditions was explored in the second phase of the experiment, Reactivity I. It was predicted in Hypothesis II that the relationship between the indices of anxiety (EMG, HR, state anxiety) under congruent analogue stress conditions and SRGTA measure would be greater than that betweem those indices under an incongruent situation and SRGTA measure. This hypothesis was confirmed for HR reactivity and postmanipulation EMG under the congruent test anxiety situation and SRGTA-E. It was not confirmed for EMG reactivity and postmanipulation HR and state anxiety under the test anxiety situation nor for any variable under the threat of shock condition.

Initially, a check on the two stress manipulations confirmed that the test anxiety situation was effective in significantly increasing EMG and HR, and the threat of shock condition was effective in increasing EMG. In spite of boasting no physical props, the test anxiety situation appeared to be closer to the hearts of the student-subjects as their exams were approaching. The fact that the imagined scene was useful in altering measureable physiological responses has implications for the experimental refinement of clinical procedures such as desensitization and hypnosis. Although the majority of the subjects reported afterwards the belief that they might actually receive a shock, the manipulation was effectively "temporally uncertain", therefore perhaps eliciting the oppositional effects of anticipation and vigilance for uncertainty removing cues, cardiac acceleration and deceleration, respectively (Bowers, 1971).

Secondly, an examination of the relationships among the postmanipution indices of anxiety pointed to a virtually identical positive association between EMG and HR under each of the situations. Therefore, the previously observed association of physiological variables at baseline was also exhibited in their values following the application of stress. Only postmanipulation EMG in the test anxiety condition exhibited a significant relationship with the congruent trait measure (SRGTA-E), and this also proved to be significantly greater than the association between EMG and the incongruent trait measure (SRGTA-PD).

Correspondingly, heart rate reactivity under the test anxiety condition was more closely related to SRGTA-E than to SRGTA-PD. These findings lend some support to the situational specificity of anxiety. Preselection of subjects based on a high-low dichotomy of the trait measure (e.g., Kendall, 1978) versus the continuum of the present study might enhance the finding of further positive association among the type of stress, the trait measure and level, and various state variables.

Effect of Treatment on Physiological Variables and State Anxiety

Results of analyses indicated a significant difference among the groups attributable to reductions in state anxiety and heart rate. While EMG magnitude was decreased substantially across groups (see Figure II), the high variability of this index might have affected the findings. A series of training sessions, rather than the single analogue period preceded by an adaptation session, could have contributed to greater EMG control and presumably, to greater within group homogeneity. Differential reaction to the first application of analogue stress might have increased the variability of the already quite changeable measure of EMG. An *a priori* cutoff of extremely high and low scores (±2 SD) might be useful in illustrating a clearer picture of differential EMG decrease. Alternatively, fairly uniform decreases in muscle tension as a result of resting following stress, regardless of kind of treatment or control, might represent the true state of affairs.

When the groups were arranged according to the response pattern maximally discriminating among them, they were in order of effectiveness: PR, False-FB, HR-FB, Combined-FB, R-Control, and EMG-FB. Further analyses pointed to a significant difference between PR and EMG-FB and between False-FB and EMG-FB, with subjects in the PR and False-FB groups exceeding EMG-FB subjects in both state anxiety and HR reduction. The relatively greater success of PR and False-FB in decreasing state anxiety might be associated with the need to separately modify the subjective state of an individual in addition to physiological responses. In progressive relaxation, not only were major muscle groups relaxed, but the individual was specifically told that she was "feeling relaxed". (See Appendix B-4). The expectation of relaxation was implicit, yet clear, in the False-FB condition. In part, the subjects were instructed as follows: "...the tone you will hear will provide you with information, or feedback, regarding the level of your physiological activity...the lower the tone, the more physiologically relaxed you are becoming...." (see Appendix B-5). The total frequency, ostensibly denoting EMG magnitude, was quite noticeably reduced during this "training" period. Therefore, both the PR and False-FB subjects were provided with the cognitive label for their state, and this might have affected their self-report of lowered state anxiety (e.g, Schachter, & Singer, 1962). The inclusion of "coping" or self-mastery statements with physiological relaxation technique (e.g., Reeves, & Mealia, 1975) found some support for anxiety reduction from these data.

This finding also underlines the necessity of the selection of a control group that experiences the same, or a similar, expectation of gain as the experimental group (Lick, 1975). The false-feedback of a "successful" subject seemed to be an appropriate control for the manipulation of the subjective state as well as the nonspecific activities associated with physiological monitoring.

The progressive relaxation and false feedback groups exceeded the EMG feedback group in HR reduction. It has been suggested that PR, through manipulation of both set and physiological state, provokes a general lowering of sympathetic activity, including HR, instead of a particular pattern (Lang et al., 1972). The concomitant reduction of HR and frontalis EMG in PR could, at first glance, be interpreted as support for the reciprocal inhibition hypothesis. However, the absence of HR reduction along with considerable EMG reduction in the EMG-FB group points to at least the partial independence of these response systems. Connor (1974) argued that the establishment of an efferent relaxation response requires cognitive activity, which, in turn, is related to cardiac acceleration (Lacey, 1967). Progressive relaxation, in contrast to EMG-FB, also attends specifically to respiration rate, a muscle activity closely related to HR. Therefore, PR might be the most effective of the procedures overall because of its separate modification of various responses within and among behavioral systems rather than generalization from a single response.

The greater HR decrease in the False-FB group than in the EMG-FB group might be accounted for by a difference in stimulus perception between the two groups. Although the ruse of false feedback was considered convincing by the self-report of subjects in the postexperimental questionnaire, the False-FB subjects might have been more obliged than the EMG-FB subjects to pay close attention to the environment. This watchful activity, in contrast to the mental work possible involved in exerting control over the tone, tends to be associated with cardiac deceleration (Lacey, 1967). Attention to the irregular, but perceptably decreasing, tone could have itself induced a lowered HR. It might also be that the reduction of state anxiety in both False-FB and PR is associated with the decreased cardiac rate.

When muscle tension, heart rate, and state anxiety were considered as indices of emotional state, results of the analyses pointed to the partial independence and interactive nature of the response systems. Progressive relaxation, which attends to the explicit modification of the major muscles, respiration rate, and subjective state, was the most generally effective. Given the equipment requirements for biofeedback procedures and paucity of evidence that meaningful generalization across response systems occurs, progressive relaxation appears to be a treatment of choice for reduction of anxiety (e.g., Kondo, et al., 1975). Discussion of each hypothesis regarding treatment follows:

It was predicted in Hypothesis III that individuals in the training procedures (EMG-FB, HR-FB, Combined-FB, and PR) would exceed individuals in the control groups (False-FB and R-Control) in their overall reduction of physiological activity and state anxiety. Analyses failed to confirm this hypothesis. Because of the implicit manipulation of subjective state in False-FB, it was included with the treatment groups for a second comparison with R-Control. This comparison was also nonsignificant. As illustrated in Figure II, each of the six groups, including R-Control, substantially decreased their frontalis muscle tension during the 25 min. period. Differential patterning within each group was evident in HR and state anxiety response. Although neither of these indices were reduced in the R-Control group as a result of "just relaxing", they were also not reduced in the EMG-FB group. State anxiety was not decreased in the HR-FB and Combined-FB groups even though both EMG and HR were reduced in these conditions. Only PR and False-FB, which included specific modification of subjective state, were effective in reducing self-reported anxiety. Therefore, the failure to discover an overall difference between the treatment and control groups emphasizes, at least in the analogue stage, the importance of input variables in planning the modification of behavior.

Physiological response specificity in each of the single-mode feedback procedures and progressive relaxation was examined. As predicted (Hypothesis IV), individuals receiving HR feedback were more successful in decreasing their HR's than were EMG-FB subjects but no more so then PR subjects. The progressive relaxation group also exceeded the EMG-FB group in the reduction of HR. No differences were observed among the three groups in EMG reduction. Therefore, the concomitant reduction of frontalis tension and HR, present in both the HR feedback and progressive relaxation procedures, was not evident in EMG feedback. As discussed earlier, it might be that cognitive activity, generally associated with HR increase, was more prominent in EMG feedback than either HR-FB or PR. A unifying strategy, perhaps that of control of respiration rate, might be the salient feature in the greater effectiveness of HR feedback and progressive relaxation over EMG feedback in reduction of HR. This might be further explored by various methods, such as voluntary breath-counting (as in Yoga), unobtrusive respiration rate measuring, or strategy questionnaires. The nature of the feedback signals, auditory in the EMG group and visual in the HR group, was unlikely to have required differential attention to the environment. The False-FB, PR, and the Combined-FB groups, all of whom decreased HR and EMG, responded to auditory stimuli.

Because feedback was directed to the simultaneous modification of both HR and frontalis tension in the Combined-Feedback procedure, it was anticipated that subjects in this group would exhibit a stronger coupling of EMG and HR reductions than EMG-FB or HR-FB subjects (Hypothesis V). Although the association between HR and EMG was moderately positive for the Combined-FB group, it failed to reach statistical significance and was not greater than that of either the HR-FB or EMG-FB group. The coupling of physiological response reduction in the three feedback groups did not exceed that of the control groups. However, although reductions in both EMG and HR were observed in four of six groups (Combined-FB, PR, HR-FB, False-FB), differentiation (Schwartz, 1972) was exhibited between the two variables during treatment for individuals. This directional opposition or "uncoupling" of somatic and cardiac events might not be inconsistent with the presence of a common mediating and integrating mechanism (Obrist et al., 1970b). A positive association in the reduction of EMG and HR did not prove to be a sufficient condition for anxiety control in Combined-FB subjects: state anxiety was not reduced.

The relationship of physiological response to state anxiety was investigated further for the treatment phase (Hypothesis VI). The combined decrease in HR and EMG was not found to be associated with reports of lessened state anxiety. However, examination of the data revealed interesting evidence of response patterning by groups (see Figure II). Both physiological events were reduced in the two groups to also display a decrease in state anxiety (PR and False-FB); lowered cardiac-skeletal muscle activity occurred without reducing state anxiety (HR-FB anc Combined-FB); and EMG was substantially lowered affecting neither HR nor self-report (EMG-FB and R-Control). A greater number of subjects would facilitate the investigation of these phenomena through statistical analyses.

EMG and state anxiety were associated at posttreatment, consistent with the relationship exhibited during the baseline phase but not evidenced in response to stress (Reactivity I) or at pretreatment. Trait anxiety (SRGTA-E), specific to the situation, was related to both physiological variables at baseline, and to HR response and EMG level following stress. Interestingly EMG and HR reduction were negatively associated during treatment, but their pre- and posttreatment levels were unrelated. They were positively correlated following each of the initial stress events. Therefore, while no single response pattern emerged from analyses of baseline, stress, and modification procedures, evidence accrued for the patterning of emotional events specific to the situation and to individuals.

Reactivity II: Relationship to Reactivity I and to Treatment

Reactivity II, the posttreatment application of the two stress conditions, was investigated in its relationship to Reactivity I and to Treatment. As in Reactivity I, both EMG and HR were increased in response to the second test anxiety situation, and only EMG increased in response to posttreatment threat of shock. Results indicated that, while test anxiety EMG increase in Reactivity II was actually greater than that in Reactivity I, both the pre- and postmanipulation EMG levels were lower in Reactivity II than in Reactivity I. Significantly lower state anxiety was reported for posttreatment test anxiety (see Figure III). For Reactivity II threat of shock, no difference in responsivity was observed; but subjects exhibited lower EMG and HR premanipulation levels and lower postmanipulation HR. Results of these analyses suggested that reactions to stress are probably substantially more complex than simple change scores or even absolute levels of physiological and subjective indices reflect. The differential effects of treatment were explored, and patterns relating to the kind of stress and change during treatment emerged.

It was predicted that individuals who demonstrated reduced EMG, HR, and state anxiety due to the treatment phase would exhibit lowered responsivity in Reactivity II, relative to Reactivity I (Hypothesis VII).

This prediction was confirmed for state anxiety in the test anxiety condition: subjects who most successfully decreased their state anxiety during treatment reported reduced anxiety to the second application of stress. However, inverse relationships of response to treatment and stress situations were also observed. The greater the HR reduction in the treatment phase, the greater the HR response to posttreatment test anxiety exhibited. Similarly, decreased EMG due to treatment was associated with increased EMG response to Reactivity II threat of shock. Therefore, while differing from the unidirectional picture illustrated by self-report, these findings were consistent with observations of reactions to stimuli being negatively associated with prestimulus values (Law of Initial Values) and with other data indicating an inverse relationship between physiological reactivity and control within subjects (e.g., Bell, & Schwartz, 1975). No response differences attributable to group membership were observed in Reactivity II; therefore, considerably varying treatments and controls seemed to affect response to posttreatment stress and to a lesser extent than individual patterning interacting with treatment and kind of stress. Further analyses of the relationship of Reactivity II to Treatment revealed three significant response patterns, two pertaining to test anxiety and one to threat of shock.

For test anxiety, the first pattern was affected very little by EMG change. It represented individuals who exhibited greater combined reductions of HR and state anxiety during treatment and demonstrated greater differences between the two responses, increased HR and decreased state anxiety, to posttreatment stress. These subjects might be termed "autonomic responders": they emitted a marked cardiac response to both control procedures and to analogue stress, and these were related, according to the situation, to subjective state. The second pattern for test anxiety suggested increased complexity. It described subjects who coincidentally reduced EMG and state anxiety while increasing HR during treatment and who exhibited decreased HR and state anxiety to Reactivity II. The dissociation of the Cardiac-somatic linkage was demonstrated here as well as the previously seen negative association between HR control and reactivity to stress. In contrast to the first pattern, the effect of EMG change could play the important intervening role. Interpreted broadly, these subjects might be ideal for a classic desensitization suty; reduced muscle tension and state anxiety during treatment was associated with reduced autonomic response and state anxiety to stress. Reciprocal inhibition, of course, could not be summoned for explanatory purposes.

A single significant pattern emerged from the data relating to Reactivity II threat of shock and treatment. Individuals who reduced both EMG and state anxiety during treatment exhibited heightened EMG and HR as well as reduced state anxiety to posttreatment stress. Again, the negative relationship between physiological change due to treatment and consequent response to stress attenuates the utility of treatment based on the reduction of physiological activity, particularly a single mode, for some individuals. The kind of stress, analogue to physical danger, might have been the occasion for some subjects to respond with both increased EMG and HR in spite of their reduced state anxiety.

One relationship was consistently demonstrated among the three significant patterns: reduced state anxiety to treatment was associated with reduced state anxiety in response to Reactivity II, relative to

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Reactivity I. This evidence, as well as that emerging from the earlier analyses of treatment group differences favoring progressive relaxation for general effectiveness, would seem to suggest that manipulation of subjective state is important, if not essential, for the modification of anxiety behavior.

Taken together, the analyses have repeatedly pointed to interacting, but partially independent, behavioral systems. While significant associations were demonstrated among HR, EMG, and state anxiety, these were frequently negative and appeared to be related both to the situation and to the individual. Analyses of both analogue stress conditions, test anxiety and threat of shock, underlined the importance of specificity in considering stress: situation-specific trait anxiety measures were more highly predictive of response, physiological response to the two differed consistently pre- and posttreatment, and varying treatment-related patterns emerged when considering the two. While caution must be exercised in the interpretation of response patterning because it may not be reproducible over time, a high individual consistency in itself could be important in the investigation of psychosomatic disease. A greater number of normal subjects and perhaps closely defined patient groups (e.g., migraine sufferers, ulcer patients) could be used to examine physiological and subjective patterning to varying treatment procedures and stresses over time.

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APPENDICES

APPENDIX A

Review of the Literature

According to advocates of divergent theoretical perspectives, the principal problems in the study of human behavior do not lie in the observation of events, which are relatively slow and macroscopic compared to those of other sciences, but in "how you slice the pie" (Skinner, 1953; Meehl, 1973). The analyses, or pie-slicing of behavior in the last half-century have evolved into a debate regarding the selection of important responses, the meaningful level of inference, and the functional significance of the environmental complex. The emergent dichotomy between person (organismic) variables and stimulus conditions ("trait" theories versus situationism), however, has been the occasion for both insight and distortion. Recent theoretical (Bowers, 1973; Mischel, 1973) and empirical (Bem & Funder, 1978) papers have called for an emphasis on the interaction of person and situation variables in the pursuit of a model of the person.

In the study of emotion, it is essential to recognize response complexity with regard to both intra-individual variables and stimulus conditions. In an extensive review, Lang, Rice, and Sternbach (1972) suggested that the long existing awareness of parallels between human subjective states and changes in organs innervated by the autonomic nervous system (ANS) has provided impetus to a modern form of dualism. Emotions frequently have been viewed as conjoint mental and physiological events which can be equivalently measured by either response mode. Much psychophysiological research has found groundings in the James-Lange assertion that perceptions of physiological conditions cause affective states or in its opposite, that emotions produce bodily states.

A.A. Alexander (1972) contends that the most parsimonious explanation for the failure of contemporary Cartesians to demonstrate this kind of association is that they simply are not separate events. He concurs with Stern and McDonald (1965) that investigators should "lower their sights" and turn from the search for underlying "causes" of emotion, particularly in psychological disturbance, to the study of physiological and psychological correlates of emotion.

When emotion is seen as a unitary response directly experienced by the individual and only inferred by others through various indices, the problem of study shifts from an emphasis on how the pie is sliced to how the pieces fit together. Emotion may be viewed as an operational construct, defined simultaneously by verbal (cognitive-affective), overt motor and covert physiological responses in the context of environmental conditions (Lang et al., 1972). The relationships among these variables are complex and frequently idiosyncratic (e.g. Endler, 1975).

The following is a review of the literature emphasizing various approaches to the assessment of the psychophysiological construct of anxiety, the central tenet in many personality theories. Self-reported anxiety, the psychophysiological measures of heart rate (HR) and electromyographic (EMG) response, and the conditions of analogue stress and voluntary control will be emphasized. The interaction of behavioral systems and the issues of individual, response, and situational specificity will be of central importance throughout the discussion.

Anxiety as a Construct

In spite of its ubiquity in popular expression, it is imperative to operationalize what is meant by the term anxiety. Researchers infer its presence through self-report measures, physiological indices, and/or judgments regarding an individual's overt behavior. Because dissociation between and within response systems is possible for particular situations and persons, they cannot be used interchangeably. Conceptual confusion may also arise from the fact that researchers frequently employ threat and stress as equivalent terms to anxiety. Speilberger (1972) suggests that stress be used to refer to the objective stimulus properties of a situation and threat to an individual's idiosyncratic perception of a certain situation. Anxiety is a complex construct which must be evaluated with an appreciation both for the different aspects of the stimulus array that result in the evocation of an emotion and the limitations of available indices.

State-trait distinction in anxiety. The distinction between "trait" and "state" anxiety has been made through factor analysis (Cattel, & Scheier, 1958, 1961). Spielberger (1966, 1972) has described state anxiety (A-State) as an emotional reaction "...consisting of unpleasant, consciously-perceived feelings of tension and apprehension, with associated activation or arousal of the autonomic nervous system" (1972, p. 29), and trait anxiety (A-Trait) as the tendency to respond with A-State under stress. Persons with anxiety proneness or high A-Trait, according to Spielberger, are self-depreciatory and concerned with "fear of failure": they are individuals more disposed to perceive ego-involving situations as threatening than those with low A-Trait. The degree of A-State activation is expected to be equivalent for both high and low A-Trait people under neutral or nonthreatening conditions.

Personality research guided by the distinction between state and trait anxiety has responded to the need to investigate and specify the stimuli that evoke different levels of A-State for high and low

A-Trait subjects. Although Taylor's (1953) Manifest Anxiety Scale (TMAS) was not designed to tap discriminately trait vs. state indices, the TMAS and the A-Trait Scale of the State-Trait Anxiety Inventory (STAI) (Spielberger, Gorsuch & Lushene, 1970) have been employed to assess trait anxiety in the majority of these studies. Results have been conflicting, however, because both measures evaluate anxiety experienced primarily in an interpersonal context.

Endler and his associates (Endler, Hunt & Rosenstein, 1962; Endler, & Hunt, 1969) have asserted that the expression of anxiety is influenced by a number of factors such as the proportion and kinds of evocative situations; the number, type, intensity, and duration of responses; and the relative effectiveness of the situations in eliciting specific responses. The S-R Inventory of General Trait Anxiousness (SR-GTA) has been introduced (Endler & Okada, 1974) as a self-report personality inventory designed to tap the various facets of trait anxiety. As originally developed, the SR-GTA consisted of four general situations (interpersonal, physical danger, ambiguous, and innocuous types of situations) and nine modes of response. A situation scale in which the respondent is being evaluated by others was also included for research purposes. Factor analyses has pointed to the existence of two situational factors (interpersonal and physical danger) and two response mode factors (physiological-distress and approach).

Exploring the construct validity of this multidimensional approach to anxiety, the SR-GTA was administered to samples of normal youth, normal adult, neurotic and psychotic subjects (Endler & Okada, 1974). Interestingly, the neurotic sample reported greater anxiety across situations than did either of the normal or psychotic sample. Individual differences, however, accounted for very little of the variance by groups. For normal females, situations accounted for more variance than did person-by-situation interactions. Both normal female youths and adults reported greater anxiety to the physical danger scale than did the males in the groups: anxiety as reported in the interpersonal situation did not differ between sexes. Subjects did respond differentially to the situations, with the greatest anxiety provoked by the physical danger situation and the least, by the innocuous situation (evaluative situation not included).

The general prediction arising from Endler's person-by-situation concept of anxiety is that the trait anxiety measure corresponding to the situation would be the best index of the state anxiety evoked in that situation. This hypothesis was recently tested by Kendall (1978) using 96 male college student subjects preselected on the basis of high or low scores on the A-Trait portion of the STAI, the physical danger scale of the SR-GTA (SRGTA-PD), and the evaluation scale of the SR-GTA (SRGTA-E), respectively. The subjects were explored to two analogue stress situations: a short film graphically illustrating automobile crashes and an exceedingly difficult decoding task. As expected, a triple interaction of type of stress, trait level, and trait measure emerged. That is, the high trait anxious individuals reported greater state reactions when the trait measure corresponded with the kind of stress. This effect was not found, however, for subjects divided into high and low anxious groups according to the STAI-Trait. Therefore, at least in its initial tests, the situation scales of the SR-GTA have been demonstrated to be useful in the investigation of a multidimenional approach to anxiety.

Emotion as activation. Assessment of anxiety by a self-report instrument, however, relies solely on the perception of unpleasant feelings and physiological activity. Some researchers contend that observable physiological responses, rather than the perception of them, are of primary importance. For example, Wenger postulates that emotion is "activity and reactivity of the tissues and organs innervated by the autonomic nervous system...(which) may involve but does not necessarily involve skeletal muscular response or mental activity" (Wenger, Jones & Jones, 1956, p. 343). Presumably, it may be possible to elicit specific patterns of autonomic activity to correspond with particular emotions induced by various stimuli. Whether one accepts Wenger's position _qua_ theory is less important than the fact that it has directed the investigator to the measurement of autonomic behavior in various stimulus contexts (Lang et al., 1972).

Early work in the area of physiolgocal activity in emotion emphasized a general arousal concept which presumed unified and relatively invariate responses to stimulation (e.g. Cannon, 1936; Selye, 1946). The idea that a subjectively experienced emotion is paralleled by a particular physiological state, equivalently measured by any one of a number of indicators, has met with important qualifications regarding response mode, individuals, and situations. Because the term _arousal_ connotes the more generalized idea of emotion, the term activation will be used in the current discussion. Of particular interest in assessing physiological activation in emotion is the extensive research in the area by Duffy (1962), Malmo (1959) and J.I. Lacey (1962).

In the 1950's Duffy began developing a systems approach to activation in which terms like energy mobilization, excitation, and arousal were considered identical. The activation construct "derives from and emphasizes the fact that a living organism is characteristically an energy system...the level of activation of the organism may be defined, then, as the extent of potential energy, stored in the tissue of an organism as this is shown in activity or response" (Duffy, 1962, p. 17). The pertinent dimensions of behavior were direction and intensity, with the latter being the determining factor in patterns of physiological response. However, Duffy suggested that activation is influenced not only by the nature of stimuli but also by the meaning of those stimuli to the individual; and she allowed for the possibility of varying individual patterns according to the approach or avoidance component of the situation.

Malmo (1959) described activation as excitation of the ascending reticular activating system (ARAS), a general drive without directional aspects; however, as in Duffy's concept, activation level was determined by the properties of the stimuli and conditions that surround it such as hunger or fatigue. In contrast to the formulation of Hebb (1955) which relates Q function or performance to arousal, Malmo (1959) was careful to confine generalizations concerning the relationship between physiological activity and performance.

J.I. Lacey and his colleagues have been the "most consistent conscience" in the assessment of autonomic activity (Alexander, 1972). In addition to the demonstration of various possible stereotypic response patterns, they have cautioned that physiological level must be evaluated in the context of lability and initial values, nonspecific activity, and with an awareness of the generally low intercorrelation among autonomic measures (Lacey, 1956, 1962, pp. 160-170; Lacey & Lacey, 1958).

Therefore, not only is the use of a single variable in serious dispute but also the use of a single parameter of that variable (such as maximal response or mean) warrants caution (Alexander, 1972).

Psychophysiological studies on anxiety. Although the nature of the association between physiological and psychological variates in emotion have been the frequent subject of theory, investigation of this interrelation has been largely atheoretical (Alexander, 1972). Studies conducted with greatly varying subject groups and numerous operational definitions of anxiety suggest that subjective anxiety may be reflected in both skeletal tension and autonomic reactivity, particularly heart rate.

Accelerated heart rate and large increases under stressful conditions are considered among the more reliable physiological correlates of anxiety (Martin, 1971, p.28; Cattell & Scheier, 1961, p. 208). Alexander (1972) noted that while results on basal skin resistance (BSR) are ambiguous, research on heart rate is generally consistent in reporting elevated resting levels in heterogeneous psychiatric patient groups compared to normal subjects. In an investigation of an outpatient population during periods of rest and two stress conditions, Shipman, Oken and Heath (1970) found trait anxiety (MMPI) to be high in the group with a chronically elevated heart rate. A striking contrast between these individuals and those who responded to stimulation with a high GSR (log conductance) led the authors to suggest that trait anxiety predisposes one to a cardiac outlet. Additionally, reliable measures of skin conductance (SC) tend to be more difficult to attain because careful control over both the environment from which the subject comes and the room temperature throughout the experiment is required (e.g., Watts, 1975).

Although statements regarding the roles of physiological responsivity in anxiety generally have referred to activation or arousal of the autonomic nervous system (ANS), others have emphasized the important role of the skeletal musculature. Indeed, Malmo and Shagass (1949) have described anxiety as a "heightened state of expectation reflected primarily in the skeletal muscular system." Evidence from factor analytic studies points to the involvement of both peripheral systems in anxiety: "one factor of autonomic over-reactivity and one characterized by conditioned anxiety responses (Eysenck, 1961, p. 21)." The latter factor of conditioned anxiety appears to be associated with restlessness, worry, and muscle tension (Buss, 1962).

Several studies (Williams & Williams, 1967; Davis, Malmo, & Shagass, 1954; Sainsbury & Gibson, 1954) have differentiated anxious patient populations from normals by means of elevated muscle action potentials (MAPs). Goldstein (1964) reported that baseline autonomic measures were elevated in anxious female patients relative to controls and supported earlier findings (Balsan, 1962; Martin, 1956) that skeletal muscle activity discriminates between anxious and non-anxious subjects more readily during a stress condition than during a rest period. In the previously reported study, Shipman et al. (1970) found that while no personality dimensions were associated with physiological variables at rest, the psychological stress condition was more effective than white noise in eliciting both autonomic and skeletal responses.

Responding to difficulties in generalization from patient groups to normals (Alexander, 1972; Pollin, 1962) and to serious criticism confronting earlier EMG technology (Grossman & Weiner, 1966), two investigators (Smith, 1973; Matus, 1974) have studied muscle tension differences among normals at rest. Baseline frontalis EMG levels were positively correlated with anxiety measures from Cattell's IPAT, Rotter's external locus of control in the Smith (1973) study and with Maudsley extraversion scores and the exvia-invia factor from the IPAT in the Matus (1974) study. Although frontalis muscle activity was not significantly associated with field dependence as measured by the rod and frame test, resting forearm extensor muscles correlated with field dependence in the latter investigation while the individuals in these studies were not subjected to any manipulated stress variable, they differentially responded physiologically to the experimental situation in a manner consistent with the psychological tests.

Cumulative data suggests that individual differences in physiological reactivity are more emphasized during periods of stress than rest and, additionally, that the kind of stress may be an important factor. However, personality variables may also be associated with EMG and heart rate levels at rest. Before proceeding to a more extensive discussion of psychophysiological reactivity to stress situations, consideration of these base levels is warranted.

Evaluation of Physiological Base Levels in Emotion

The assessment of base levels, used interchangeably with such terms as initial, prestimulus, resting, and baseline measures, is important to the understanding of emotion from several perspectives. Not only is there some limited evidence that persons can be differentiated by the elevation of resting levels, but there is also support for the notion that changes in response to stimulation are functionally related to these initial values. The evaluation of basal levels in emotion also requires consideration of such phenomena as homeostatic restraint and spontaneous activity.

Law of initial values. Although early physiological work often neglected even to report physiological levels prior to stimulus onset (Alexander, 1972), neither psychophysiological reactivity nor the control of physiological responses should be considered without reference to resting measures. In 1950, Wilder proposed the law of initial value (LIV) which predicts a negative intra-individual association between prestimulus level and change: that is, as the initial level increases, the true response of a variable to a stimulus decreases. This notion relies on the premise that there exists some optimal, homeostatic level for a variable; and Lacey (1956) argues accordingly that the reciprocal inhibition of the sympathetic and parasympathetic systems should directly indicate the LIV. He has suggested that a statistical manipulation based on the regression model, the autonomic lability score (ALS), be used to equate treatment effects with pretreatment differences (Lacey, 1956; Libby, Libby, & Lacey, 1972). Although there appears to be a consensus that the ALS is superior to the algebraic change score if the LIV holds (Lubin, Hord, & Johnson, 1964), no agreement exists as to whether and when the LIV represents the true state of affairs (Hord, Johnson, & Lubin, 1964; Johnson & Lubin, 1972).

Spontaneous activity and irregularity of physiological function. While consideration of basal levels is imperative in the assessment of physiological responses to stimulation, the presence of spontaneous, or nonspecific, activity may represent an equally important and at least partially independent factor (Duffy, 1930, 1946; Malmo & Smith, 1955). For the investigator interested in demonstrating the effect of a stimulus complex on the behavior of an individual, the establishment of a steady state is essential (Sidman, 1960). However, in dealing with physiological variables in emotion, there is some debate regarding the extent to which tonic levels are and optimally should be steady. According to Hoskins (1946), one of the foremost adaptive attributes of man is an ability to maintain a steady state in spite of constantly impinging internal and external environmental stresses, and the existence of such a steady state is all the more remarkable in that the organism is composed of "materials that are notable for their instability." On the other hand, since the adaptive merit of some functions requires the meeting of new needs very suddenly, adaptation may not be best served by an invariable pattern (Alexander, 1972).

The idea of defective physiological regulation has been proposed by some in at least partial explanation for the high physiological variability of highly anxious persons and for their response patterns to experimental and, presumably, to life stresses (G.L. Freeman, 1933, 1948; Freeman & Katzoff, 1942; Whitehorn & Richter, 1937; Sainbury, 1955). General response irregularity and spontaneous fluctuations in level are not only found more frequently in neurotic and acute psychotic conditions, they also may be more significant in pathology than the intensity of an emotional response (Malmo, 1959). However, because much of the research reporting variance with other physiological parameters has been "methodologically spotty", Alexander (1972) directs the researcher to more careful investigations of normal subjects.

Whether one employs 'normal' or clinical populations in psychophysiological investigations, it is imperative that subjects be well habituated to the laboratory situation to mitigate the biasing of initial levels. However, differential resting levels of both skeletal and autonomic indices may be a reflection of subjective variables or other individual differences instead of experimental artifact or poor control. Even college students commonly report apprehension on first entering the laboratory (e.g., Watts, 1975), and the mere act of physiological monitoring itself has constituted the experimental stress in experiments distinguishing normal from psychiatric patient groups (e.g., DeWolfe & Youkilis, 1975). The importance of ostensible resting levels and spontaneous activity should not be minimized.

Psychophysiological Reactivity and Anxiety. Most researchers agree that experimental stimuli are central to the psychophysiological study of anxiety. For example, Duffy (1962) suggests that individuals may be characterized by the degee of "low but statistically reliable" generalized and trans-situational muscle tension they exhibit, but that differences occur most readily in response to stimulation (e.g., Davis, Malmo, & Shagass, 1954). Making a distinction between pathological and transient anxiety and restricting his observations to the former, Malmo (1957) noted that experimental stress accentuated differences between anxiety patients and controls. Indeed, Malmo's distinction corresponds in at least one important aspect to Speilberger's (1966) constructs of trait and state anxiety. Because state or transient anxiety may be provoked by some "stress" situations and not by others, it is imperative that the A-Trait measure be congruent with the threatening situation (Shedlestsky & Endler, 1974). Characteristics of stimuli and the temporal sequence of events that result in the evocation of an anxiety response are discussed below.

Emotion Stimuli. Properties of stimuli that evoke emotional responses in humans have been most extensively explored in terms of intensity (Schnierla, 1959), novelty (Hebb, 1948) and their combination (Sokolov, 1963). While the ability of these stimulus characteristics to elicit an emotional response has been amply demonstrated (Lang et al., 1972), emotional behavior clearly is more than the reflexive output of a stimulus array. Stimuli appear to influence physiological responses largely within the context of an individual's present attitude and past experience.

In contrast to most prior work in the area, Lacey and his coworkers (e.g., Lacey, 1959, 1967; Lacey, Kagen, & Moss, 1968; Lacey & Lacey, 1972) have empirically questioned what stimulus characteristics affect what specific parameters of a physiological response system. They have consistently observed "directional fractionation", or the tendency of different components of the autonomic pattern to respond in different directions to the same stimulus (Lacey, 1959, 1967). For example, Libby, Lacey, and Lacey (1972) reported a sympathetic-like pupillary dilation and a parasympathetic-like cardiac deceleration are related to the attention-interest properties of stimuli. Cardiac slowing was also linearly related to a pleasantness dimension, with unpleasant stimuli eliciting the greatest slowing; and pupillary dilation was most in evidence to stimuli midway on the Pleasantness-Evaluation factor and greater to unpleasant than to pleasant stimuli. While the use of pictorial stimuli has been criticized with regard to the pupil data (Janisse, 1973), the heart rate findings were consistent with previous work (Lacey, Kagen, Lacey, & Moss, 1963; Lacey & Lacey, 1970) on "situational stereotypy", a phrase suggesting that different tasks, requiring different modes of interaction with the environment, may elicit different stereotyped response patterns. They postulate that a task requiring close attention to the environment is accompanied by a depressor component whereas "mental work" facilitates an acceleratory and pressor component. This hypothesis has received some support and an interesting elaboration in a recent study by Cacioppo, Sandman, and Walker (1978). Twenty subjects, trained for five days to raise and lower HR by means of a discriminative operant conditioning procedure, were subjected to communications promoting positions with which undergraduates disagreed during raised, lowered, and baseline heart rate trials. Counterarguments and resistance to persuasion were greater during raised heart rate trials than during lowered heart rate trials.

In a study on affective sound, Gang and Teft (1975) explored the stimulus dimensions of familiarity (vs. novelty) and annoyance value in the context of the suggestion by Lacey et al. (1963) that heart rate increases are associated with stimulus "rejection" and heart rate deceleration with stimulus "acceptance" or "attention". Heart rate and measures (MAACL) of anxiety, depression, and hostility (Zuckerman & Lubin, 1965) varied directly with the subjects' familiarity and subjective experience with the acoustic stimulus, a dental drill. The findings not only support Lacey's stimulus acceptance-rejection position, they also reflect a relationship between the mean heart rate increases and the degree of rejection of the environment. Gang and Teft emphasized the importance of cognitive and affective factors in stimulus effect: two stimuli which may appear similar, such as white noise and the sound of a high speed dental drill, can provoke quite different and varied reactions.

The experiential orientations toward a stressor were recently investigated from a different perspective by Barrell and Price (1977). They found that the threat of a very painful electric shock provoked some subjects to confront and others to avoid the stressor and that these attitudes were related to some viseral and somatic responses. A confronting orientation exhibited higher muscle tension (trapezius EMG) when compared to the avoiding orientation, and avoiding was accompanied by higher heart rate when compared to confronting. This latter finding lends further support to the idea that heart rate increase may be associated with stimulus "rejection".

Operationally controlling the possibility of avoiding aversive stimuli, Obrist and his associates (Obrist, Gaebelein, Teller, Langer, Grignolo, Light, & McCubbin, 1978) reported three experiments evaluating beta-adrenergic effects as a function of individual control over stressors. The young adult male subjects exhibited more pronounced beta-adrenergic influences, as indexed by heart rate and carotid dp/dt, under conditions in which they were either lead to believe they had control or where some control was in fact provided as in a shock-avoidance task. Conversely, beta-adrenergic influences were either minimal or short-lived under conditions where no control was possible (cold pressor, pornographic film, inescapable shocks) or conditions which provided ready mastery of the task.

A stressor becomes a threat when it is perceived as such by the individual and only then is it effective in the experimental elicitation of emotional behavior (e.g., Hodges & Spielberger, 1966; Gang & Teft, 1975). The evaluation of psychophysiological reaction to stress also may require attention to differing experiental orientations of approach and avoidance (Barrell & Price, 1977) and whether or not avoidance is possible (Obrist et al., 1978).

Psychophysiological response patterns. It appears that the temporal sequencing of the anxiety-evoking situation itself, as well as stimulus properties, may be of significance in considering the problem of anxiety and psychophysiological reactivity. Malmo (1959) observed that acute schizophrenic and psychoneurotic patients exhibited an intense response and a low degree of adaptation (habituation) to repeated stresses. Indeed, drawing from Cannon's distinction between appetitive and emergency functions of the ANS, Malmo commented that psychiatric patients responded to ordinary life situations as if they were emergencies. Consistent with this picture, Wachtel (1967) described an anxiety patient as keeping constant vigilance, over-attending to small variations in his environment. Lader and Matthews (1968) postulate that the underlying impairment of habituation exhibited by anxious individuals is itself determined by the high tonic level of arousal due to either chronic anxiety or anxiety increased by the experimental situation relative to normals.

Because no theory regarding physiological dysfunction in emotion has accrued consistent empirical support, the term habituation will be used in the following discussion to refer to a diminution of autonomic (or skeletal) response rather than to connote an underlying neural mechanism (e.g., Watts, 1975). It might be argued that the failure of a response to diminish implies the superimposition of sensitization instead of the absence of habituation (Groves & Thompson, 1970). Autonomic and skeletal responses will be reviewed separately.

Studies designed to observe autonomic responses to temporally certain (signal) and uncertain (non-signal) stimuli have yielded data which suggest that anxiety may be related to a less efficient deployment of attention and over-reaction to even moderately intense stimuli. Lader and Wing (1966) noted that anxious subjects exhibited higher basal SC levels, smaller responses to initial stimuli, and markedly slower rates of habituation to repeated presentations of non-signal stimuli. While the tones (100 dB, 100Hz) were clearly within Sokolov's (1963) pre-pain zone, Hart (1974) suggested that the failure to habituate might also produce a defensive response (DR) rather than an orienting response (OR) in the anxious person. He assessed the OR and DR of anxious patients and normal subjects on measures of both SC and HR to three intensities of signal and non-signal tones. Following the suggestion of Graham and Clifton (1966), a decrease in HR was used as an index of an OR, and HR acceleration to denote a DR. Although the anxious patients exhibited more frequent spontaneous SC responses, the two groups differed neither on baseline measure nor in the magnitude or rate of habituation of SC to the tones under both signal and non-signal conditions. Analysis of second by second changes in HR revealed a deficit in OR and a greater tendency to respond with a pattern characteristic of a DR in the anxious subjects, a difference most apparent under signal conditions. In the normal subjects, the only component of response demonstrating habituation was the initial decrease in HR for 50 and 75 dB tones; deceleration on signal trials appeared to be relatively independent of stimulus intensity.

Research on shock and threat of shock also demonstrates the effect of expectation of stimuli on autonomic reactivity and subjective anxiety. After giving subjects experience with the maximal intensity of shock, Bowers (1971) observed an acceleration in HR to a temporally certain shock and a HR decrease to temporally uncertain shock, attributing the latter to the oppositional effects of anxiety involved in anticipation and vigilance for uncertainty removing cues. Watts (1975) measured SC and HR in subjects matched for age, sex, and TMAS scores under threat and control conditions and found that SCL and HR increases in the experimental group were restricted to the period when the shock was thought to be imminent. Subjects under the stress condition expressed greater subjective anxiety in the single posttest rating, and they also appeared to be more attentive to the timing of the stimuli, a set which might be expected to facilitate habituation (Coffey, 1966).

The significance of stimuli and differences in anticipation and habituation related to anxiety is also relevant to measures of the skeletal musculature. In reviewing the literature on learning and muscle activity as measured by electromyography, Goldstein (1972) reported a complex relationship among attentiveness, increased effort and high motivational level, all of which augment MAPs, and cannot in practice be discriminated. The preparatory period and that immediately following a task appear to be of particular importance in the assessment of anxiety.

Anxiety patients frequently report tension, feeling "fidgety" and difficulty in relaxing; indeed, Jacobson (1938) suggested that the latter was responsible for the persistance of the mental state. Reusch and his colleagues (Reusch, Cobb, & Finesinger, 1941; Reusch

& Finesinger, 1943) found that subjects expressing feelings of body tension were unable to relax (as indicated by elevated MAPs of the forearm flexors and extensors) during the intervals between a simple hand exercise. Malmo et al. (1951) observed that the most reliable tensional differences between psychiatric patients and controls were to be found in the preparatory period. Although there were equivalent autonomic anticipatory response in both groups, the patient group exhibited far greater skeletal responsitivity; and the persistance of this greater tension (in the absence of initial differences) characterized the psychoneurotic from other patients. Consistent with Easen's (1959) observation that muscle activity varies with subjective feelings of effort rather than with the degree of applied force, the psychiatric patients in this study (Malmo et al., 1951) required greater arm tension in a rapid discrimination task that did controls. In another, ostensibly less stressful voluntary task, subjects were required to press a button on the tenth beat of a metronome (Davidowitz, Brown-Meyers, Kohn, Welch, & Haynes, 1955). Not only were MAPs greater in the psychiatric patients than in controls before and after responding but elevated MAPs in the inactive arm of the patients during the task also discriminated between the groups. Wing (1969) found greater forearm tension in anxious subjects in anticipation and following but not during a similar task. Martin (1956), conversely, found that EMG levels of patients differed from controls only during stressful interviews. While motor tasks are equivalently novel for all subjects, it may be that psychiatric patients are more familiar with an interview situation and, thus exhibit less anticipation and greater recovery relative to normals in such a context. It appears from these electromyographic studies that anxious individuals may show anticipation, subjective effort, and inability to rest after a task to a greater extent than do normal controls.

Data from investigations on psychophysiological reactivity support the contention that physiological activation cannot be equivalently measured as a unified phenomenon without regard to the specific response and parameter. Additionally, the evidence suggests that the response of significance may vary according to an interaction of the individual and different aspects of the evocative situation.

Relationship Among Physiological Variates

The association among physiological factors will be discussed with reference to response specificity, autonomic balance and the skeletal autonomic relationship.

Response specificity. Psychophysiological research has provided evidence of individual differences in physiological response modality. Goldstein et al. (1964) observed that persons could be distinguished on the basis of a consistent tendency to exhibit an elevated response of either the autonomic nervous system as measured by heart rate and blood pressure or of the skeletal muscular system; and others (Shipman et al., 1970; Kempe, 1956) have attributed differential personality characteristics to the skeletal muscle and autonomic responder. In a different approach to response specificity, Malmo and his colleagues (Malmo & Shagass, 1949a, 1949b; Malmo, Shagass, & Davis, 1950, 1950b) studied the physiological responses of psychiatric patients to painful stimuli: the subjects, who had histories but no recent experience of either cardiovascular or head and neck complaints, were most reactive to stressors in the system associated with their symptoms.

While limiting his observations to the autonomic nervous system, response specificity with regard to both stimuli and individuals has been most extensively studied by J.I. Lacey and co-workers (e.g., Lacey, Bateman, Lacey, & Moss, 1953; Lacey & Lacey, 1958). Evidence for autonomic response stereotypy has accrued from within session investigations using a variety of subjects (adults, children, males and females) and experimental stressors (mental arithmetic, hyperventilation, cold pressor, word association). Trans-situational individual differences both in terms of maximal responsitivity of the same variate and autonomic patterning, as reflected by the hierarchy of responses in standard score form, have been observed. In addition, individuals tend to vary over relatively short periods of time in the degree of response stereotypy they exhibit: "rigid reactors" demonstrate highly consistent response hierarchies while "random reactors" respond to different stimuli with different autonomic patterns. Employing an analysis of covariance, two studies (Engel, 1950; Engel & Bickford, 1961) have confirmed and extended Lacey's findings to demonstrate the coexistence of response patterns specific both to stimuli and individuals.

Autonomic balance. Most viscera are dually innervated by the sympathetic (SNS) and parasympathetic (PNS) nervous systems which are generally assumed to operate in a reciprocal fashion. According to Cannon's legacy, emotional disturbance is accompanied by parasympathetic excitation as well as sympathetic-adrenal (norepinephrine) discharge; and investigations that have measured PNS innervations directly (rather than as reciprocals of sympathetic phenomena) document that cholinergic discharge may occur even in mild states of excitation (Gellhorn, Cortell, & Feldman, 1941). When evaluating autonomic responsitivity in emotion, a distinction between SNS and PNS influence cannot be made with regard to heart rate. Lacey and co-workers (e.g., Libby, Lacey, & Lacey, 1972) have responded to ANS interaction by referring to the responses of effector organs as sympathetic-like and parasympathetic-like.

The complexity of the interaction between adrenergic and cholinergic influences on autonomic responsitivity has been demonstrated in anatomical and physiological research (e.g., Higgins, Vatner & Brauwald, 1973) as well as in psychophysiological studies. Obrist and his colleagues (Obrist, Lawler, Howard, Smithson, Martin, & Manning, 1974; Obrist, Howard, Lawler, Sutterer, Smithson, & Martin, 1972) asserted that sympathetic influences are more unequivocally reflected in heart contractility while heart rate more clearly manifests the vagal or PNS innervation of the heart. At the same time, heart rate will also indicate SNS activity and may be used as a simpler method to evaluate sympathetic influence. It is not, however, a simple index as alterations in vagal tone continually act to modify it. Indeed, a paradoxical increase in heart rate can be elicited by vagal stimulation delivered at particular frequencies and at specific times during the cardiac cycle; the latter phenomenon is not determined by an adrenergic mechanism, since it persists after beta-adrenergic blockage and decentralization of the stellate ganglia (Higgins, et al., 1973).

Although the phenomenon of individual response specificity holds some intriguing possibilities for the understanding of personality differences in emotional behavior and, more specifically, in psychosomatic disorders (Sternbach, 1966), the question of stability requires a careful approach. Oken and colleagues (Oken, Grinker, Heath, Herta, Korchin, Sabshin, & Schwartz, 1962) found that stereotypy, in terms of maximal response and hierarchy, was irreproducible one week later, and Johnson, Hord, and Lubin (1962) observed that one-half of their subjects failed to exhibit a response specificity after a 48 hr. period. Lang et al. (1972) emphasized that, emotion may be more stereotyped than other behaviors, the pertinent response systems are all separately modifiable by experience and by genetically determined development. Consequently, high individual consistency may not be reasonably expected except in psychosomatic disease. They (Lang et al., 1972) further stress that the response patterns associated with both evocative stimuli and individuals are not "blatantly apparent" to the observer: they frequently require sophisticated statistical techniques to detect.

While researchers of emotional behavior must be cognizant of response specificities, caution is warranted in characterizing persons by their physiological reactions and in generalizing from one physiological index to another. The selection of appropriate physiological requires attention to autonomic balance and the somatoautonomic relationship.

Because of the generally low correlation among autonomic measures ("quantitative dissociation"; cf. Lacey, 1967) in response to stimuli, the terms autonomic arousal and autonomic activity as they are typically used in descriptions of anxiety have little meaning unless operationally defined in terms of a certain physiolgoical index. In addition, the extent to which ANS events vary together appears to be influenced by stimulus conditions. For example, Obrist (1963) observed that specificity of autonomic response was reflected in the different patterns of reactions to stimuli considered noxious but unthreatening: these slowed HR and increased blood pressure levels. In a study on heart rate conditioning in a single monkey, Engel and Gottleib (1970) observed that cardiac rate and arterial blood pressure changes varied together during the slowing condition but were unrelated during the speeding condition. They suggest, therefore, that the two functions are mediated through different physiological mediators. In a review of recent theoretical models concerning learned cardiovascular control, Williamson and Blanchard (1979) have suggested that different physiological mechanisms might be involved in HR speeding and slowing. The issue of specificity in conditioning and voluntary control of HR will be discussed in greater detail later.

The skeletal-autonomic relationship. The association between skeletal muscle and autonomic responses is important to an understanding of anxiety from the perspectives of both reactivity and control. Mowrer (1947) posited a two-factor learning theory in which somatic and visceral events were viewed as autonomous processes subject to modification by different learning processes. More current work on emotional behavior has also tended to assume that heart rate changes can become independent from other biological processes in the manner of a spontaneous response. However, Obrist et al. (1970b) contend that data from studies using various paradigms support cardiac-somatic coupling and that, even when reliable cardiac and somatic effects are directionally opposed, this independence does not reflect a biologically substantive relationship. That is, the two kinds of responses have common mediating and integrating mechanisms. Indeed, the neurophysiological literature indicates a linkage relevant to both excitatory (Rushmer, 1962) and inhibitory effects (Lofving, 1961). Evidence has been forwarded suggesting limbic (Kaada, 1960; Lofving, 1961), central-hypothalamic (Rushmer, 1962), and hypothalamic mediation (Abrahams, Hilton, & Zerozyna, 1960). With specific reference to emotional behavior, Gellhorn (1964) points to the "modulating" roles of ANS and muscular events: proprioceptive stimuli (tension or relaxation of the striated muscle) to the posterior hypothalmus prompts sympathetic balance. If the balance of hypothalamic functions are critical to emotional processes facial contraction patterns would lead to efferent discharges via hypothalamic-cortical systems and influence emotion (Also see Schwartz, Fair, Salt, Mandel, & Klerman, 1976). Muscle tension, therefore, may initiate or maintain emotional behavior in the absence of verbal or overt muscle responses.

The following discussion will deal with the somatoautonomic relationship in the contexts of cardiac-somatic coupling under various stimulus conditions and mediation hypotheses in the conditioning of autonomic variates. The measure of heart rate will be emphasized; however, the activities of the vasculature and skin conductance will be mentioned where appropriate.

Obrist et al. (1970b) asserted that the cardiac-somatic linkage reflects a metabolically functional process: the heart must provide blood to working muscles in gross changes and the relationship is necessarily similar in more subtle changes. Indeed, attempts to modify either cardiac or somatic events employing simple and stressful reaction time (RT) paradigms and responses to pressor stimuli have generally involved a concomitant change in the other measures. Obrist et al. (1969) presented data to suggest that decreases in both heart rate and skeletal responses in RT experiments may be peripheral manifestations of a central mechanism involving the inhibition of ongoing task irrelevant behavior. Within subject analyses revealed that the individuals with larger reductions in HR, spontaneous EMG bursts or response frequencies have tended to respond more quickly. This finding is consistent with evidence positing that an orienting response (OR) involving attention to the environment prompts a HR decrease (Graham & Clifton, 1966): according to Obrist et al. (1970b), one way for the organism to prepare is to suspend other activities. While obrist and co-workers have not observed anticipatory increases in skeletal tension in muscle groups associated with the execution of a sensory-motor task, a recent investigation has indicated that HR change varies more reliably with motor effort than stimulus input. Epstein, Boudreu and Kling (1975) noted a significant increase in HR during the preparatory period, with the gradient being steeper on trials when a dynamometer squeeze was anticipated than when it was not. Different approaches to the assessment of somatic activity were used in the two studies making a comparison difficult. However, it seems that the decelerative effect on HR prompted by attention to the environment may be overridden in situations where a specific and strong motor output is expected.

The association of cardiac and skeletal muscle activities has been demonstrated in two different respects during aversive conditioning (Obrist, 1968). Not only do experimental manipulations which induce changes in the direction or magnitude in one effect similarly influence the other, but also reduction in heart rate decrease has been specifically associated with those trials where ongoing somatic events are not reduced within subjects (Obrist, et al. 1970a). However, Obrist et al. (1974) have recently observed an independence of HR and somatic activities (general postural adjustments, chin EMG and vertical eye movements) in situations which were quite stressful. Using an avoidance paradigm to assess sympathetic influences in normal human subjects, they obtained data to suggest an "uncoupling" of cardiac (Hr and contractility) and somatic events under conditions in which the subject had no previous experience with shock and did not know whether it was avoidable. The authors, therefore, include the factor of uncertainty in their description of the intensity of a stressful situation which evokes a beta-adrenergic sympathetic influence on the heart. Results from a study by Jennings and his colleagues (Jennings, Averill, Opton, & Lazarus, 1971) have indicated a less than perfect cardiac-somatic coupling; however, only chin EMG, a measure with very little base level activity in adults, was used to assess motor events.

Physiological responses to conceptual tasks also have pointed to the importance of the cardiac-somatic linkage. The association between cardiovascular and skeletal muscle events may provide a biologically necessary basis, even a triggering mechanism, by which processes not directly related to somatic activities influence cardiac variates. Cohen (1967) presented data which suggests that the cardiovascular response to mental arithmetic is exaggerated beyond metabolic requirements, a finding supported by an earlier study (Brod, Fencl, Hijl, & Jirka, 1959) which reports a pattern of cardiovascular reaction to arithmetic problems similar to hypertension in normal, non-pathological subjects. However, Cohen (1967) also notes that a somatic component (an increase in oxygen consumption in the forearm muscle) is in evidence which could act to initiate the increased cardiac activity. This is consistent with an acceleration in somatic activity as measured by electromyography (e.g., Duffy, 1962) under similar conditions.

The role of the somatoautonomic relationship in the conditioning of autonomic events has long been the occasion for speculation and controversy. Skinner (1938) expressed doubt that ANS responses could be operantly conditioned; and in a 1954 review, Smith proposed that all autonomic conditioning is an artifact of skeletal muscle responding. More recently, the debate has been forwarded by Katkin and Murray (1968) and Crider, Schwartz and Shnidman (1969). Emphasizing alternative explanations of positive findings on the instrumental conditioning of various autonomic responses, Katkin and Murray (1968) suggested that the apparently voluntary control exercised over autonomic activities such as heart rate may not be direct, but linked instead to a mediating voluntary operant. They propose that the subject is actually being reinforced for somatic, verbal, or cognitive activity, and that it is this response that may serve as either a conditioned or unconditioned stimulus for ANS responding.

Miller and Dworkin (1972) have reported the considerable difficulty in replicating studies from their laboratory performed with curarized rats, studies considered to the the "...truly definitive series of experiments establishing the phenomenon of instrumental conditioning of autonomically mediated responses (Katkin, & Murray, 1968, p. 65)." A number of explanations for this failure to replicate have been forwarded, e.g., the usual pharmaceutical supplier of curare changed sources in 1969. In any event, the Miller investigations do not preclude the possibility that both cardiac and somatic events are controlled or initiated by a common mechanism within the CNS. Studies purporting to demonstrate the operant conditioning of autonomic events may be demonstrations that cardiac-somatic processes versus just the cardiac components are subject to reinforcement contingencies (Obrist, et al. 1970b).

Other reports (Lisina, 1965; Rice, 1966) yield conflicting results concerning the nature of the somatoautonomic relationship in learning. However, much of the inconsistency may be related to the selection of autonomic and skeletal muscle events. In human studies there has been little systematic evaluation of the concomitance of operantly modified HR changes and somatic responses other than respiratory activity in which results are mixed (see Katkin & Murray, 1968). Williamson and Blanchard (1979a) have also concluded in their recent review of the literature that the question of potential mediation remains open. They noted, however, that somatic influences seemed to be associated with significant HR changes (primarily HR increases), more closely than any other single factor considered in their extensive review.

While the question of skeletal mediation in the instrumental learning of autonomic response may not be crucial with regard to practical applications, it may be scientifically imperative to determine whether the effect should be framed classical or instrumental conditioning, or both. Not only the conditioning process itself but also its implications for therapeutic effects (Miller, & Dworkin, 1972; Goldstein, 1972; Green, Walters, Greed, & Murphy, 1969) necessitate a more adequate understanding of the autonomic and skeletal components of a response pattern and of their relationship to transfer of training (Miller & Dworkin, 1972). The problem of mediation also requires that attention be focused on the role of cognitive-affective factors in emotion.

Cognitive factors in emotion. The present section will deal with subjective factors both as input variables and as 'personality' disposition variables relevant to the psychophysiological response of anxiety. The question of emotional specificity as it pertains to the relationship of psychological and physiological indices will be reviewed in this context.

Emotional specificity. Verbal accounts of emotion have tended to be at best modestly related to physiological variates. Some of this apparent dissociation may be attributed to the use of self-report instruments that are incongruent with the experimental situation and the selection of a single physiological mode and parameter to assess activation. However, data from studies which induce arousal and manipulated set (e.g., Schachter & Singer, 1962; Lazarus, 1967, pp. 151-169) have provided examples of the partial independence and interactive nature of these behavioral systems.

Assigning subjects to groups according to drug injection (epinephrine or saline placebo), information (informed, uninformed or misinformed), and set condition (anger or euphoria), Schachter and

Singer found a distribution of self-reported affect which suggested the influence of two components in emotion: (a) an undifferentiated state of physiological arousal and (b) the availability of cognitive labels to elicit behavior along particular emotional lines. The association of higher pulse rates which greater subjective emotion in all groups lends support to their specific assertion that a person "labels, interprets, and identifies this stirred up state in terms of the characteristics of the precipitating situation and one's apperceptive mass" (Schachter & Singer, 1962, p. 398).

Schachter, and Singer's two-factor theory is consistent with two-component approaches to activation (i.e., intensity and valence) such as that outlined by Duffy (1962) and the obvious fact that a high degree of sympathetic-like arousal can accompany physical exercise without report of emotional change. However, this consistency is not necessarily equivalent to strong support. Even though epinephrine may elicit an undifferentiated arousal open to varying emotional contexts, specific physiological states also may be more likely to produce one kind of emotional behavior than another (Lang, et al. 1972). 1972).

Like Schachter, Lazarus (1967, pp. 151-169) has pointed to the integral role of cognitive factors in emotion. Employing stressful stimuli (films of operation and injury) rather than drugs to illicit an emotional response, he observed attenuation of both autonomic arousal (SC) and self-reported anxiety in subjects who heard sound tracks encouraging "denial" or "intellectualization" of the frightening events. However, the phenomenon was not conclusively demonstrated, and Lazarus suggested that the effects of such covertly administered sets interact with personality and temperament characteristics.

The question of emotional specificity probably has been extended furtherest by D.G. Graham (1962) in her statement that every attitude may be associated with a potentially discernable pattern of physiological responses. Although investigations of emotional behavior under conditions of hypnosis initially appeared to offer intriguing possibilities, more recent and adequately controlled studies have required caution in interpreting results (Lang, et al., 1972). For example, in contrast to the close and specific relationship between physiological and psychological variables demonstrated by Graham and his colleagues (Graham, Stern, & Winokin, 1958), Hilgard and his associates (Hilgard, Morgan, Lange, Lenox, McDond, Marshall, & Sachs, 1974) recently have shown that the response systems may be separately modifiable under hypnosis. Subjects exhibited an increase in heart rate on the application of a sufficiently cold (0° - 5°C) pressor test; and there was a significant difference in HR following hypnotic induction with suggestion of analgesia. However, the decrease in HR was not related to a reduction in felt pain. Thirdly, HR acceleration during hallucinated pain in highly hypnotizable subjects did not differ from the rise recorded during normal waking or hypnotically analgesic conditions. A physiolgical indicator can be correlated with subjectively felt pain under given experimental conditions; but that correlation may be negated, for example, when subjective pain is reduced through suggestion. Additionally, anxious or tense behavior anticipatory to the stress, or to the pain itself, may elicit HR increases apart from any direct influence of the stimulus. Hilgard et al. (1974) argue, in concordance with Hilgard's (1973) "neo-dissociation" theory, that the motivational-emotional aspects of pain are more modifiable than sensory-discriminary components.

Within this body of literature, diverse paradigms were used to explore the question of emotion and the role of cognition. Some studies (e.g., Schachter & Singer, 1962; Lazarus, 1967) induced physiological arousal and manipulated set in order to observe the interaction while others (e.g., Graham, et al., 1958) induced emotional attitude and observed physiological changes. The combination of both manipulations was illustrated by the Hilgard, et al. (1974) study. The degree of emotional specificity in physiology and the relative impact of cognitive factors observed seem to be substantially influenced by experimental design.

Perception of stimuli. The observation of physiological responses exhibited by individuals with apparently diverse cognitive-affective orientations to the environment represents another approach to the assessment of the psychophysiology of emotion. The personality dimensions of locus of control (Rotter, 1954, 1966) and perceptual field dependence (Witkin & Oltman, 1967) have been related to different aspects of the anxiety response. Although measures of these constructs have failed to significantly correlate in some studies (Feather, 1967), the two are conceptually consistent to the extent that both field dependent and externally-controlled individuals rely to a greater extent upon environment to provide them with cues regarding their behavior than do field independent and internally-controlled persons.

In addition to the previously discussed research (Smith, 1973; Matus, 1974) associating locus of control and field dependence to resting levels of frontalis and forearm extensor tension, respectively, there is correlational evidence that both personality measures are related to anxiety. Investigations have reported the significant association of Rotter's I-E Scale with the TMAS (Ray & Katahn, 1965) and with self-reported debilitating anxiety and neurotic symptoms (Feather, 1967). The nature of the relationship of locus of control to anxiety, however, is unclear: the question of whether the belief in external control precipitates anxiety or whether anxiety facilitates a belief in external control remains unanswered.

Dale and Eagen (1975) investigated the relationship among field dependence, manifest anxiety (TMAS), and coronary proneness (Boitner, 1967) in the large group of college students. The latter measure is based on Friedman and Roseman's (1973) description of Type A behavior. Although results were nonsignificant for females, field dependence was found to significantly correlate with anxiety and field independence with coronary proneness for males. No association was observed between anxiety and coronary proneness. Therefore, the authors concluded that perceptual mode, specifically the dimension of field dependence-independence, accounted for a significant proportion of variance in an individual's selection of a mode of anxiety.

Other studies on perceptual field dependence suggested that field independent persons not only possess greater body articulation (Silverman, Cohen, Shmavonian, & Greenberg, 1961) but also are better able to control their psychophysiological reactivity under condition of sensory (Cohen, Silverman, & Shmavonian, 1963) and social isolation (Zuckerman, 1968). Two investigations (Escalona & Heider, 1959; Dyck, Witkin, & Oltman, 1967) have reported that differences noted in the four to 32-month period of life seemed predictive of the degree of field dependence in the six to eight year period. Infants later assessed as field independent exhibited moderate levels of body activity with predominantly low levels of muscle tension. Field dependent children, on the other hand, had demonstrated extremely high or low activity levels and were often tense, with the latter being the more striking difference. Employing a number of measures other than field dependence, Shipman, et al. (1970) observed an increase in both heart rate and muscle tension during white noise in "...environmentally oriented, socially dependent...stimulus bound (persons) lacking internal reference points" (p. 364).

Investigations of psychophysiological reactivity in emotion have employed various designs, means of eliciting arousal and ways of providing cognitive-affective labels. Although emotional stimuli appear to exert some differential effect according to their objective characteristics, it seems clear that stress reactions may vary as a function of cognitive-affective factors. Taken as a whole, this research points to a complex interaction among the physiology and psychology of the individual and the particular context in which he responds.

Therapy and control. The roles of physiological arousal and control in the psychologically defined responses of anxiety and stress-perception long have been subjects of considerable controversy. Positions vary greatly in the way the interrelationships among the three expressive systems in emotion -- cognitive-verbal, physiological and overt motor -- are viewed. In a psychotherapeutic context, the association among these behavioral components becomes particularly important: it determines which factors are the appropriate targets for modification.

Although therapies of anxiety-related problems frequently have focused on altering a single response system, there is only qualified evidence that meaningful generalization occurs. In J.I. Lacey's (1962) review on the interpretation of psychotherapy data, he cautions against "simple faith" in an uncomplicated association between physiological and psychological variables. A reduction in indices of physiological tension does not necessarily correspond to a decrease in subjective tension, and vice-versa. On the contrary, research previously discussed in the present review suggests that psychophysiological responses may be specific to the individual, the situation and/or to variates within behavioral systems. The following section will emphasize therapy and control of anxiety with regard to the relaxation response, the reciprocal inhibition hypothesis, physiological learning, and the comparison of treatment techniques.

<u>The relaxation response</u>. The relaxation response has been referred to by Hess (1957) as a "protective mechanism against overstress belonging to the trophotropic-endophylactic system and promoting restorative processes" (p. 40). It is generally believed to represent a reduction in sympathetic, or emergency, responses and perhaps also an increase in parasympathetic activity (Benson, Beary, & Carol, 1974). However, because of multiple response system involvement and the fact that no foci relate to particular individual isolated responses such as in the cortical motor zone (Hess, 1957), a diversity of opinion exists regarding the most effective use of input variables to induce a relaxed state.

On the grounds of their available neurophysiological evidence, Jacobson postulated in 1938 that decreased muscle activity should facilitate reduced sympathetic activity through a centrally mediated feedback system. This is broadly consistent with Gellhorn's (1967) view that the principal effect of muscle relaxation is on autonomic balance: shift from ergotropic (posterior hypothalamic) activity to trophotropic (anterior hypothalamic) dominance is assumed to inhibit the sympathetic arousal system. However, Jacobson's (1938) progressive relaxation (PR), a method for acquiring increased discriminative control over skeletal muscles until one is able to induce very low levels of tonus in major groups, results in general lowering of sympathetic activity instead of precisely prompting a particular response or pattern (Lang, et al., 1972). Describing a different approach to the same end, Luthe (1969) defined autogenic therapy (AT) as self-induced modification of corticodiencephalic interrelationships which facilitate the activation of trophotropic activity in lower brain centers. The six autogenic exercises emphasize "passive concentration" (Luthe, 1972) and have resulted in both decreased heart rate and muscle tension (Luthe, 1969). Progressive relaxation and autogenic training have been used in the treatment of various anxiety-related complaints on the assumption the autonomic level changes are central to reduced subjective tension.

Reciprocal Inhibition. The importance of ANS activity to anxiety control has perhaps been most extended by Wolpe (1958, 1963, 1971). He (Wolpe, 1963) has stated that "...there is reason to think that most neuroses are primarily conditioned habits of autonomic response (p. 23)." Following Jacobson's (1938) position and viewing anxiety as a response characterized by high levels of muscle tension and sympathetic arousal, Wolpe (1958) proposed that skeletal muscle tension could thus be expected to be incompatible with, or to reciprocally inhibit, anxiety. He specifically anticipated reduced SNS activity to accompany the successful use of voluntary muscle relaxation in the presence of stress-producing fear stimuli (1958, pp. 72-73, 135). The counterconditioning program, systematic desensitization, prescribes a hierarchical scaling of anxiety-evoking stimuli and is aimed at the modification of particular stimulus-response associations (Wolpe, 1958, 1971).

Although Wolpe's procedure has received impressive clinical support, recent investigations manipulating either anxiety or muscle tension level, or both, have yielded little evidence for a simple version of the reciprocal inhibition hypothesis. Wilson and Wilson (1970), dividing male subjects among three anxiety levels and three muscle tension conditions, expected that muscle relaxation instruction preceding a stressful paired-assocate learning task would improve learning in the high anxious subjects by decreasing debilitating reactivity to the learning situation. However, they found that the learning of muscle tension subjects excelled that of subjects in the muscle relaxation condition regardless of anxiety level and, further, that high and medium anxious subjects did not differ in learning efficiency, both being significantly superior to low anxious subjects. The data seemed to suggest, as well, that the physiological "coping" response to stress may vary among individuals according to their anxiety level: the learning of high anxious subjects was superior in the induced muscle relaxation condition. Supporting this is evidence presented by Grim (1971) in an investigation studying the effect of self-induced muscle tension and relaxation aided by auditory feedback of breath sounds on anxiety level. Grim found that masseter tension increased low initial anxiety as measured by a self-report inventory and lowered high initial anxiety. Although respiration feedback decreased anxiety at all but the lowest levels, Grim noted that tensing, in addition to relaxation, should be explored as an anxiety-reducing technique for highly anxious subjects in desensitization therapy.

In a series of investigations on the voluntary control of tension headaches, Otis and Pike (1975) arrived at similarly unorthdox findings regarding the value of tensing. The subjects in their initial experiments were expected to receive trapezius EMG feedback under instructions to raise, rest and lower muscle tension. However, due to a "fluke" in the computer, the individuals received feedback only during instructions to increase their muscle tension. Because most subjects significantly reduced their headaches and maintained this control in a one-year follow-up the autors suggested that the magnitude of physiological activity is a less important factor than response effects. They noted the inadvertant similarity between Jacobson's PR and their procedure and advanced the position that relief of tension upon returning to baseline represents a more reinforcing event than lowering from baseline. This is consistent with Engel's (1960) finding that instructions to both raise and lower HR are helpful in aiding patients to control cardiac arrythmias.

Results from a recent study (Conner, 1974) on the autonomic effects of brief relaxation training also have pointed to a more limited role of level change in anxiety control than would be predicated by the reciprocal inhibition hypothesis. Although the muscle relaxation group did not differ from the music controls in either verbal report of anxiety or autonomic level following training, they exhibited significantly greater HR during cue-training and significantly decreased HR response to two mild anxiety conditions (heat-threat and aversive tone). A similar "cross-over" phenomenon has been reported in a desensitization study (Wolpe & Flood, 1970), and Connor (1974) suggested that establishing an efferent relaxation response requires cognitive activity, which is related to cardiac acceleration (Lacey, 1967). A number of studies (Grossberg & Wilson, 1968; Matthews & Gelder, 1969; Edelman, 1971; Sue, 1972) have reported results that are inconsistent with anxiety being characterized by an increase in physiological activity. Current theoretical psoitions (e.g., Lang, 1969; Matthews, 1971; Goldfried, 1971) acknowledge both the cognitive aspects of anxiety and relaxation and the active response modification that occurs in desensitization.

Accordingly, Leitenberg and his associates (Leitenber, Agras, Bunz, & Wincae, 1971) argued that physiologically defined anxiety need not be inhibited first in order to modify phobic behaviors and that reduced anxiety may sometimes be a consequence rather than a cause of behavioral change. Noting an absence of any correlation between self-rating on a scale of fears and actual avoidance of harmless snakes, Lang (1968) stated that "we should apply specific techniques to the different behavioral systems that we are trying to alter-verbal, overt-motor and somatic (p. 93)." In this context, Becker and Costello (1975) reported that subject controlled graduated exposure with feedback of exposure times resulted in significantly less avoidance behavior in snake-phobic persons. A change in reported fear lagged behind a change in avoidance behavior. Leitenberg and co-workers (Leitenberg, Agras, Allen, Butz, & Edwards, 1975) studied the effects of precise feedback of performance in a "reinforced practice" treatment paradigm. They observed that information regarding exposure time to phobic situations dramatically increased the rate of performance over the earlier experimental phase of contingent therapist praise. In yet another approach to the modification of phobias, Reeves and Mealia (1975) explored the utility of cue-controlled relaxation (Cautella, 1966) in the context of replacing unadaptive, neurotic self-verbalizations with "coping" statements (Meichenbaum, 1973). They found the combination of relaxation training using EMG feedback and the pairing of a self-generated cue work ("relax") with low levels of muscle tension to be effective in the treatment of subjects with a fear of flying. Lick (1975) has pointed out the importance of controlling for placebo effects in desensitization studies: unless a control manipulation prompted the same expectancy for gain as the active treatment, it is not appropriate for cognitive and other nonspecific influences.

Cognitive factors, particularly those pertaining to dimensions of self-mastery, appear to be crucial to an understanding of anxiety-related problems in the therapeutic context. Rotter's I-E Scale successfully predicted 11 of 13 tension headache cases of who would continue (I's) and who would drop out (E's) of the biofeedback centered therapy (Otis & Pike, 1975). Davison and Valins (1969) presented data suggesting that behavioral gains construed by a person as attributable to external forces, such as a drug, would transfer to a lesser extent beyond treatment than changes due to one's own efforts.

The weight of the evidence reviewed in this section supports the idea that the response systems in anxiety can be separately modified and that the behaviors of significance may vary as an interaction of individual and situational variables. Pelletier (1975) stressed the inextricable interaction of mind, body and environment; and Hukill (1975) contended that the "essence" of all therapy may be a re-learning of the psyche-soma dichotomy. An integrative or multimodal approach (Lazarus, 1973; Schwartz et al., 1978) to the therapy and control of anxiety seems imperative. The following section will review physiological learning and control and its relation to cognitive-affective variables.

Physiological learning and control. Thus far in the present paper, dimensions of physiological control in anxiety largely have referred to exaggerated anticipatory responses and reactions to stress, a failure to adapt or habituate to stimuli and greater response irregularity. Both the heart rate response (HRR) (Gunn et al., 1972) and that of the skeletal musculature (EMG) (Goldstein, 1972) have been compared to a reflex because of their instaneous, involuntary occurrence following a sudden stimulus and their ability to undergo classical conditioning. Although the reflexive characteristics will continue to be relevant, the focus of the current section will be on the voluntary control of heart rate and EMG responses and individual differences according to cognitive-affective variables. The relatively recent advent of biofeedback, a technique which provide the individual with information regarding his physiological activities via an amplified index, has brought the issues of awareness, instructional set and other cognitive factors into the area of operant control of physiological variates.

Early studies on the operant control of heart rate in humans demonstrated that individuals could slow (Engel & Hanson, 1966) and attain bi-directional control (Brener & Hothersall, 1966, 1967) of their heart rate without being informed of the contingencies. In fact, the subjects in the slowing investigation (Engel & Hanson, 1966) who correctly guessed that they were to modify heart rate performed less well than those who could not articulate knowledge of the relevant response; but, because HR responds to cognitive activity with acceleration (Lacey, 1967), the presumably more inquisitive subjects simply may have been expending too much effort. More recent evidence in the field of biofeedback has suggested that instructional set may be a critically important factor in voluntary control of heart rate (Bergman & Johnson, 1972; Williamson & Blanchard, 1979) and frontalis tension (Otis & Pike, 1975). Donelson (1966) observed that HR changes in either direction occurred more readily on initial instructions, and Engel (1972) has noted that brief exposure may be useful in aiding subjects to select an effective, if previously learned, repertoire for HR change. Bell and Schwartz (1975) presented data from subjective reports of cognitive maneuvers which supported such a "behavioral repertoire" hypothesis. Furthermore, Schwartz (1972) has suggested that feedback may play a significant role in what particular patterns are voluntarily controlled: the idea that muscle tension and heart rate are concomitant reflections of a specific cognitive or affective state cannot be excluded (Bell & Schwartz, 1975).

Individuals vary, however, in perceptual mode (Witkin & Oltman, 1967), locus of control (Rotter, 1954) and the degree to which they express awareness of changes in physiological responses (Mandler, Mandler and Uviller, 1958). These differences in the way that individuals differ on the dimension of environmental perception have been related to the voluntary control of HR. Mandler et al. (1958) developed the Autonomic Perception Questionnaire (APQ) on the basis that high APQ scorers overestimate their autonomic reactions while low APQ scorers underestimate ANS activity; and they have found that the APQ correlates positively with the TMAS (Taylor, 1954) measure of trait anxiety. Bergman and Johnson (1971) found that individuals scoring in the middle range of the APQ displayed greater bidrectional control of HR than those with low or high APQ scores. They were able to repeat a demonstration of this difference only under HR speeding conditions in a replication reported in the same study. However, other investigators (Blanchard, Young, & McLeod, 1972; Rayter & Sandler, 1975) have reported results similar to Bergman and Johnson's initial findings in the voluntary raising and lowering of HR under externalized feedback conditions.

Employing a different approach to perception of autonomic activity, Sirota, Shapiro and Schwartz (1975) dichotomized subjects according to a pre-experimental questionnaire designed to assess awareness of cardiovascular changes during anxiety or fear situations. Subjects received analogue meter feedback and monetary bonuses during

15 sec. trial periods for raising and lowering HR: four of five trials were followed by shock stimulation of the forearms of the subjects. Heart rate differed significantly under the three conditions; however, marked changes in the perceived intensity of shock associated in direction to HR occurred only for the subjects evaluated as "cardiac-aware". The authors suggested that this finding supports the notion that individuals can be trained to control anxiety and/or pain through the voluntary control of emotionally relevant physiological functions.

The relation of locus of control (Rotter, 1954, 1966) and perceptual mode (Witkin & Oltman, 1967) to psychological and physiological indices of anxiety have been discussed in a previous section of this review. Studies on voluntary heart rate control have demonstrated the effect of both locus of control (Fotopoulous, 1970; Ray, 1974) and perceptual mode (Dale & Anderson, 1975). In an investigation of HR increase, Fotopoulous (1970) found that the control of Internals exceeded that of Externals under both simple instruction and oscilloscope feedback conditions. The additional information/reinforcement of an Experimenter-operated signal buzzer was required for the Externals to attain a similar level of performance. Ray's (1974) study of bidirectional HR control yielded results supportive of the Fotopoulous (1970) finding that Internals were better able to increase HR than Externals. However, Externals proved to be significantly more proficient at decreasing heart rate than Internals. This strong interaction effect between locus of control and conditioning of HR direction suggests that the hypothesis of Internal superiority in skilled learning cannot be simply extended to the control of physiological responses. Self-reported strategies in the Ray (1974) study suggested that Externals tend to rely on the external environment for a frame of reference and Internals attempt to exert cognitive control. According to the notion of situational stereotype (Lacey, 1967; Libby et al., 1972), these strategies may be psychophysiologically associated with the differential success of Internals and Externals on heart rate increase and decrease tasks. Dale and Anderson (1975) found that field independent individuals were superior in HR control under conditions of speeding, slowing and maintaining an average heart rate. Unlike the Fotopoulous study in which additional information aided the performance of Externals, Dale and Anderson found no evidence for a relationship between the amount of feedback available and voluntary control of the cardiovascular system. The investigations differed, however, in the kind of additional information received by subjects, with the former (Fotopoulous, 1970) being an Experimenter-operated indicator of "success" and the latter (Dale & Anderson, 1975) being simultaneous sensory feedback regarding muscle tension.

In addition to the bidirectional continuum, voluntary control of heart rate has been explored with regard to HR variability. Irregularity of cardiac and other physiological responses appear to have particular relevance to anxiety; Lang and his associates (Lang, Strofe, & Hasting, 1967) have found that subjects are able to control HR variability with accurate visual feedback but not if they receive misleading information regarding performance. In this context, McFarland and Combs (1974) have explored the relationships among anxiety (TMAS), amount of feedback, and HR control. Subjects in the medium-anxious range were better able to control (synchronization of HR with clicks adjusted to resting rate) their heart rate variability than those in the high-anxious group. The highly anxious individuals actually performed more successfully during the rest than test periods. Furthermore, correlations between heart rate control scores on the one hand and resting HR and HR changes on the other are negative for low-anxious subjects but positive for those in the high-anxious group. The authors suggested that very anxious or very unanxious persons, like high and low autonomic perceivers, have poor contact with cardiac feedback.

Cardiac variability, therefore, bears a complex relationship both to anxiety and to the ability to raise and lower heart rate. As in other studies assessing anxiety by the TMAS (McFarland & Combs, 1974) and by ratings of patient anxiety (Zuckerman, Persky, & Curtis, 1968), Stephans and associates (Stephans, Harris, Brady, & Shaffer, 1975) found that anxiety (MMPI) was unassociated with resting HR level. However, anxiety in the latter study was negatively correlated with ability to increase and decrease HR and with resting HR variability, a finding supported by Wilson and Dykman (1960) using MMPI-assessed anxiety. Stephans and associates also observed a positive association between HR variability and bidirectional cardiac control the ability to raise and lower HR also being positively correlated. They speculated that in physiological learning, as in general operant conditioning, it is easier to increase the frequency of an already present response than to produce a new one.

Even though cumulative data from psychophysiological research supports the strong, if complex, relation of anxiety to heightened autonomic responsivity and to reduced control, the association between reactivity and voluntary control per se has received little exploration in an emotional context (Lang et al., 1972). However, in contrast to the nonspecific activity notion of physiological variability, Bell and Schwartz (1975) have recently approached heart rate response from a situational perspective. In-laboratory heart rates were obtained during "Lacey-type' accelerative (mental arithmetic and alphabet) and decelerative (tones and lights) tasks (Lacey et al., 1963), and during prefeedback, feedback and postfeedback phases of bidirectional cardiac control. Self-reported out-of-laboratory pulse rates were gathered during a prescribed variety of ordinary activities, including the experimental cognitive task, over two days. They found that the in-lab accelerative tasks bracketed the upper levels of heart rate variability but the 'reactivity-down' tasks reduced HR to levels no lower than a number of other daily conditions. While both experimental reactivity conditions produced significant HR changes from pretask levels, neither the increase nor decrease in cardiac rate reliably predicted control performance across subjects. However, the authors noted an inverse association between reactivity and control within subjects: the more pronounced the HR response to the accelerative task relative to resting level, the more successfully subjects decreased their HR under postfeedback "down" instructions. This finding, together with the previously discussed "crossover" effect (Connor, 1974) and the inverse relation between resting HR variability and bidirectional control Stephans et al., 1975), suggest that cardiac variability can have adaptive aspects.

of the cardiovascular system, are also of interest in the contexts of physiological learning and therapeutic control. Various terms, such as "differentiation", "decoupling" and "dissociation", have been advanced to describe the relationship between heart rate and blood pressure when changes in one index were statistically reliable while changes in the other were not (Fey & Lindholm, 1975). Schwartz, (1972) has defined "differentiation" as changes of two variables in opposite directions. Several studies (Stephans et al., 1975; Brener & Kleinman, 1970; Shapiro et al., 1969) have demonstrated that decreases in heart rate occur with reductions in blood pressure. Investigating the modification of heart rate and blood pressure, Shapiro, Schwartz and Tursky (1972) have found that individuals are able to control each variate without concomitant changes in the other when feedback is concurrently contingent on both, and a stronger association was observed between changes in heart rate and diastolic pressure than between heart rate changes and systolic pressure. However, in a controlled study, Fey and Lindholm (1975) recently have observed that heart rate speeded and slowed in normotensive groups receiving contingent visual feedback for increases and decreases in systolic blood pressure. They contended that the absence of statistical significance in previous studies cannot be used to argue the absence of a relationship. Furthemore, Fey and Lindholm buttress their position with the suggestion that differentiation may be more likely with increases in blood pressure and heart rate given the physically inactive experimental environment than decreases or no changes relative to baseline.

Reports supporting a general activiation factor in the context of control of a specific autonomic or skeletal tension index are quite

Other factors pertaining to the voluntary control of heart rate are potentially relevant to an understanding of psychophysiological behaviors in anxiety. These include the questions of different mechanisms being involved in cardiac speeding and slowing, respiratory mediation, and the extent to which HR covaries with other indices such as blood pressure and the skeletal musculature. Employing subjects uninformed of the target behavior, Engel and Hansen (1966) contend that reinforcement per se is not sufficient to lower heart rate; and Gatchel (1974) observed no systematic association between the frequency of feedback and HR slowing performance. Although fully instructed subjects were able to increase but not decrease HR before feedback, Bell and Schwartz (1975) noted that the addition of full meter feedback aided the subjects to both raise and lower HR relative to resting levels. Performance in the bidirectional control remained constant and transferred to the postfeedback condition. Lang and Twentyman (1974), investigating two procedures for cardiac control, found that while no difference was demonstrated for HR slowing, analogue feedback prompted significantly greater HR acceleration than a binary method. They also observed a significant trials effect for the acquisition of HR slowing which was not characteristic of HR speeding: slowing was accompanied by a marked rebound during time-out periods. Changes mediated by feedback, however, were sustained on instruction although at a somewhat reduced level.

Dichotomizing subjects by median split into groups of good and poor bidirectional heart rate controllers, Blankstein (1975) observed differential strategies during periods in which they were to raise and lower HR. The groups increased their respiration rates equally during

HR increase trials and did not differ in perceived control during decrease trials, Good controllers, however, slowed their respiration rates (RR) during attempts to lower HR while poor controllers increased their RR slightly. The more accomplished subjects also reported feeling more tense and more aware of control during the HR increase trials, but they did not report reeling more relaxed HR decrease trials. Using subjects who were aware only that feedback was contingent on some aspect of their internal behavior, Brener and Hothersall (1966) observed that the association between HR and respiratory changes was not substantial, but they presented data suggesting that changes in the two indices are generally in the same direction.

As discussed earlier, Obrist et al. (1970) speculated that cardiac speeding is facilitated by a central coupling of somatic and autonomic events. If somatic-autonomic coupling holds for heart rate slowing as well as speeding, it then can be argued that the smaller, and presumably more difficult, slowing change is a viseral representation of the problem many subjects experience substantially decreasing muscle tonus levels (Lang & Twentyman, 1974). At the same time, evidence has accrued which requires a consideration of the notion that heart rate increases and decreases involve different mechanisms: for example, cardiac speeding and slowing are unconditioned responses to different psychological stimuli (Lacey, 1967). Learned cardiovascular response, therefore, it perhaps more appropriately construed as a complex, skilled learning task rather than as the conditioning of simple, unidimensional behavior (Williamson & Blanchard, 1979a).

The relationships among autonomic measures, particularly those divergent. In a study of a small group of hypertensives in which feedback was contingent on decreases in systolic blood pressure, Goldman and co-workers (Goldman, Kleinman, Snow, Bidus, & Korol, 1975) found that decreases in systolic and diastolic blood pressure were associated with improvement on a category test but neither appeared to be related to mean heart rate or integrated frontalis EMG. On the other hand, reductions in both blood pressures have been observed to a greater degree during frontalis EMG and relaxation training than during control conditions (Montgomery, Love, & Moeller, 1974). With regard to muscle tonus levels, Nidever (1959) and Balsan (1962) indicated that skeletal tension in both men and women is concentrated about the limb musculature with only the muscles of head and neck appearing to be unrelated. In contrast, a number of more recent investigations (Bydzynski & Stoyva, 1969; Raskin, Johnson, & Rondestvedt, 1973; Budzynski, Stoyva, & Adler, 1970; and Davis, Saunders, Creer, & Chai, 1973) have reported that subjects trained to lower frontalis EMG levels perceived deep muscle relaxation generalized to other muscles of the body, especially the upper body and head musculature. Otis and Pike (1975) observed that feedback mediated reduction in trapezius tension seems to generalize to other muscle groups in the cephalic regions but not to muscles of the appendates.

In specifically testing the assumption that conditioning of one muscle to relax will generalize to other muscle groups, Alexander (1973) found that the subjects who were most successful in reducing frontalis EMG exhibited greater tension in forearm EMG over sessions than those who manifested less lowering. In a recent study from the same laboratory (Alexander, White, & Wallace, 1977), normal adult subjects received forearm feedback training followed by frontalis training and vice-versa for a second group. Two control groups initially relaxed on their own and then were administered either frontalis or forearm feedback training. Although all groups produced significant EMG reductions, the groups did not differ from each other nor did training in one muscle seem to facilitate training in the other. Indeed Grim (1971) suggested that "...attending to proprioceptive stimuli, which is probably necessary in the preliminary phase of learning to relax, particularly a single muscle, may cause a tensing increase in other muscles (p. 16)." Specificity of the skeletal muscle response not only has been demonstrated with regard to individual differences in reactivity (Shipman et al., 1970; Goldstein, Grinker, & Heath, 1964) but also in control (Alexander, 1973; Jacobson, 1967).

The relationship of EMG levels to subjective evaluations of relaxation is particularly important from the therapeutic perspective of physiological learning. Positive, if statistically nonsignificant, correlations between self-reported relaxation and frontalis EMG levels have been found for progressively relaxed subjects (Lader & Matthews, 1971), and similar trends also have been observed between reductions in frontalis tension and trait anxiety (STAI) for subjects trained under an auditory eyes-closed condition (Alexander, French, & Goodman, 1975.). Data recently advanced by Shevidy and Kleinman (1977) indicated that normal subjects' estimates of subjective tension increased above baseline during increases in frontalis EMG activity but did not significantly change during reductions in frontalis EMG. Although the finding of a sex difference pointed to an interaction effect, results from another controlled study indicated that feedback-mediated decreases in frontalis level were unrelated to decreases in subjective units of tension (Mehearg & Eschette, 1975).

Cumulative evidence from diverse camps in the field of physiological learning generally argue against the existence of a general activation factor -- one which dictates concomitant changes between various physiological indices and between physiological and psychological variables. However, in recent comparison reviews concerning learned cardiovascular responses, Williamson and Blanchard (1979a, b) concluded that the related issues of mediation and specificity are only beginning to be addressed. They outlined a conceptualization of the mediation issue that may be useful in the integration of specificity vs. general activation models. Rather than adopt the assumption that one peripheral response is causally related to another, they suggested the premise that cognitive, somatic and autonomic responses are mediated at a higher neural level. The mediation issue in physiological learning then involves the idea that individuals may initially elicit some sort of generalized response but that, as training proceeds, the diminution or elimination of "surplus behaviors" will occur with specificity. Although its nature remains obscure, efforts to maximize therapeutic influence must take the interaction between physiological modalities, cognitive-affective variables, and situational factors into consideration. The following section will discuss research in which various approaches to psychophysiological control are compared.

Comparison of treatment studies. The efficacy of biofeedback as a therapeutic technique has been extensively investigated with persons suffering from tension headache and, to a lesser degree, migraine headache. The headache, however, is by no means an uncommon affliction. In an epidemological study, Waters and O'Connor (1971) have found 78.7% of the more than three thousand adult women surveyed reported headaches over the previous year, with the incidence decreasing with age. Of these, the investigators estimated the frequency of migraine headache, as opposed to muscle-contraction ('psychogenic' or 'tension') headache, at 19% using three criteria (unilateral, preceded by warning, accompanied by nausea). A number of studies (Budynski & Stoyva, 1973; Sargeant, Green, & Walters, 1973; Wichramaskara, 1973) have shown that EMG assisted feedback is a productive mode in the reduction of tension headache. However, this research, "confirms the efficacy of the combination of biofeedback and home practice in relaxation; their designs do not make it possible to isolate the effects of biofeedback alone (Blanchard, Young, & Jackson, 1974; p. 578)." Several recent investigations have compared the effectiveness of verbal relaxation instructions to that of EMG feedback in the treatment of tension headache. Cox, Freundlich and Meyer (1975) found virtually identical results and treatment trends for the two procedures, with both being superior to a medication placebo on all measures except a shift to internality. Similarly, Otis and Turner (1975) observed that relaxation training was as effective as trapezius EMG feedback training in tension headache reduction, but neither method proved useful for persons suffering from combined tension-migraine. A somewhat different conclusion, however, has been reached by Hutchings, Morgret and Reinking (1975) in their comparison of verbal relaxation instructions (Wolpe-Jacobson), EMG frontalis training, and a combination of the two techniques. While all three methods were productive, the feedback and combined treatments proved superior to relaxation training without EMG assistance.

Although some well-controlled feedback studies (e.g., Budzynski, Stoyva, & Adler, 1974) appear to demonstrate that tension headache reduction cannot be attributed to change over time or to simple therapist contact, others have questioned the role of EMG feedback per se in headache treatment. For example, Otis and Pike (1975) have found that trapezius EMG levels during headache episodes do not differ from resting levels during non-headache periods, with the former sometimes being even lower. The phenomenon of self-monitoring has provoked both problems and potential for research on tension and anxiety related complaints. Waters and O'Connor (1971) noted evidence that progressively fewer headache episodes were reported during the six months that diaries were kept, resulting in a selective dropout from their epidemiological study. Similarly, Otis and Pike (1975) found that their particularly careful pre-experimental self-monitoring schedule -- the recording of headache presence or absence and intensity every two hours -- left them with no subjects. A six-week follow-up on the pre-empted subjects found a considerable drop in headache density, with most individuals remaining headache free, in spite of no change occurring between pre- and postexperimental EMG levels. The authors suggested that what subjects learn in a feedback session or when the two-hour timer rings is "to get in touch with themselves", to gain control by interrupting internal dialogue. Support for this notion accrues from studies integrating self-monitoring with relaxation training (Tasto & Hinkle, 1973), with EMG feedback (Reeves, 1975), and with a combination of autogenic and feedback training (Pearse, Walters, Sargeant & Meers, 1975). Thus, while there is qualified evidence that high EMG levels in the frontalis and/or trapezius are related to tension headache, other data confirm the necessity to integrate physiological and cognitive-affective factors in treatment.

Studies comparing therapeutic methods for the treatment of anxious individuals also demonstrate the less than perfect association between physiological indices and affective states. Two recent investigations have found that anxiety patients (Kondo, Canter, & Knott, 1975) and psychiatric patients reporting chronically elevated levels of tension (Breeden, Bean, Scandreet, & Kondo, 1975) learned to lower frontalis EMG more successfully with feedback training but reported greater relief from anxiety after progressive relaxation. Using anxious inpatients, Townsend, House and Addario (1975) have compared EMG frontalis feedback training, supplemented by daily self-practice in progressive relaxation, with a structured group psychotherapy treatment addressed specifically to the anxiety problems. A significantly greater number of relaxation subjects than group therapy participants met improvement criteria defined as a decrease of 20% or more in at least two of the following: a reduction in state anxiety (STAI), trait anxiety (STAI), or total mood disturbance (POMS). However, the relaxation group had had reported greater, if statistically nonsignificant, A-State and A-Trait; and the improved scores of feedback subjects were virtually identical to those of the group therapy subjects. This is particularly important in light of the fact that pretest state anxiety (STAI) is the single best predictor of probable anxiety reduction across a variety of subjects including psychiatric patients, college and high school students (Scopp, 1975).

Other investigators have explored the relative efficacy of various relaxation methods with transcendental meditation (TM), a technique emphasizing passive concentration on a meaningless single syllable sound or "mantra", on patients to yield inconsistent results. In a series of uncontrolled studies, Wallace (1970) has observed that TM provokes a slowing of heart rate and respiration and an increase in galvanic skin response (GSR). Glueck and Stroebel (1975) reported the most consistent physiological finding in their study of psychiatric patients to be a universal increase in GSR up to 30% above baseline during TM (Wallace reported GSR increases as high as 400%). Due to high attrition in autogenic and EEG alpha feedback training groups, Glueck and Stroebel selected "comparison twins" from among other inpatients in order to assess potential gains made by TM subjects, and the latter showed greater improvement than all hospital discharges. The authors also compared TM with a similar relaxation technique developed by Benson, et al. (1974) in which muscle relaxation was emphasized and the word "one" substituted for a mantra and found TM the more effective in promoting alpha-wave density. However, evidence from a study using normal subjects has shown that while marked physiological changes (heart rate, frontalis tension and occipital alpha) occur in individuals simply asked to relax, subjects practicing TM do not demonstrate significant changes in these indices (Travis, Kondo, & Knott, 1975). In a controlled study employing a muscle relaxation technique "maximally similar" to TM as well as a no-treatment group, Buroff and Schwarz (1978) reported that TM subjects did not differ from control on behavioral measures of trait anxiety. The undergraduates exposed to TM did, however, report a steady decrease in subjective trait anxiety (S-R Inventory summed across situations, Endler et al., 1962) over the nine week treatment period while the other groups remained unchanged.

It appears then, that transcendental meditation may be useful for eliciting relaxation, but there is no convincing evidence that it is superior to any of the other pedestrian techniques. While TM theoretically has therapeutic potential for the treatment of anxiety-related problems, Glueck and Stroebel note that researchers in the area are thwarted by the "rather considerable mystery" surrounding the mantra maintained by the Maharishi and his followers.

Several recent investigations (e.g. Scopp, 1975; Haynes, Moseley, & McGowan, 1974; Staples, Coursey, & Smith, 1975; Beiman, Israel, & Johnson, 1978; Jordan & Schallow, 1975; Sime & Degood, 1977), have explored the complex relationship between physiolgoical and subjective indices of anxiety and relaxation using various methods and large subject groups. In a study assessing changes in cognitive-affective variables, Scoop (1975) compared the efficacy of four treatments -- a modified progressive relaxation technique, breathing exercises adapted from yoga, a combination of the two or "full-treatment", and a control of lectures on relaxation -- with groups of psychiatric patients, college and high school students. He found significant decreases in both state and trait anxiety (STAI) for subjects in the three experimental conditions and a reliable increase in the control group, with no change score differences among the three samples and no treatment by sample interactions. In addition, reductions in mean A-State and A-Trait scores for the full-treatment group were approximately equal to the sum of the

A-State scores for the relaxation and breathing groups, a finding which Scopp (1975) suggests lends support to the Lazarus (1973) multi-modal approach to relaxation therapy. Haynes et al. (1974) found that frontalis EMG feedback was superior to "passive" (Wolpe, 1969) and "active" (Jacobson, 1970) verbal relaxation instructions, false feedback, and a simple control condition in lowering frontalis EMG below baseline. Results indicated that individuals with high manifest anxiety (TMAS) exhibited greater resting frontalis tension and did not decrease this arousal index to a level as low as persons with lower TMAS scores. At the same time, feedback and verbal relaxation instructions in this single session study were equally effective in reducing subjective anxiety (TMAS). Comparing progressive relaxation, EMG feedback and autogenic training, Staples et al. (1975) analogously found that only the feedback procedure lowered frontalis tension across sessions although differences in posture, actual practice time, and a mitigated auto-suggestive component may account for this finding. They emphasized, however, that all three methods produced reliable relaxation with sessions and a decrease in measures of state anxiety (MAACL, TMAS) across sessions. Not only was progressive relaxation equivalent in EMG data where feedback subjects whould have a distinct advantage, but the progressively relaxed individuals expressed a greater understanding of the relaxed state.

The relative effectiveness of EMG feedback and progressive relaxation training in producing psychological and physiological relaxation has been investigated by Jordan and Schallow (1975) in the context of individual differences in locus of control (Rotter, 1966).

Although interpretation of EMG data was difficult because of initial differences among treatment and control groups, results indicated that only Internals in both training procedures were able to significantly decrease frontalis tension over trials as did progressively relaxed Externals. In addition, while all three groups reliably reduced MAPs from baseline to treatment, only Internals in the two training procedures were able to maintain a level of relaxation in posttreatment significantly lower than baseline. Results from posttreatment ratings of affect variables supported the importance of both cognitive orientation and training procedure in the psychophysiological assessment of relaxation. While no affect differences attributable to locus of control emerged in the control condition, Internals in both treatment procedures experessed greater subjective relaxation and less tension than Externals, with progressively relaxed Internals also rating themselves as significantly less anxious than Externals in the same condition. The interaction among cognitive, physiological and affective variates is further illustrated by correlational evidence between indices of frontalis tensions and postexperimental subjective ratings by treatment group. Measures of baseline, treatment and posttreatment frontalis levels were related significantly to self-reported relaxation and anxiety in the progressive relaxation group; and the posttreatment frontalis level of feedback subjects was reliably associated with subjective ratings of relaxation and tension. However, while EMG change scores were not related to posttreatment affect in the progressive relaxation subjects, frontalis tension reduction in the feedback group was significantly correlated with both anxiety and relaxation. It may be that feedback instructions (i.e., a decrease in tonal frequency denotes a lowering of frontalis tension) provide the subjects with an extrinsic indication of muscle activity relating more closely to change than level. In addition, a lowered tone suggests task success which may disclose why EMG level in feedback subjects is associated with relaxation and tension while EMG change is correlated with relaxation and anxiety. Individual differences in physiological response modality and subjective assessment of emotions (relaxation and anxiety did not significantly correlate for Internals across all treatment conditions) also are indicated. The fact that neither frontalis level nor change scores were associated with self-reported affect in the control group, however, may be at lease partially explained by the strategy questionnaire finding that subjects in the two training procedures "thought more about muscle activity" than control subjects.

The notion that EMG feedback enhances awareness of muscular tension has found support in a recent study by Sime and DeGood (1977). They found that EMG activity from the frontalis muscle was decreased significantly by both EMG feedback and progressive muscle relaxation but not by the music control. However, the only significant correlations between pre- and posttraining EMG level and awareness of tension were exhibited for the EMG feedback group and for the combination of the two treatment groups.

The effects of live vs. audiotaped verbal relaxation instructions, EMG feedback, and self-relaxation on autonomic (HR, GSR) arousal, somatic (respiration rate, EMG) arousal and subjective tension (MAACL) were investigated by Beiman, Israel and Johnson (1978).

The forty self-referred male and female subjects attended five training sessions. The live relaxation instructions were found to be superior to the taped instructions in the reduction of physiological arousal but not on subjective tension. The self-relaxation subjects and EMG feedback subjects exhibited significant reductions in somatic and subjective tension with no difference between the groups. Interestingly, the self-relaxation subjects demonstrated greater reductions in autonomic arousal than did the EMG feedback subjects. The general ability of subjects to decrease HR without the facilitation of training procedures has been demonstrated elsewhere on both normal subjects (Ray & Lamb, 1974) and psychiatric patients (Rupert & Holmes, 1978). On the posttraining control, all groups were able to significantly reduce muscle and subjective tension when requested, with no difference among the groups. Live progressive relaxation, however, was the only procedure to be associated with subject control over the frequency of electrodermal response (GSR). The authors suggested that this differential patterning might be indicative of the other groups "trying to relax".

Although very little experimental data is available (Boef & Hurrell, 1975; Kinsman, O'Bannion, Robinson & Staudenmayer, 1975), the consideration of transfer of training is essential to an evaluation of relaxation procedures in relation to treatment of anxiety. It has been pointed out that client attitudes toward procedures are significant for both motivational and therapeutic reasons (Devine & Fernald, 1973) and belief in the technique may well be a critically important factor in the elicitation of the relaxation response in particular (Benson et al., 1974). With regard to comparison studies, two investigations (Staples, et al., 1975; Jordan & Schallow, 1975) have reported that subjects preferred progressive relaxation to feedback training, and another (Glueck & Stroebel, 1975) suggested that transcendental meditation motivates persons more successfully than either EEG-alpha feedback or autogenic training to continue practice. Whatmore (1975), however, advanced a physiology of relearning position which requires that effective and lasting relaxation training must produce a sustained restoration of previously signal-erroring circuitry to normal and not just placebo effects.

In her recent review, Tarler-Benlolo (1978) outlined the difficulties in evaluating studies which compare relaxation procedure: number of subjects, matching of subjects, control groups, number of training sessions, delivery of instructions (live vs. taped), home practice, tests for generalization, and follow-up data. Deliberately not including an assessment of cognitive-affective variables, she concluded that the results of most of the studies indicated that verbal relaxation and biofeedback (EMG) seemed to be equally effective in producing positive results. When one also considers the subjective element in anxiety response, the weight of the evidence points to the importance of interactionism between the individual and situation as well as between physiological and cognitive-affective factors.

Appendix B

APPENDIX B-1

SUBJECT QUESTIONNAIRE

Subject No. _____ Date____________

Age _____ Time of Day_____

Because this research project involves the monitoring of physiological measures, the following personal information is needed. Please complete as accurately as possible. Confidentiality will be maintained.

1. Have you had any coffee and/or tea during the last 2 hours? Yes____ No____
   If so, approximately how many cups? ______

2. Have you had any coffee and/or tea during the last 24 hours? Yes____ No____
   If so, approximately how many cups? ______

3. Have you smoked any cigarettes duirng the last 2 hours? Yes____ No____
   If so, how many? _____

4. Have you smoked any cigarettes during the last 24 hours? Yes____ No____
   If so, how many? _____

5. Have you ever suffered from a cardiovascular disorder? Yes____ No____
   If so, please explain

6. Are you currently taking a prescription drug? Yes____ No____
   If so, please not the kind of drug and approximate time of the last dose.

7. Have you taken a nonprescription drug (other than coffee/tea during the last 24 hours? Yes____ No____

8. Are you currently taking the birth control pill? Yes____ No____
   If not, approximately what day of the menstrual cycle are you now in? Counting Day 1 as the first day of the cycle, 1-3____ 4-6____ 7-9____ 10-12____

   13-15____ 16=18____ 19-21____ 22-24____ 25-27____ 28-31 and over____

APPENDIX B-2

INVENTORY OF ATTITUDES TOWARD GENERAL SITUATIONS

Subject No. _____ Date_______________

This inventory represents a means of studying people's reactions to and attitudes towards various types of General situations. On the following pages are represented five general kinds of situations which most people have encountered. For each of these general kinds of situations certain common types of persaonl reactions and feelings are listed. Indicate in the alternatives, representing the five points on the scale shown in this booklet, the degree to which you would show these reactions and feelings in the situations indicated.

Here is an example:

"You are getting ready to start the day"

Feel uncomfortable	1	2	3	4	5	
	Not at all					Very comfortable

If you feel very uncomfortable in this situation you would circle alternative 5 (see A below); if you feel somewhat uncomfortable you would circle either alternative 2, 3, or 4 depending on how uncomfortable; if in this situation you do not feel uncomfortable at all, you would circle alternative 1 (see B below).

If you have no questions, please turn to the items on the following pages.

EXAMPLES:	A	1	2	3	4	5
	B	1	2	3	4	5

"YOU ARE IN SITUATIONS INVOLVING INTERACTION WITH OTHER PEOPLE"

(We are primarily interested in your reactions in General to those situations that involve interacting with other people. This includes situations that involve friends, family acquaintances, strangers, etc.)

Circle one of the five alternatives for each of the following 15 items.

		1	2	3	4	5
1.	Seek experiences like this	1 Very much	2	3	4	5 Not at all
2.	Feel upset	1 Not at all	2	3	4	5 Very upset
3.	Perspire	1 Not at all	2	3	4	5 Very much
4.	Feel relaxed	1 Very relaxed	2	3	4	5 Not at all
5.	Have an "uneasy feeling"	1 Not at all	2	3	4	5 Very much
6.	Look forward to these situations	1 Very much	2	3	4	5 Not at all
7.	Get fluttering feeling in stomach	1 Not at all	2	3	4	5 Very much
8.	Feel comfortable	1 Very comfortable	2	3	4	5 Not at all
9.	Feel tense	1 Not at all	2	3	4	5 Very tense
10.	Enjoy these situations	1 Very much	2	3	4	5 Not at all
11.	Heart beats faster	1 Not at all	2	3	4	5 Much faster
12.	Feel secure	1 Very secure	2	3	4	5 Not at all
13.	Feel anxious	1 Not at all	2	3	4	5 Very anxious
14.	Feel self-confident	1 Very much	2	3	4	5 Not at all
15.	Feel nervous	1 Not al all	2	3	4	5 Very nervous

"YOU ARE IN SITUATION WHERE YOU ARE ABOUT TO OR MAY ENCOUNTER PHYSICAL DANGER'

(We are primarily interested in your reactions in General to those situations that involve dealing with potentially dangerous things or objects.)

Circle one of the five alternatives for each of the following 15 items.

16. Seek experiences like this	1 Very much	2	3	4	5	5 Not at all
17. Feel upset	1 Not at all	2	3	4	5 Very upset	
18. Perspire	1 Not at all	2	3	4	5 Very much	
19. Feel relaxed	1 Very relaxed	2	3	4	5 Not at all	
20. Have an "uneasy feeling"	1 Not at all	2	3	4	5 Very much	
21. Look forward to these situations	1 Very much	2	3	4	5 Not at all	
22. Get fluttering feeling in stomach	1 Not at all	2	3	4	5 Very much	
23. Feel comfortable	1 Very comfortable	2	3	4	5 Not at all	
24. Feel tense	1 Not at all	2	3	4	5 Very tense	
25. Enjoy these situations	1 Very much	2	3	4	5 Not at all	
26. Heart beats faster	1 Not at all	2	3	4	5 Much faster	
27. Fee secure	1 Very secure	2	3	4	5 Not at all	
28. Feel anxious	1 Not at all	2	3	4	5 Very anxious	
29. Feel self-confident	1 Very much	2	3	4	5 Not at all	
30. Feel nervous	1 Not at all	2	3	4	5 Very nervous	

"YOU ARE IN A NEW OR STRANGE SITUATION"

(We are primarily interested in your reaction in General to novel or unfamiliar situations, including those where you are uncertain as to waht to expect. These may involve either people or objects or both.)

Circle one of the five alternatives for each of the following 15 items.

		1	2	3	4	5
31.	Seek experiences like this	1 Very much	2	3	4	5 Not at all
32.	Feel upset	1 Not at all	2	3	4	5 Very upset
33.	Perspire	1 Not at all	2	3	4	5 Very much
34.	Feel relaxed	1 Very relaxed	2	3	4	5 Not at all
35.	Have an "uneasy feeling:	1 Not at all	2	3	4	5 Very much
36.	Look forward to these situations	1 Very much	2	3	4	5 Not at all
37.	Get fluttering feeling in stomach	1 Not at all	2	3	4	5 Very much
38.	Feel comfortable	1 Very comfortable	2	3	4	5 Not at all
39.	Feel tense	1 Not at all	2	3	4	5 Very tense
40.	Enjoy these situations	1 Very much	2	3	4	5 Not at all
41.	Heart beats faster	1 Not at all	2	3	4	5 Much faster
42.	Feel secure	1 Very secure	2	3	4	5 Not at all
43.	Feel anxious	ot 1 Not at all	2	3	4	5 Very anxious
44.	Feel self-confident	1 Very much	2	3	4	5 Not at all
45.	Feel nervous	1 Not at all	2	3	4	5 Very nervous

"YOU ARE INVOLVED IN YOUR DAILY ROUTINES"

(We are primarily interested in your reactions in General to those situations that you usually and typically encounter in your daily life. That is, how do you generally or typically or usually feel.)

Circle one of the five alternatives for each of the following 15 items.

		1	2	3	4	5
46.	Seek experiences like this	1 Very much	2	3	4	5 Not at all
47.	Feel upset	1 Not at all	2	3	4	5 Very upset
48.	Perspire	1 Not at all	2	3	4	5 Very much
49.	Feel relaxed	1 Very relaxed	2	3	4	5 Not at all
50.	Have an "uneasy feeling"	1 Not at all	2	3	4	5 Veru much
51.	Look forward to these situations	1 Very much	2	3	4	5 Not at all
52.	Get fluttering feeling in stomach	1 Not at all	2	3	4	5 Very much
53.	Feel comfortable	1 Very comfortable	2	3	4	5 Not at all
54.	Feel tense	1 Not at all	2	3	4	5 Very tense
55.	Enjoy these situations	1 Very much	2	3	4	5 Not at all
56.	Heart beats faster	1 Not at all	2	3	4	5 Much faster
57.	Feel secure	1 Very secure	2	3	4	5 Not at all
58.	Feel anxious	1 Not at all	2	3	4	5 Very anxious
59.	Feel self-confident	1 Very much	2	3	4	5 Not at all
60.	Feel nervous	1 Not at all	2	3	4	5 Very nervous

"YOU ARE IN SITUATIONS WHERE YOU ARE BEING EVALUATED BY OTHER PEOPLE"

(We are primarily interested in your reactions in General to those situations where you are being evaluated or observed by other people. This includes situations at work, school, in sports, social situations, etc.)

Circle one of the five alternatives for each of the following 15 items.

		1	2	3	4	5
61.	Seek experience like this	1 Very much	2	3	4	5 Not at all
62.	Feel upset	1 Not at all	2	3	4	5 Very upset
63.	Perspire	1 Not at all	2	3	4	5 Very much
64.	Feel relaxed	1 Very relaxed	2	3	4	5 Not at all
65.	Have an "uneasy feeling"	1 Not at all	2	3	4	5 Very much
66.	Look forward to these situations	1 Very much	2	3	4	5 Not at all
67.	Get fluttering feeling in stomach	1 Not at all	2	3	4	5 Very much
68.	Feel comfortabel	1 Very comfortable	2	3	4	5 Not at all
69.	Feel tense	1 Not at all	2	3	4	5 Very tense
70.	Enjoy these situations	1 Very much	2	3	4	5 Not at all
71.	Heart beats faster	1 Not at all	2	3	4	5 Much faster
72.	Feel secure	1 Very secure	2	3	4	5 Not at all
73.	Feel anxious	1 Not at all	2	3	4	5 Very anxious
74.	Feel self-confident	1 Very much	2	3	4	5 Not at all
75.	Feel nervous	1 Not at all	2	3	4	5 Very nervous

APPENDIX B-3

State-Trait Anxiety Inventory[1,2] (STAI)

A number of statements which people have used to describe themselves appear below. Read each statement and then circle the appropriate number to indicate how you feel <u>right now</u>, that is, at this moment. A ONE indicates not at all, a TWO, somewhat, a THREE, moderately and FOUR means very much so.

There are no right or wrong answers. Do not spend too much time on any one statement.

1.	I feel calm	1	2	3	4
2.	I feel secure	1	2	3	4
3.	I am tense	1	2	3	4
4.	I am regretful	1	2	3	4
5.	I feel at ease	1	2	3	4
6.	I feel upset	1	2	3	4
7.	I am presently worried over possible misfortunes	1	2	3	4
8.	I feel rested	1	2	3	4
9.	I feel anxious	1	2	3	4
10.	I feel comfortable	1	2	3	4
11.	I feel self-confident	1	2	3	4
12.	I feel nervous	1	2	3	4
13.	I am jittery	1	2	3	4
14.	I feel "high strung"	1	2	3	4
15.	I am relaxed	1	2	3	4
16.	I feel content	1	2	3	4
17.	I am worried	1	2	3	4
18.	I feel over-excited and "rattled	1	2	3	4
19.	I feel joyful	1	2	3	4
20.	I feel pleasant	1	2	3	4

[1] (Spielberger, 1970)

[2] Referred to as "Self-Evalution Questionnaire" on subject form.

APPENDIX B-3, Cont.

Read each statement below and circle the appropriate number to indicat how you generally feel.

There are no right or wrong answers. Do not spend too much time on any one statement.

1.	I feel pleasant	1	2	3	4
2.	I tire quickly	1	2	3	4
3.	I feel like crying	1	2	3	4
4.	I wish I could be as happy as others seem to be	1	2	3	4
5.	I am losing out on things because I can't make up my mind soon enough	1	2	3	4
6.	I feel rested	1	2	3	4
7.	I am "calm, cool, and collected"	1	2	3	4
8.	I feel that difficulties are piling up so that I can't overcome them.	1	2	3	4
9.	I worry too much over something that really doesn't matter	1	2	3	4
10.	I am happy	1	2	3	4
11.	I am inclined to take things hard	1	2	3	4
12.	I lack self-confidence	1	2	3	4
13.	I feel secure	1	2	3	4
14.	I try to avoid facing a crisis or difficulty	1	2	3	4
15.	I feel blue	1	2	3	4
16.	I am content	1	2	3	4
17.	Some unimportant thought runs through my mind and bothers me	1	2	3	4
18.	I take disappointments so keenly that I can't put them out of my mind	1	2	3	4
19.	I am a steady person	1	2	3	4
20.	I get in a state of tension or turmoil as I think over my recent concerns and interests	1	2	3	4

APPENDIX B-4

Subject Data Sheet for Verbal Responses
Session II - State Anxiety Measure

I. AFTER TEST ANXIETY

1.	I feel calm	1	2	3	4
2.	I am tense	1	2	3	4
3.	I am regretful	1	2	3	4
4.	I am worried	1	2	3	4
5.	I feel anxious	1	2	3	4
6.	I am relaxed	1	2	3	4
7.	I feel pleasant	1	2	3	4

II. AFTER THREAT OF SHOCK

1.	I feel calm	1	2	3	4
2.	I am tense	1	2	3	4
3.	I am regretful	1	2	3	4
4.	I am worried	1	2	3	4
5.	I feel anxious	1	2	3	4
6.	I am relaxed	1	2	3	4
7.	I feel pleasant	1	2	3	4

III. PRE-TREATMENT

1.	I feel calm	1	2	3	4
2.	I am tense	1	2	3	4
3.	I am regretful	1	2	3	4
4.	I am worried	1	2	3	4
5.	I feel anxious	1	2	3	4
6.	I am relaxed	1	2	3	4
7.	I feel pleasant	1	2	3	4

IV. POST-TREATMENT

1.	I feel calm	1	2	3	4
2.	I am tense	1	2	3	4
3.	I am regretful	1	2	3	4
4.	I am worried	1	2	3	4
5.	I feel anxious	1	2	3	4
6.	I am relaxed	1	2	3	4
7.	I feel pleasant	1	2	3	4

V. AFTER TEST ANXIETY

1.	I feel calm	1	2	3	4
2.	I am tense	1	2	3	4
3.	I am regretful	1	2	3	4
4.	I am worried	1	2	3	4
5.	I feel anxious	1	2	3	4
6.	I am relaxed	1	2	3	4
7.	I feel pleasant	1	2	3	4

VI. AFTER THREAT OF SHOCK

1.	I feel calm	1	2	3	4
2.	I am tense	1	2	3	4
3.	I am regretful	1	2	3	4
4.	I am worried	1	2	3	4
5.	I feel anxious	1	2	3	4
6.	I am relaxed	1	2	3	4
7.	I feel pleasant	1	2	3	4

SCORE I.

SCORE II.

SCORE III.

SCORE IV.

SCORE V.

SCORE VI.

NOTE; The item "I am worried" is phrased "I am presently worrying over possible misfortunes" in the tape-recording.

Analogue Stress Presentation Order

A_____ B_____

Appendix C

APPENDIX C-1

EMG-Feedback Instructions

In a moment, a biofeedback procedure will begin. The tone you will hear will provide you with information, or feedback, regarding the level of your forehead muscle tension. That is, the higher your forehead muscle tension is, the higher the tone will be. The lower your muscle tension, the lower the tone. Again, a high tone indicates a high level of muscle tension. The lower the tone, the more physiologically relaxed you are becoming. Your task, then, is to reduce your forehead muscle tension as much as possible, to lower the tone for 25 min. Avoid any unnecessary movement, and avoid closing your eyes for long periods of time. Now, begin. (Onset of tone.)

APPENDIX C-2

Heart Rate Feedback Instructions

In a moment, a biofeedback procedure will begin. Please use your left hand to remove the cover from the instrument on the table in front of you and then resume your reclining position. As you can see, this instrument measures the pulse from the middle finger of your right hand. Your task for the next 25 min. will be to lower your pulse rate as much as possible. The visual information, or feedback, provided by the instrument will be a help to you. The needle moving to the left will indicate a lower pulse rate and greater physiological relaxation. Your task, then, for the next 25 min. will be to lower your pulse rate. Avoid any unnecessary movement and avoid closing your eyes for long periods of time. Now, begin.

APPENDIX C-3

Combined-Feedback Instructions

In a moment, a biofeedback procedure will begin. This task will consist of two activities. First, please use your left hand to remove the cover from the instrument on the table in front of you and then resume your reclining position. As you can see, this instrument measures the pulse from the middle finger of your right hand. The visual information, or feedback, provided by this instrument will be a help to you in your task. One part of your biofeedback task will be to lower your pulse rate as much as possible for 25 min. The needle moving to the left will indicate a lower pulse rate and greater physiological relaxation.

The second part of your task will be to lower your forehead muscle tension as much as possible during this same time. The tone you will hear will provide you with information, or feedback, regarding your forehead muscle tension. That is, the higher your forehead muscle tension is, the higher the tone will be. The lower your muscle tension, the lower the tone. A high tone indicates a high level of muscle tension. The lower the tone, the more physiologically relaxed you are becoming. Now, for 25 min., your task will be to both lower the tone and lower your pulse rate. Avoid any unnecessary movement, and avoid closing your eyes for long periods of time. Now, begin. (Onset of tone.)

APPENDIX C-4

Progressive Relaxation Instructions

In a moment, progressive relaxation instructions will begin. These are verbal instructions designed to assist you in attaining a state of deep relaxation. Please listen to each direction and follow the instructions. They will now begin.

Assume a comfortable position; and, for a moment, pay attention to the feelings throughout your body. If you feel particularly tense in any part of your body, try to relax it. Now, attend to your breathing for a few moments. (Pause) Now, tense your left leg and tense for five seconds - 1, 2, 3, 4, 5. Release. Feel the contrast between the tension and relaxation in your leg muscles. Attend to this feeling for a moment. (Pause) Now, repeat. Tense your left leg for five seconds - 1, 2, 3, 4, 5. Release. Note the feeling of warmth and heaviness in your relaxed leg. Let the feeling extend to the entire left side of your body. Notice your breathing, making it smooth and regular. Now, lift your left arm from the chair and make a fist. Hold your tightened arm for five seconds - 1, 2, 3, 4, 5. Let it drop. Attend to the differences between tension and relaxation. Notice the feeling of warmth, of heaviness. Now, repeat the tightening of your left arm - 1, 2, 3, 4, 5. Let it drop. Pay attention to the feelings in this relaxed arm for a moment. Again, let the feelings extend to the left side of your body. Your breathing is becoming deeper, more regular. Your body is beginning to feel warmer, heavier. How, tense your right leg and hold five seconds. (Pause) Now, release. Again, feel the contrast between tension and relaxation. Let the feelings extend over your entire body. It is a feeling of warmth, heaviness.

Your breathing is becoming deeper, more regular, deeper and more regular. Repeat the tension in your right leg and hold - 1, 2, 3, 4, 5. Release. Attend to the feeling of warmth and heaviness throughout your body. (Pause) Now, tense your right arm without disturbing the measuring device on your hand - 1, 2, 3, 4, 5. Relax. Attend to to contrast between tension and relaxation in these muscles. (Pause) Now, repeat, tensing your right arm for five seconds. (Pause) Let the feelings of relaxation, warmth, and heaviness extend over your entire body. (Pause) Again, attend to your breathing. It is becoming deeper and more regular. (Pause) Now, tense your stomach muscles as tightly as possible and hold for five seconds. (Pause) Now, release. Pay attention to the differences in these muscles. (Pause) Again, tighten thse stomach muscles and hold. (Pause) Release. Let the feelings of relaxation extend over your body. You are feeling warmer, heavier. (Pause) Now, tighten your chest muscles - 1, 2, 3, 4, 5. Relax. Attend to your breathing. You are breathing more slowly. Your breathing is becoming deeper, more regular. (Pause) Again, tighten your chest muscles. (Pause) Relax. Attend to your breathing -- slow and regular. You are breathing more deeply and evenly. (Pause) Now, tense your forehead muscles and hold. (Pause) Relax. Let the feeling of relaxation extend over the muscles of your face. Make your forehead smooth, as smooth as the surface of a calm lake. (Pause) Now, again, tense your forehead muscles and hold for five seconds. (Pause) Relax. Again, let the feeling of relaxation extend over the muscles of your face. (Pause) Now, tense your jaw muscles tightly and hold for five seconds - 1, 2, 3, 4, 5. Now, release. Again, let the feelings of relaxation and warmth extend over the muscles of your face. (Pause) You are becoming very calm. You are breathing deeply and evenly, deeply and evenly. (Pause) Let the feelings of relaxation, warmth, and heaviness now begin at your toes and slowly move throughout your body. (Pause) Now, it is beginning at your fingers, slowly extending to your arms and your entire body. (Pause) The muscles of your shoulders and neck are becoming very relaxed, warmer, heavier. The feeling of relaxation is moving to your face. Your face is calm, smooth. You're feeling very relaxed. Your breathing is smoother, quieter. (Pause) Now, remain in this relaxed state for the next few moments.

APPENDIX C-5

False Feedback Instructions

In a moment, a biofeedback procedure will begin. The tone you will hear will provide you with information, or feedback, regarding the leve of your physiological activity. That is, the higher your physiological activity is, the higher the tone will be. The lower your physiological activity, the lower the tone. Again, a high tone indicates high physiological activity. The lower the tone, the more physiologically relaxed you are becoming. Your task, then, is to lower your physiological activity as much as possible, to lower the tone for 25 min. Avoid any unnecessary movement, and avoid closing your eyes for long periods of time. Now begin. (Onset of tone)

APPENDIX C-6

Rest Control Instructions

In a moment, you will be provided with an opportunity to deeply relax for 25 min. Assume a comfortable position, and pay attention to the feelings throughout your body for a few moments. If you feel particularly tense in any part of your body, try to relax it during this period. (Pause) Also, notice your breathing, your inhaling and exhaling, making it as smooth and regular as possible. Avoid any unnecessary movement, and avoid closing your eyes for long periods of time. Now, begin relaxing for 25 min.

Appendix D

APPENDIX D

Postexperimental Questionnaire

Subject No. ____________ Date ____________________

Did you believe that there was an actual possiblity that you would receive a shock during the experiment?

Yes____ No ____

If your subject number began with A, E, or C, please indicate what percentage of time you felt that the tone was actually under your control.

0 10 20 30 40 50 60 70 80 90 100