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Physiological, Cognitive and Motor Assessments of Systematic Desensitization

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To the Graduate Council:

I am submitting herewith a dissertation written by Vey Michael Nordquist entitled "Physiological, Cognitive and Motor Assessments of Systematic Desensitization." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Psychology.

James M. Anker, Major Professor

We have read this dissertation and recommend its acceptance:

Jasper Brener, Robert Wahler, Jack E. Holmes

Accepted for the Council:

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(Original signatures are on file with official student records.)

June 12, 1970

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and recommend its acceptance:

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PHYSIOLOGICAL, COGNITIVE AND MOTOR ASSESSMENTS OF SYSTEMATIC DESENSITIZATION

A Dissertation

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy

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by

Vey Michael Nordquist

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ABSTRACT

Twenty-four snake phobic subjects were randomly assigned to one of four conditions in order to test directly the mechanisms underlying Systematic Desensitization therapy. Only those Ss who were treated with systematic desensitization showed significant reductions in physiological, cognitive and motor estimates of fear. No Treatment Control and Hierarchy-Yoked Ss did not improve on a single measure after treatment. Relaxation-Yoked Ss did report significant decrements in fear after treatment, but their verbal fear decrement was not sustained when proximity to the phobic stimulus was increased. The results supported Wolpe's contention that systematic desensitization operates on the basis of the reciprocal inhibition principle. Reductions in both skeletal-motor and sympathetic measures of fear were found to be closely associated with concomitant reductions in verbal and motor estimates of fear.

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CHAPTER I

INTRODUCTION

Working first with animals (1948) and later with humans (1952; 1954; 1958), Joseph Wolpe developed a treatment technique for the neuroses called systematic desensitization. Guided by Hull's concept of "conditional inhibition" (Hull, 1943) and extrapolating from Sherrington's (1947) notion of "reciprocal inhibition," Wolpe formulated a counterconditioning hypothesis for eliminating maladaptive anxiety. According to this hypothesis, the ability of a stimulus to elicit a fear response will be weakened "If a response antagonistic to anxiety can be made to occur in the presence of anxiety-evoking stimuli so that it is accompanied by a complete or partial suppression of the anxiety response . . . (Wolpe, 1954, p. 205; 1958, p. 71)." Wolpe (1954, p. 205) defined anxiety as "the Autonomic response pattern or patterns that are characteristically part of the organism's response pattern to noxious stimulation . . ." More specifically, he believed that the overt manifestations we most commonly associate with anxiety are mediated primarily by sympathetic activity of the autonomic nervous system. Furthermore, he contended that the sympathetic and parasympathetic divisions of the autonomic nervous system are incompatible, citing evidence in support of this notion (Ax, 1953). Consequently, Wolpe became interested in identifying response patterns in

humans primarily mediated by parasympathetic activity of the autonomic nervous system. If he could present anxiety-evoking stimuli in the presence of a dominant parasympathetic state, he felt the bond between the stimuli and the anxiety would be weakened.

In systematic desensitization, increments of imagined anxiety evoked by the feared stimulus are created in the context of deep relaxation. The patient usually receives six to seven sessions of training in muscle relaxation (Wolpe, 1958). The patient and therapist construct together an "anxiety hierarchy," several scenes based upon a common anxiety theme and ordered from the least to the most disturbing scene. In treatment the patient relaxes and then is instructed to imagine the first scene. Progression up the hierarchy is determined by the patient's ability to remain relaxed. Once he can successfully imagine a scene without reporting any anxiety, he is presented the next scene, and so on, until the hierarchy is completed. Thus the desensitization package is comprised of three operations: (1) training in abbreviated deep muscle relaxation, (2) the identification and ordering of anxiety-eliciting stimuli, and (3) the gradual, hierarchial presentation of anxiety provoking scenes in the client's imagination while he remains in a partial or complete state of muscle relaxation.

The first two operations above are considered of minor

significance by Wolpe (1958). The third operation, the contiguous pairing of anxiety-evoking stimuli and relaxation is considered to be the crucial procedure for reducing anxiety. Through this operation sympathetic activity is felt to be reciprocally inhibited by the continued predominance of parasympathetic activity. Deep muscle relaxation presumably mediates the activity of the parasympathetic branch of the autonomic nervous system.

That systematic desensitization is effective can hardly be questioned. Paul (1969) recently reviewed 75 papers on the application of systematic desensitization therapy by more than 90 different therapists with nearly 1000 different patients. He concludes:

> The findings were overwhelmingly positive, and for the first time in the history of psychological treatments, a specific theraputic package reliably produced measurable benefits for clients across a broad range of distressing problems in which anxiety was of fundamental importance. (p. 159).

Other researchers (e.g., Rachman, 1967; Ullman and Krasner, 1965; Eysenck and Rachman, 1965; Grossberg, 1964) have reached similar conclusions. What is not so terribly clear, however, is how desensitization works. For example, Rachman (1965) conducted an experiment "to explore the effective mechanism contained in the treatment called systematic desensitization based on relaxation (p. 245)." He concluded that "marked reductions in fear were obtained only in the desensitization with relaxation group" and that "the combined effects of relaxation and desensitization are essential to theraputic

progress. Neither relaxation nor desensitization are effective in their own right (p. 245)." In a later review of the literature (Rachman, 1967) he reached essentially the same conclusion.

Davison (1968) also set out to "test directly the hypothesis that Systematic Desensitization involves a genuine counterconditioning process (p. 3)." Four groups (Systematic Desensitization, Pseudo Systematic Desensitization, No Relaxation, No Treatment Control) were matched on the strength of their snake avoidance scores. The Pseudo Systematic Desensitization group was identical to the Systematic Desensitization group except that the content of the imagined hierarchy consisted of 26 snake-irrelevant items drawn from common childhood experiences. Both groups received appropriate rationale. The exposure (no relaxation) group was also identical to the Systematic Desensitization group, except these Ss never received training in deep muscle relaxation. The pseudo-desensitization and no relaxation Ss were each yoked to a matched Systematic Desensitization S whose progress determined (1) the number of treatment sessions, (2) the duration of each session, (3) the number of stimulus exposures per session and (4) the duration of each exposure. Criterion measures were a Behavioral Approach Test (Lang and Lazovik, 1963) and a ten point self-rated scale of fear. After treatment, Systematic Desensitization Ss showed significantly more snake-approach behavior than Ss in either the Pseudo-Systematic Desensitization groups ($p < .01$), Exposure groups ($p < .005$) or the

No-Treatment Control group ($p. < .01$). The last three groups did not differ significantly on any measure. Only Ss in the Systematic Desensitization group exhibited a decrement in reported anxiety, although not significant. Seven of eight Systematic Desensitization Ss showed significant improvement as compared to one significantly improved S in the Pseudo-Systematic Desensitization group and none in the other two groups.

Davison's work was essentially a more sophisticated replication of earlier studies (i.e., Lazovik and Lang, 1960; Lang and Lazovik, 1963; Lang, Lazovik and Reynolds, 1965) which found similar cause-effect relationships. Although all of these studies, Davison's and Rachman's included, were experimental analogues of the clinical setting, their results favored the reciprocal inhibition hypothesis. That counter-conditioning of sympathetic activity had actually occurred, however, still remained to be demonstrated.

Actually, of the 20 controlled studies reviewed by Paul (1969), only four attempted to get direct measures of physiological activity (i.e., Paul, 1966; Zeisset, 1968; Moore, 1965; Lamont and Edwards, 1967). Moore's findings are open to question since none of his asthmatic patients were able to reduce the number of asthmatic attacks per week after treatment. Zeisset's (1966) results were also confounded by a number of factors (cf., Paul, 1969). Paul (1966) did report pre to post autonomic shifts in the

predicted direction, but he was not interested in analyzing the operational mechanisms in Systematic Desensitization. Rather, he compared the effects of the Systematic Desensitization treatment with a pseudo-treatment and traditional insight treatment.

Lamont and Edwards (1967) matched two groups (Systematic Desensitization and Extinction) of snake phobic Ss on the amounts and sequence of relaxation and tension received during treatment. Like Rachman (1965) and Davison (1968) they too were interested in directly testing the importance of the contiguous pairing of relaxation and anxiety stimulus visualization. They reasoned that if reciprocal inhibition was the basic principle underlying Systematic Desensitization, then Ss who are asked to tense their muscles while imagining the stimulus hierarchy (extinction group) should not show as much fear reduction after treatment as Ss who receive Systematic Desensitization to the same stimulus hierarchy. However, if extinction was the basic principle, the two groups probably would do about the same. Using the Fear Survey Schedule (Lang and Lazovik, 1963), Fear Thermometer (Walk, 1956), Behavioral Approach Test (Lazovik and Lang, 1960), the number of hierarchy items deconditioned, and GSR as their measures of fear, the authors reported the Systematic Desensitization procedure to be significantly better on only one criterion measure (Fear Survey Snake Item). The difference between the two treatment groups on the electrodermal measure

was not significant. Nevertheless, Lamont and Edwards concluded that the results supported the reciprocal inhibition position. It should be noted that actually neither group received standard desensitization. Both groups tensed muscles while visualizing the hierarchy scenes. Ss in the Systematic Desensitization group relaxed their muscles only upon termination of a scene presentation, while the extinction Ss continued to contract their muscles for a prescribed period of time. Differential effects between groups were also obscured by the low number of hierarchy scenes successfully completed (mean SD = 5.27; mean Ext. = 3.45: total possible scenes = 16). The failure to make use of a no-treatment control made cause-effect analysis impossible, and the value of the study is even further in doubt since pre to post measures of change were not significant for either group.

In addition to those studies cited by Paul (1969), a small number of researchers have attempted to relate physiological activity to treatment effects. Kondas (1967); Strahley (1967) and Leon (1968) all used the Palmer Perspiration Test. The test either failed to differentiate treatment effects or proved to be unreliable, as in Leon's (1968) case. Wolpe et al., (1968) has reported preliminary findings which suggest a close correspondence between a patient's verbal report and decrements in autonomic parameters of emotionsl response. No data, however, are supplied to support these findings.

More convincing evidence in support of the reciprocal inhibition principle comes from Paul (1968). He compared the effects of brief relaxation training to hypnotic suggestion and a no-treatment control across four physiological variables (Heart Rate, Respiratory Rate, Tonic Muscle Tension and Skin Conductance) and one cognitive variable (Anxiety Differential). Very impressive results revealed . . . "brief relaxation training to produce subjective and physiological changes in the direction opposite to anxiety, as assumed by the reciprocal inhibition principle from which systematic desensitization was derived (p. 436)." Paul (1968) feels his research meets "A necessary requirement for interpreting the major mode of operation of systematic desensitization as response suppression or modified counterconditioning . . . (p. 436)."

Other researchers, however, have begun to find disfavor with the reciprocal inhibition principle on the grounds that it fails to account for change sometimes observed in "extinction" treatment groups. Rachman (1968), for example, has recently changed from his earlier position, (1965; 1967) stating:

> Although relaxation appears to be a necessary component of systematic desensitization treatment, there does not seem to be convincing evidence that muscular relaxation is necessary (p. 160).

According to Rachman (1968) the crucial operation in the desensitization package is an induced feeling of calmness or what he calls "mental relaxation" brought about by verbal

instructions from the therapist. He cites in particular the work of Wolpin and Raines (1966) who successfully desensitized four snake phobic Ss, two without relaxation training and two while tensing their muscles. He also cites a review of the animal curare literature done by Davison (1966). Davison notes that animals under curare (presumably total muscle relaxation) can be conditioned (conditioned fear response) to avoid neutral stimuli in their normal state, suggesting that fear responses can be learned even when an animal is totally "relaxed." Davison proposes that relaxing one's muscles produces either strong affective states within the organism (mental relaxation?) or a reduction in efferent messages, both of which could act to inhibit anxiety.

The most recent challenge to the reciprocal inhibition hypothesis comes from research done by Nawas et al., (1970a) and Nawas et al., (1970b). In the first study, Ss were assigned to one of four groups on the basis of matched Fear Thermometer and Behavioral Approach Test scores. Besides a No-Treatment Control group, there were three treatment groups; Systematic Desensitization, Pseuod-Systematic Desensitization (paired irrelevant imagined stimuli with relaxation) and a Yoked Systematic Desensitization group (no relaxation). Ss in the three treatment groups moved up a 20 item hierarchy after reporting two consecutive scene presentations without experiencing anxiety. Nawas et al., (1970a) report that both the Systematic Desensitization and Yoked Systematic

Desensitization groups did significantly better on the Behavioral Approach Test after treatment than either the Pseudo Systematic Desensitization or No-Treatment Control groups. There was no difference between groups on the Fear Thermometer. They conclude:

> Clearly the findings of this study indicate that desensitization to an item early in the hierarchy is not a prerequisite to desensitization to more aversive items. The additive residuals of anxiety which Wolpe speaks of, if indeed they occur, do not jeopardize the success of treatment (p. 63).

It is interesting to note that not only did the Fear Thermometer fail to change, but the authors themselves fail to give information as to the starting point on the initial Behavioral Approach Test, or more conspicuously, the number of Ss who actually touched the snake after treatment. With the data they present, there is no way of deriving either the initial Behavioral Approach Test scores or the number of snake touches. Should an average movement from eight feet to four feet on the Behavioral Approach Test be considered evidence of "treatment success," even though such a move may be statistically significant?

In their second study, Nawas et al., (1970b) attempted to test more directly the need for muscle relaxation in the desensitization procedure. Along with a no-treatment control group, Ss were matched on Fear Thermometer and Behavioral Approach Test scores and assigned to either a standardized Systematic Desensitization group (SSD), an Aversive Imagery and Muscle Tense group (AMT) where they received the aversive

SSD scenes paired with muscle tension, a Pseudo Desensitization group which listened to anecdotes previously judged neutral in affective tone, or an Aversive Imagery and Neutral Task group (ANT) where SSD aversive scenes were paired with one of seven tasks rated neutral in affective tone.

After treatment, the Standardized Systematic Desensitization Ss did significantly better on the Behavioral Approach Test than Ss in either ANT or AMT groups ($p < .05$). Both of these latter groups, however, did significantly better than either the No-Treatment control or Pseudo Control groups. Nawas et al., conclude that ". . . Rachmans (1968) argument which questions the need for muscular relaxation is a valid one (p. 66)," and again, "The apparent superiority of the Standardized Systematic Desensitization over the ANT and AMT treatments is probably due to the 'pleasant state,' to use Davison's (1966) term, which Jacobsonian relaxation brings about and which is not likely to be attained, in equal measure, by the performance of neutral or muscular tension tasks (p. 67)."

The same criticisms of the Nawas et al., (1970a) study may be applied here as well. However, the important theoretical issue is not and should not be the inclusion or exclusion of relaxation training in the Systematic Desensitization treatment package. Too often relaxation training has been isolated by researchers to either prove or disprove the reciprocal inhibition principle without direct evidence of autonomic

effects purportedly mediated by deep muscle relaxation. Wolpe himself (1958) offers a number of other response modalites which he proposes are incompatible with anxiety; incompatible, that is, at an autonomic level. It is quite possible, for example, that muscle tension, the act of contracting various muscle groups, produces a decrement in one or more systems of the sympathetic division of the autonomic nervous system. Even Rachman (1968) freely admits that his interpretations "could be accommodated" by the reciprocal inhibition theory (p. 164). It is, therefore, important to remember that Wolpe (1954, p. 205) has defined anxiety as "the autonomic response pattern or patterns that are characteristically part of the organism's response pattern to noxious stimulation. . ." That systematic desensitization actually produces decrements in sympathetic activity through the contiguous pairing of muscle relaxation and anxiety-evoking stimuli still remains to be demonstrated. "Progress in resolving this issue will demand yet more refined experimental design and a closer look at the autonomic and neuromuscular responses in both treatment and change." (Lang, 1969, p. 174).

CHAPTER II

THE PRESENT STUDY

The purpose of the present study was to test directly the reciprocal inhibition principle at three different levels-physiological (autonomic and skeletal-motor), cognitive (self-report) and motor (proximity to an aversive stimulus), and to investigate the relationship between pysiological, cognitive and motor indices of fear. As Paul (1968) points out:

> Current research suggests that 'anxiety' may best be thought of as a descriptive term for a complex pattern of responses characterized by subjective feelings of apprehension and tension associated with heightened physiological arousal, especially of the sympathetic branch of the autonomic nervous system (p. 425).

Clearly the implication is that physiological, cognitive, and motor indices of fear are positively related. As early as 1953, however, Lacey (1953) was able to demonstrate marked individual differences between Ss in response to the same stressor conditions. Although in most instances a general arousal pattern at the autonomic level usually occurred in the presence of stressor stimuli, Ss did not respond equally across physiological channels when under stress. Some channels went up while others went down. The implications of this phenomenon are clear. Failure to find significant changes in one channel of physiological reactivity does not mean that other channels are also inactive. In order to make

any statements about general autonomic level, particularly in those cases where significant differences are lacking, one should be capable of making statements about a number of different physiological channels.

That cognitive and physiological indices of anxiety are positively related is also unclear. Sarason (1960), after reviewing the literature in this area, concluded that "Measures of questionnaire-defined anxiety such as MAS do not seem to relate consistently to physiological responding (p. 408)." McReynolds et al., (1966) lists a number of studies that failed to find significant relationships between physiological measures of anxiety, on the one hand, and psychometric measures on the other hand. In their own research McReynolds et al., (1966) also failed to produce significant correlations between autonomic and psychometric anxiety parameters, even though their design (intra-subject) favored such results (Lazarus, et al., 1963).

The relationship between motor and cognitive measures of fear is also unclear. Davison (1968) reported a high correlation ($r = .81$) between approach and reported fear decrement. Lang and Lazovik (1963) also report reductions in subjective fear and concomitant decrements in proximity to the phobic stimulus. Others (e.g., Leon, 1968; Nawas et al., 1970a) failed to find a reduction in reported fear and approach decrements. The major problem with these latter studies (and others) however, is that no systematic attempt

was made to assess reported reductions in fear at different points along the Behavioral Approach Test. Usually, fear scores are taken only at that point on the Behavioral Approach Test where S terminates his approach. Theoretically, one would not expect pre and post Behavioral Approach Test termination points to be necessarily different. The difference, if any, in reported fear should be found at points on the Behavioral Approach Test preceding the terminal point, since fear reduction must theoretically precede an avoidance decrement.

There is then, considerable evidence to suggest that *a priori* assumptions as to the nature of the relationships between physiological, cognitive and motor indices of fear may be unwarranted. The purpose of this study, therefore, was not to make hard predictions about the nature of these relationships, but rather to get adequate and accurate measures of each index and investigate the relationship between them.

In order to show that the reciprocal inhibition principle is the basic mechanism responsible for successful desensitization, we attempted to demonstrate the following: first, that the contiguity of relaxation and anxiety-evoking stimuli reduces fear significantly more than either the anxiety-evoking stimuli alone, relaxation alone, or no treatment at all; second, that relaxation training and the anxiety hierarchy separately are not sufficient to produce significant

decrements in fear in any of the three fear indices when compared to no treatment at all; third, that subjective reports of fear and physiological activity are directly related to the proximity of an aversive stimulus - the closer the stimulus, the greater the reported and "physiological" fear; and fourth, that gains in proximity to the aversive stimulus occur only when decrements in autonomic activity are produced through the contiguous pairing of relaxation and anxiety-evoking stimuli.

Subjects

Ss were selected by E1 from four local colleges in the San Francisco bay area. Most of the Ss were students in introductory psychology courses. E1 simply asked those students who were extremely afraid of harmless snakes if they would be interested in participating in a research project, the major purpose of which was to study new ways of measuring physiological reactivity. Appointments were made with those who volunteered. Each S was administered the Minnesota Multiphasic Personality Inventory. Female subjects who's T scores stayed within a 30-70 T-range then received sessions one and two (see below). The first 24 Ss who passed the Behavioral Approach Test comprised the final population. Their ages ranged from 18 to 23.

Experimenters

Two experimenters, E1 and E2, participated in the research. E1 was a 26 year old graduate student in clinical

psychology. E2 was an 18 year old male high school student who volunteered to assist E1. E2's only task was to rate snake activity during the Behavioral Approach Test. Snake activity was scored on a five point scale from zero (no activity) to four (constant movement). E2 knew nothing about the nature of the research. Both E2 and E1 scored snake movement on one-half of the pre and post treatment Behavioral Approach Tests. Reliability checks were run between E's after each Behavioral Approach Test.

Phobic Stimulus

A live, three foot gopher snake named Dusty was used as the phobic stimulus. He was loaned to E1 by a biology instructor in a local, private pre and elementary school. Dusty had been handled thousands of times by three, four and five year old children. The risk of snake bite was therefore considered minimal. Dusty was housed in a 1' x 1' x 2' wire mesh cage. The door was on the left side of the cage rather than the top which permitted easy access to Dusty (see Behavioral Approach Test below).

Apparatus

All treatment and control conditions were conducted in a sound-proofed experimental room at the VA Hospital, Palo Alto, California. The room was approximately 15' x 12' x 10' in dimensions. The polygraph with an earth ground was housed in an adjacent sound-proofed room. The rooms were connected

by one door. E1 and E2 could see S through two strategically placed mirrors described below. All electrodes were fed into three junction boxes (one for Heart Rate, one for Skin Potential and one for the Electromyogram) located under a chair in the experimental room. Shielded cables led from these boxes to the control room. One electrode attached to the left leg served as a common S ground. In addition to the reclining chair, the experimental room also housed a four-legged tram table, the top of which was tilted a 30 degree angle. This tram was used to support the snake during the Behavioral Approach Test (also described below). The tram and the chair were the only pieces of apparatus housed in the experimental room. Both remained there throughout the duration of the experiment.

Criterion Measures

Behavioral Approach Test. The Behavioral Approach Test is generally considered to be the most rigid test of fear change (Lang and Lazovik, 1963). It was first devised by Lazovik and Lang (1960) and simply involved the computation of scores based on the distance between S and a phobic stimulus before and after treatment. Since Ss in this experiment were rendered virtually immobile by the polygraph electrodes, a modification of Lang and Lazovik's technique had to be devised. During each BAT, a caged snake was placed by E1 on a tram situated exactly nine feet from the front-right

edge of S's chair. A thin but strong cord was attached to the front of the tram. The cord led to the control room through a pulley system out of S's sight. After E1 had placed the snake on top of the tram, he returned to the control room where he made ready to pull the tram one foot closer to S at one minute intervals. S had a very clear view of the snake since the tram top was tilted at a 30 degree angle toward S. At one minute intervals, the tram was pulled one foot closer until S signaled "stop" by raising her right index finger (for full description of instructions to S, see procedural section below). After an additional one minute, Dusty was removed from the room. A Behavioral Approach Test score was computed for each S in the following manner: If S was able to unlock the cage door, but not touch Dusty, she received a score of one. Touching the cage was scored two, cage alongside S was three, cage at one foot from S four, and so on. In order to get an accurate estimate of fear change from pre to post Behavioral Approach Tests, one must take into consideration the point at which S stopped on the first Behavioral Approach Test. A change from nine to six is not equivalent to a change from three to one since the avoidance gradient gets steeper as one approaches an aversive stimulus. Behavioral Approach Test difference scores were, therefore, converted to adjusted change scores by using the formula advocated by Lang and Lazovik (1963):

$$\text{Change score} = \frac{\text{initial score} - \text{present score}}{\text{initial score}}$$

Fear Thermometer. A modification of Walk's (1956) fear thermometer (FT) was used to get a subjective estimate of S's level of fear during the Behavioral Approach Test. A scale from 0 to 100 was constructed and placed on the wall opposite S's chair, exactly ten feet from S. A complete description of the scale and its use is given below. Ss were instructed to rate their level of fear on the basis of this scale during each one minute interval of the Behavioral Approach Test.

Physiological Measures. Physiological measures were continuously recorded on a four channel Grass Model 5 Polygraph. Grass chart paper was driven at 1mm/sec. The same electrolyte, Bechman 5 percent concentrate of NACL, was used for all connections. After cleaning each electrode site with alcohol, the skin was prepared by rubbing it vigorously for one minute with a gauze pad coated with the electrolyte. The electrodes (Grass, silver cup) for all three physiological indices were then coated and secured to the skin just below the electrode cup in order to prevent movement artifact.

(1) Electromyogram. Muscle tension was recorded from the masseter muscle located at a point 3/4 inch anterior to and 1/2 inch above the angle of the jaw on the right side of the face. The center of the active electrode was placed at this site. The second electrode was placed two inches directly

above the first electrode. This placement produced quite reliable reactions. Its drawback was, of course, the artifact produced if S talked. Our Ss were constantly told not to talk except when asked to rate themselves. Pen deflections 5mm on either side of a verbal report were not used in the scoring. The signal was fed through an integrater on the Grass polygraph. A muscle tension score in mean microvolts/second was determined for each S by noting the five largest integrated muscle action potentials during each one minute interval of the Behavioral Approach Test and computing their average.

(2) Heart Rate. Heart rate was recorded by placing electrodes immediately above each ankle. A third electrode was placed over the radial artery of the left wrist. This left S's right hand free to open the cage and touch the snake. The Heart Rate signal was fed through a tachograph on the Grass polygraph which converted the signal to a beat-to-beat print-out on the chart paper. Time between beats was represented by a wave from whose vertical distance indicated time in milliseconds between consecutive heart rate R waves. The five smallest beat-to-beat intervals during each one minute interval of the Behavioral Approach Test were averaged to produce mean beat-to-beat Heart Rate scores in milliseconds.

(3) Skin Potential. A silver-disc electrode was grounded to the dorsal surface of the left forearm, just below the elbow. A second electrode was placed on the ventral surface of the same arm about 8 cm from the active palm of the left hand. A third electrode was secured to the distal phalanx of the middle finger. The palmer potential gradient was therefore measured between the second and third electrodes. Impedance was set at 5 mv/cm. Mean Skin Potential scores in millivolts/centimeter were computed for each one minute interval of the Behavioral Approach Test by averaging the five largest pen deflections, either positive or negative, away from baseline.

Scores representing the physiological and cognitive measures of fear were derived from essentially the same points in time during the Behavioral Approach Test; namely, during the one minute interval at each foot point of the snake approach run. The total number of scores varied across Ss depending on how close S permitted the snake to approach. Since we were interested in getting scores which reflected the overall level of fear during the entire Behavioral Approach Test, a statistical procedure (Winer 1962) was employed which separated variance due to treatment effects, proximity effect (e.g., changes in arousal due to snake proximity), and treatments X proximity. The analysis adjusted for unequal cell frequencies within groups and unequal n between groups.

All of the data was scored by E1. One-half of the data was also scored by a trained graduate student in clinical psychology who was unfamiliar with the purpose of the research. Records were scored blind by both E1 and the student; i.e., neither had access to S's name or treatment condition. Reliability checks were run for each measure by computing the number of scorer agreements, subtracting from them the number of disagreements and then dividing by agreements. Interscorer reliability exceeded .95 on all measures. Data analyses were performed by the University of Tennessee's IBM Computer and by E1.

Procedure

All Ss were run by E1. During the first session, E1 met S and told her he was interested in monitoring different psysiological and psychological manifestations of tension. E1 assured S that there were no tricks involved, and that no harm would come to her because of the polygraph electrodes or anything else. S was then asked to sit in a semi-recumbent position in a reclining chair situated at one end of the room while E1 attached eight electrodes on S. It usually took about ten minutes to attach the electrodes. During this time E1 was careful to explain the purpose of each electrode and continued to assure S that no harm would come to her. When E1 had finished securing the electrodes, he informed S that he was about to retire to an adjoining room to check the

calibration of the machine. S was told that from this point on, all instructions would be delivered to her by a tape recorder that was also in the adjacent room with the Grass polygraph. A 5 inch by 5 inch hole in the wall permitted clear audio transmission of the instructions. The polygraph wires also lead through this hole.

After E had told S that taped instructions were about to be transmitted to her, E1 instructed S to get comfortable, to relax as much as possible, but to restrict movement to a minimum and not to talk. E1 then left the experimental room and calibrated the Grass polygraph. The tape recorder was then started and S was given the following instructions:

> In this experiment we are interested in assessing the relationship between various measures of tension. Specifically, we are interested in the relationship between physiological indices of tension and your own subjective estimate of how tense you feel at particular points in time. For this purpose, we have constructed a scale of tension to help you evaluate your own internal state of anxiety. If you will look on the wall directly in front of you, you will see a scale with numbers ranging from 0 to 100. These numbers represent different levels of tension. A score of 100, for example, would represent the most fear you have ever experienced at any one time during your lifetime. We will give you a few moments to recall the one incident which produced the strongest fear reaction in you. When you have thought of the incident, try to remember as closely as you can exactly how you felt at that time. That feeling would be the equivalent of a score of 100 on the tension scale. Okay, try now to recall an incident . . . Now that you know what a score of 100 means, lets go down the scale to zero. This score should represent for you a feeling of total relaxation - no tension whatsoever, very similar to the feeling you might have while soaking in a warm tub of water after a tough day or the feeling you have just before falling asleep. Now that you know what the two extreme poles on the scale represent, it should be relatively easy

> for you to assign various levels of tension to each point on the scale. Fifty, for example, would be exactly one-half of the most tension you have ever experienced. Twenty-five would be half way between 0 and 50, and so on.
>
> For the next 20 minutes, we want you to relax as much as you can. At different times, we will ask you to rate the level of tension you are experiencing right at that point. Okay, please rate yourself now.

S continued to rate herself at five minute intervals during the first 15 minutes, and at one minute intervals during the last five minutes of the 20 minute period. At the end of this habituation period, E1 entered the experimental room, removed the electrodes and made an appointment with S to return the next day, or as soon as possible.

The second session was identical to session one for all Ss except that the information about the tension scale was deleted. S was told that she was to rate her level of tension for 20 minutes, just as she had done the preceding day. After the 20 minute habituation period was over, however, taped instructions continued in the following manner:

> You have done very well to this point. We would now like to see how you will react to the presentation of a live, harmless snake. In the next room, housed in a wire mesh cage is a harmless gopher snake. In just a moment, I am going to bring the snake in, still secured in his cage, and place him on the tram which is situated immediately in front of you, 10 feet from the edge of your chair. After placing the snake on the tram, I will leave the room and you will be asked to rate your level of tension, just as you have been doing today. After you rate your tension, the tram will move one foot closer to you, and you will be asked to rate your tension again. This process will continue at one minute intervals until you signal stop by raising your right index finger. I will then come in and remove the snake from the room. Please listen carefully

> now to what I am about to say. It is extremely important for our research purposes that you not signal stop until you cannot possibly stand to have the snake come any closer to you. Don't give up easily. Try as hard as you can . . . please. Now I will bring the snake in and place him on the tram.

After Dusty had been placed on the tram, E1 left the room and returned to the polygraph. E1 and E2 then began scoring snake activity. At one minute intervals, the tram moved one foot closer to S. E1 controlled the movement through a rope and pully system. The tram was padded and moved along a track on the floor so that direction as well as sudden sounds or squeaks from the tram were controlled. Both E1 and E2 were able to get a direct frontal view of Dusty's movement by mirror system constructed for this purpose. Activity ratings were made at one minute intervals to coincide with S's verbal reports of fear. During the course of the experiment not one S inquired about the mirrors.

After S signaled stop, Dusty was removed and E 1 disengaged S from the electrodes. Appointments were then scheduled with each S who failed to touch the snake and who reported a subjective rating of 50 or more during the last one minute interval of the Behavioral Approach Test. After this second session, all Ss were randomly assigned to one of four groups.

Group I - (Systematic Desensitization (SD). Ss in this condition received three taped 30 minute sessions of abbreviated muscle relaxation (Paul, 1966). After E1

attached the electrodes, he placed S in a semi-recumbent position, left the room and started the tape recorder which delivered the following instructions to S:

> We have selected you to continue on in this research because of your marked fear of snakes. You have been unable to control your fear because you have not learned how to relax in the presence of harmless snakes. In order for you to rid yourself of this fear, you must be taught how to control your anxiety. Clinical psychologists have recently devised a technique called systematic desensitization with which they have had remarkable success in reducing irrational fears. It is based upon the principle that humans cannot be anxious and relaxed at the same time. In the first step of this treatment, you will be taught how to relax your muscles to a very deep state. After three training sessions, you will be able to relax your whole body in a matter of seconds. Once you have learned to control your level of tension, you will be asked during the remaining sessions to imagine a series of ten scenes arranged on a dimension of 'snake anxiety' from the least to most disturbing scene. In the first scene, for example, you will imagine yourself at a distance of 100 feet away from the snake, and in the second scene, 50 feet, and in the third scene 25 feet, and so on. During each scene presentation and immediately after presentations, you will use relaxation to inhibit your anxiety. Scenes will be repeated over and over, until eventually, you will be able to imagine yourself handling a live, harmless snake without feeling any fear. You will move up the 'anxiety hierarchy' at your own pace, never moving from one scene to the next until we are both satisfied that you can imagine the scene clearly and vividly without experiencing any anxiety whatsoever.
>
> You may feel right now that imagination is one thing, but reality is quite another; that way you can do in your imagination has no relationship to what you can do in reality. Actually, the contrary is more true. Clinical psychologists have consistently found that Ss who can vividly imagine themselves handling a snake without fear can actually do so later on. Let's begin now with the first of the three training sessions in deep muscle relaxation. In one minute, you will begin receiving your first instructions.

At this point, E1 calibrated the polygraph, changed tapes

and started the relaxation tape. S was instructed to contract and relax various muscle groups beginning with the dominant hand and forearm and leading through the dominant upper arm, non-dominant hand and forearm, non-dominant upper arm, forehead, eyes and nose, cheeks and mouth, neck and throat, chest, back, respiratory muscles, abdomen, upper legs, calfs, ankles and feet. Two tension and release cycles were run for each muscle group. After all muscle groups had been treated, S was instructed to relax and enjoy the feeling for one minute. Termination instructions were then delivered.

Each S in the Systematic Desensitization group received three sessions of abbreviated relaxation training. Although Wolpe (1958) recommends six training sessions, a number of experimental investigations have reported success with three and even fewer training sessions (i.e., Paul, 1966; Rachman, 1965; Ramsey, 1966; Cook, 1966). After completing relaxation training, each S commenced with scene presentations during the fourth treatment session. After attaching the electrodes, E1 again left the experimental room to calibrate the polygraph. After giving S sufficient time to relax, S was first told to signal E1 by raising her right index finger if she experienced tension at any time during a scene presentation. S was also told to signal E1 in the same fashion when ready to commence scene presentations. (E1 could see S's hand in a strategically placed mirror out of S's sight). After these initial brief instructions, E1 read the first scene

in the hierarchy to S (see Appendix A). Scenes were presented for 20 second periods or until S signaled a scene termination. S could not move to the next scene until she had successfully imagined a scene twice for 20 seconds without experiencing anxiety. If E1 observed rather gross pen displacements during a scene, even though S failed to signal anxiety, he continued to present the scene. After S successfully imagined a scene for 20 seconds, E 1 verbally rewarded her by saying "good" or "fine" or "you're doing just fine." If she failed to imagine the scene for a full 20 seconds, E1 instructed her to relax and signal when ready to continue. E1 noted on the polygraph chart paper when each scene was presented and when it was terminated. He therefore had an accurate record of the number of scene presentations, time/presentation, time between presentations and verbal reinforcements after presentations. Ss were run usually for 20 minutes or until they tired. Sessions were always terminated after a successful 20 second presentation. The next treatment session began with the scene on which the previous session had been terminated. After completing treatment, each S repeated the procedure run in session two.

Group II[1] - (Relaxation-Yoked). Ss in this condition received the same taped training in deep muscle relaxation as

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[1]Ss in this condition were not in a strict sense held to the same experimenter control as Ss in Groups I, III and IV. Ss in the H-Y group received exactly the same number of sessions as their yoked SD partner. Unfortunately, Ss in the R-Y group received only half the number of hierarchy sessions as their yoked SD partner. A difference in the number

Ss in the Systematic Desensitization group. Instructions with regard to training were also the same. However, these Ss did not receive instructions about an "anxiety hierarchy." Instead, they were told that they would be asked to visualize ten scenes which clinical psychologists used to help people achieve truly deep states of muscle relaxation. The "relaxation hierarchy" was actually comprised of ten scenes previously rated by three judges to fall midway between highly relaxing and highly unrelaxing poles on a seven point scale. These judges were, of course, unfamiliar with the nature of the research. (For a list of the scenes and explanation of the hierarchy construction, see Appendix B). After three sessions of relaxation training, Relaxation-Yoked Ss were asked to imagine each scene as clearly as possible while ramaining totally relaxed. These Ss were yoked to a Systematic Desensitization partner by ranking and pairing fear thermometer scores taken from the last one minute interval of the Behavioral Approach Test. They therefore visualized the same number of scenes for the same period of time as their yoked Systematic Desensitization partner and were instructed to relax for the same amount of time between scene presentations. Identical verbal reinforcements after scenes were also administered by

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of sessions across groups should not concern anyone, however, if it can be shown that a "sessions effect" could not possibly have accounted for differences groups. The average number of sessions for the SD and H-Y groups was seven. The average for the R-Y group was five.

El. One day after completing the last scene in the hierarchy, Ss in this group repeated the procedures outlined in session two.

Group III - (Hierarchy-Yoked). Ss in this condition did not receive training in deep muscle relaxation. Instead, they were asked to sit upright in the recliner while El attached the electrodes. After El left the room, they received the following taped instructions:

> You have been asked to continue in this research because of your marked fear of snakes. You are afraid of snakes because you are unable to stay close enough to them for a period sufficient to permit a reduction of your level of fear. In short, your fear causes you to avoid snakes rather than face them. This does not mean you should force yourself to handle a snake regardless of your level of fear. The trick is to approach the snake gradually, step by step, without running away. Movement from one step to the next, however, should not occur until all of your fear is gone. Unfortunately, most people are unable to accurately assess their level of fear. If they had some means of knowing exactly how they were reacting at each step, their approach toward the snake would be very much facilitated. We have such a means available to us. By monitoring your physiological activity, we will be able to accurately assess your level of fear. We plan to have you imagine ten separate scenes in which you will visualize yourself getting closer and closer to a live harmless snake. In scene ten, for example, you will vividly imagine yourself handling the snake. It is through this hierarchy of scenes that we plan to have you move 'step by step'. You may feel that what you imagine cannot possibly have any application in 'real life'. Actually, the contrary is more true. Clinical psychologists have found repeatedly that Ss who can imagine themselves handling a snake without fear can actually do so later on. The problem, then, is not in imagining, but in making sure that you do not move from one scene to the next until you are physiologically ready to do so. In order for us to be able to determine this actual 'movement' point, we must have extremely accurate measures of your average physiological activity. During the next three sessions, therefore, we want you to sit in

> recliner and follow the instructions I shall deliver. We simply want to get measures of your physiological activity while you perform a series of tasks. The tasks are included so that we might better obtain your usual or most common level of physiological activity. By the end of the third treatment session, we will have enough information to permit us to begin with the hierarchy presentation. Okay, get comfortable, and we will begin.

Each S was then run through a series of pseudo tasks (see Appendix C) for three consecutive 30 minute sessions held one week apart. During session four, they were then instructed to visualize the same ten fear-hierarchy scenes that were presented to the Systematic Desensitization Ss. Hierarchy-Yoked Ss were also yoked to a Systematic Desensitization partner in the same fashion as Relaxation-Yoked Ss. They, therefore, received the same number of scene presentations, time between scenes and verbal reinforcements as their yoked Systematic Desensitization partner. They were not instructed to relax after scenes, however. Instead, they were told to sit quietly until E1 was ready to present the next scene. All six Ss repeated the Behavioral Approach Test one day after completing "treatment."

Group IV - (No Treatment Control). Ss in this condition were used to evaluate any effects due to the passage of time. After the first Behavioral Approach Test, they were asked to return one month later for the second Behavioral Approach Test. They were simply told that we were interested in the stability of the relationships between various physiological and psychological indices of tension.

CHAPTER III

RESULTS

Pre-Treatment

Randomized group analyses of variance adjusted for unequal cell frequencies within groups and unequal n across groups by an unweighted means solution (Winer, 1962), were performed on all physiological measures, the cognitive measure, and the snake activity measure, obtained during the first Behavioral Approach Test. An Analysis of variance for randomized groups was also performed on the raw BAT scores to test for possible pre-treatment differences between groups. No significant differences (all p's $<.20$) were found on any measure, suggesting that the randomization procedure adequately equated all four groups on all measures prior to treatment.

The interactions of groups x proximity points (distance of S from snake) were non-significant for all physiological measures and the cognitive measure as well. As predicted, there were significant proximity effects for the EMG ($F=4.77$, $df=5/102$, $p<.01$), SP ($F=8.78$, $df=5/102$, $p<.001$) and FT ($F=4.29$, $df=5/102$, $p<.01$). The HR proximity effect was not significant. Duncan's New Multiple Range Tests were performed on the six proximity means for each significant measure. The results of the analysis are presented in Table I. Rather clear but distinct patterns are apparent for the

TABLE I

DUNCAN'S NEW MULTIPLE RANGE TEST[1] FOR PROXIMITY MAIN EFFECT

Snake Proximity	Criterion Measures					
	Electromyogram					
	5'	1'	3'	7'	TC	9'
5 feet		6.81	8.70	21.38	26.17*	55.38**
1 foot			1.89	14.57	19.36	48.77**
3 feet				12.68	17.47	46.68**
7 feet					4.79	34.00**
Touch Cage						29.21**
	Skin Potential					
	1'	5'	3'	7'	TC	9'
1 foot		.13	.68*	.77*	1.01**	2.36***
5 feet			.55	.64	.88	2.13***
3 feet				.09	.33	1.58***
7 feet					.24	1.49***
Touch Cage						1.25***

TABLE I (continued)

Snake Proximity	Criterion Measures					
	Fear Thermometer					
	9'	7'	5'	1'	3'	TC
9 feet		8.12	13.45*	17.60***	20.25***	21.25***
7 feet			5.33	9.48	12.13	13.13
5 feet				7.35	6.80	7.80
1 foot					2.65	3.65
3 feet						1.00

*p $<$.05 **p $<$.01 ***p $<$.005

[1]Standard error of single mean computed with n=18.

physiological and cognitive measures. When the snake is first brought into the room, one can observe a marked rise in autonomic and skeletal-motor activity which is then followed by a recovery period during the intermediate phase of the BAT. As the snake continues to approach S, however, one observes a second rise in physiological activity which reaches its peak at the terminal point of the BAT. In contrast to this physiological pattern, subjective estimates do not reflect a "startle" effect in response to the initial snake presentation. Rather, initial reports fall in the relaxed range and progressively increase as the snake comes closer until, finally, Ss report considerable anxiety at the point of approach termination. A graphic presentation of effects for all three measures is provided in Figure 1. These data support the notion of a moderate relationship between physiological and cognitive estimates of fear in the presence of a fear-evoking stimulus, particularly as the distance between stimulus and S is reduced.

Post Treatment

Behavioral Approach Test. A change score formula (see page 19) was used to convert simple difference scores to adjusted change scores.. Treatment group differences on mean change scores were significant at the $p < .08$ level. Duncan's New Multiple Range Test (Edwards, 1960) for these mean differences are summarized in Table II. There was

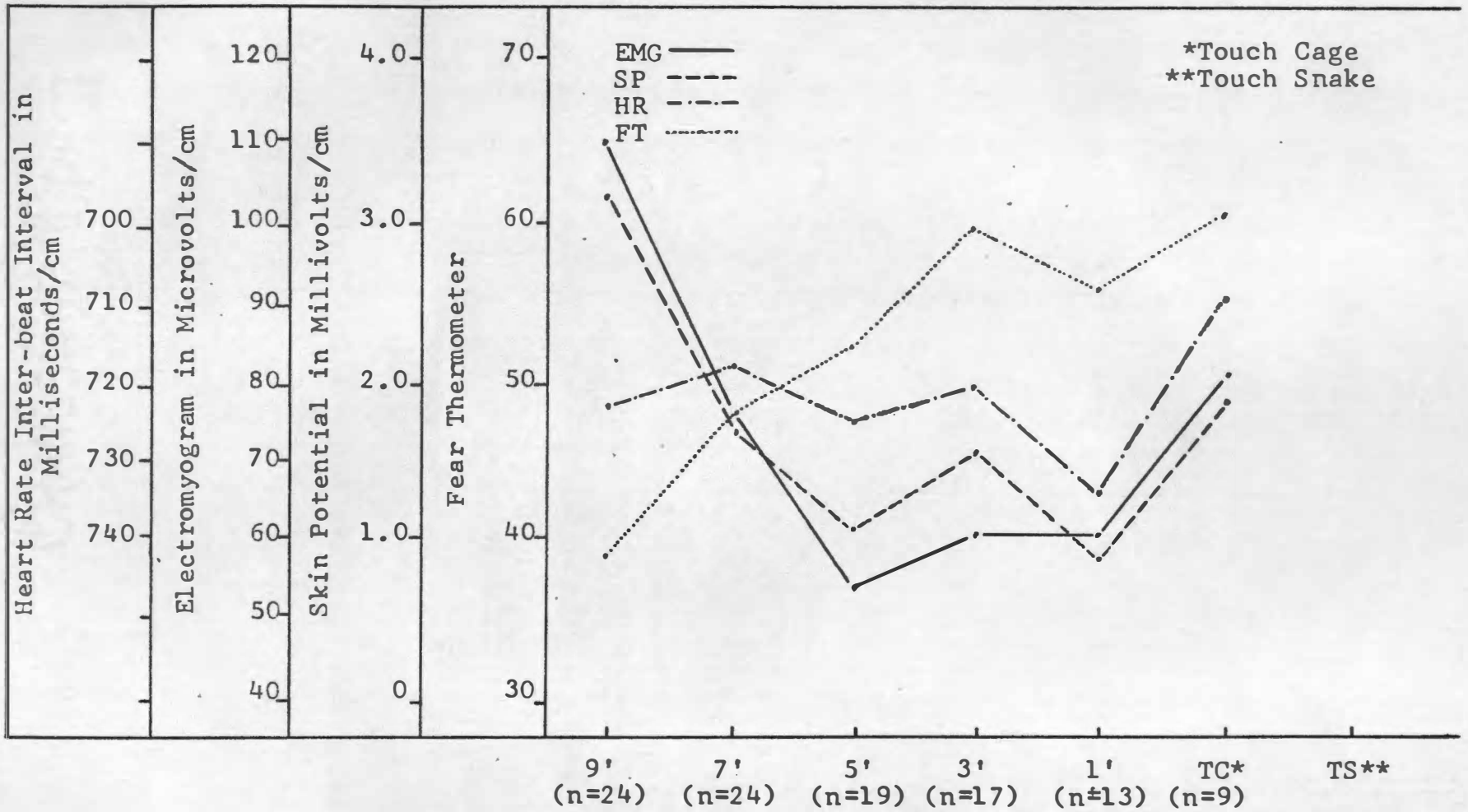

Figure 1. Mean proximity scores for EMG, SP, HR and FT during pre treatment Behavioral Approach Test.

TABLE II

DUNCAN'S NEW MULTIPLE RANGE TEST FOR BEHAVIORAL APPROACH TEST CHANGE SCORES

Group	R-Y	C	H-Y	SD
R-Y		.202	.262	.604*
C			.042	.384
H-Y				.342

*p .05

significantly more approach behavior after treatment in the SD group than in the R-Y group. Although not significant, the differences between the SD, NTC and H-Y groups were in the predicted direction.

Mean BAT differences were not as large as expected because three NTC S and two H-Y Ss were able to touch the snake after treatment as compared to no R-Y Ss and five SD Ss. Before treatment, it was decided to score any touch, regardless of duration, as a "success." We had not anticipated control Ss touching the snake since a number of investigators (i.e., Lang and Lazovik, 1963; Leon, 1968) had already shown no significant BAT differences for control Ss over as many as four separate snake runs. Fortunately, we had thought to instruct Ss who touched the snake to leave their hand on Dusty until instructed to remove it (duration one minute). All five SD Ss were able to touch Dusty for the full one minute period. None of the other five Ss (three NTC, two H-Y) were able to leave their hand on Dusty for one second, let alone one minute! Their characteristic response was to quickly dart a hand in and out of the cage as fast as possible. None touched Dusty more than once. As a further test of "treatment success," E1, after removing the Grass electrodes, instructed each S to open the cage door and remove Dusty from his cage. All five Ss successfully removed the snake from his cage. None of the other Ss were able to do so. If we had selected either the one minute touch or the cage removal task as our criterion for "success," we would have observed highly

significant differences between groups as predicted.

There is further evidence of the marked "qualitative" difference observed between the five SD Ss and the five other Ss who were able to "touch" the snake. By combining the scores of the latter five Ss and computing mean EMG, HR, SP and FT scores for the two groups during the last one minute interval of the BAT, we were able to run T tests on the mean differences between groups for all four measures. Although the mean HR difference was not significant ($p < .20$), mean EMG ($T=2.63$, $p < .025$), mean SP ($T=4.90$, $p < .005$) and FT ($T=4.46$, $p < .005$) scores were all highly significant. These results further support our notion that the SD Ss were indeed much less fearful while touching Dusty than the five Ss who had not been treated with systematic desensitization.

Fear Thermometer. An analysis of variance, adjusted for unequal cell frequencies and unequal n's across groups (Winer, 1962), yielded highly significant treatment effects ($F=11.34$, $p < .001$). The results of Duncan's New Multiple Range Test may be found in Table III. Over the entire BAT run, SD Ss reported significantly less fear as measured by the FT than either the R-Y ($p < .05$), H-Y ($p < .001$) or NTC ($p < .001$) Ss. R-Y Ss reported significantly less fear than both the H-Y ($p < .05$) and NTC Ss ($p < .005$). The difference between NTC and H-Y means was not significant. A clearer picture of differential treatment effects is provided in

TABLE III

DUNCAN'S NEW MULTIPLE RANGE TEST[1] FOR THERMOMETER POST TREATMENT EFFECT

Group	SD(n=42)	R-Y(n=35)	H-Y(n=30)	C(n=35)
SD		14.21*	32.60***	35.86***
			18.29*	21.55**
				3.26

*p <.05 **p <.01 ***p <.005

[1]Standard error of single mean computed with n=36.

Figure 2. One can see the rather marked decrement in reported fear for SD Ss as compared to Ss in the other three groups. Of particular interest is the significant interaction effect between snake proximity and treatments ($F=1.95$, $df=17/116$, $p < .01$). The interaction indicates that systematic desensitization was more effective in producing a prolonged fear decrement over the entire BAT than any of the other three groups. Once again, proximity effects were highly significant in the predicted direction ($F=4.21$, $df=6/116$, $p < .001$) indicating that subjective fear increased as the distance between S and the fear-evoking stimulus was reduced. A multiple comparison run on proximity means is presented in Table IV. The pattern is virtually identical to the pattern observed during the first BAT.

Electromyogram. An analysis of variance on unweighted means, adjusted for unequal cell frequencies and unequal n's across groups (Winer, 1962), yielded significant treatment effects ($F=3.47$, $df=3/20$, $p < .05$). The results of Duncan's New Multiple Range Test are presented in Table V. EMG activity over the entire BAT run was significantly less for SD Ss when compared to either the NTC ($p < .05$) or H-Y ($p < .01$) Ss. The mean difference between SD and R-Y subjects, although in the predicted direction, was not significant. There were no significant differences among the R-Y, H-Y or NTC conditions.

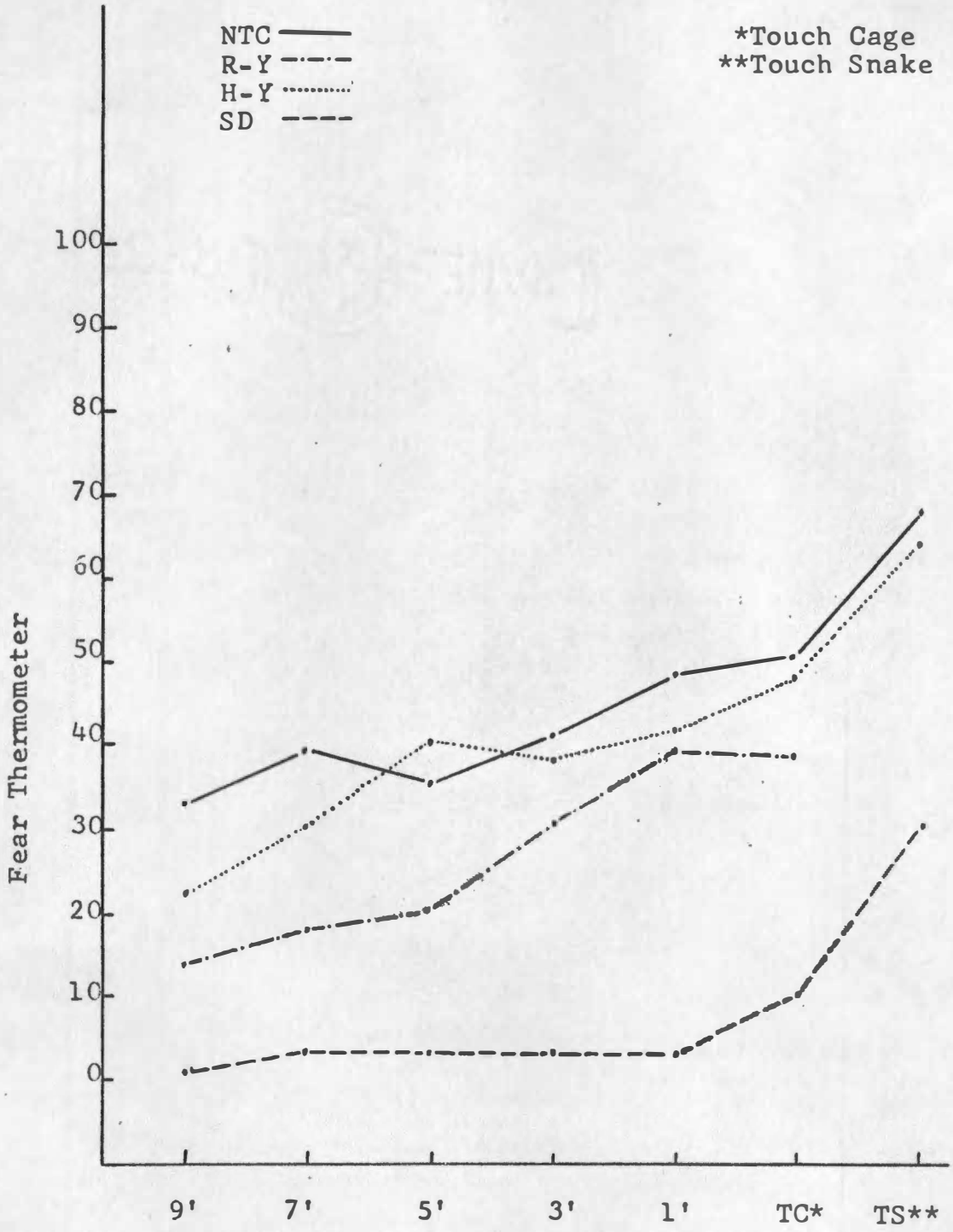

Figure 2. Mean fear thermometer proximity scores for post Behavioral Approach Test.

TABLE IV

DUNCAN'S NEW MULTIPLE RANGE TEST[1] FOR POST FEAR THERMOMETER PROXIMITY EFFECT

Snake Proximity	9'	7'	5'	3'	1'	TC	TS
9 feet		5.00	7.12	9.93	15.58**	19.02***	21.29***
7 feet			2.12	4.93	10.58	14.02	16.29***
5 feet				2.81	8.46	11.90	14.17
3 feet					5.65	9.09	11.36
1 foot						3.44	5.71
Touch Cage							2.27

*p <.05 **p <.01 ***p <.005

[1]Standard error of single mean computed with n=20

TABLE V

DUNCAN'S NEW MULTIPLE RATING TEST[1] FOR POST ELECTROMYOGRAM TREATMENT EFFECT

Group	SD (n=42)	R-Y (n=35)	C (n=35)	H-Y (n=32)
SD		28.75	36.53*	49.65**
R-Y			7.78	20.90
C				13.12

*p <.05 **p <.01

[1]Standard error of single mean computed with n=36

Systematic Desensitization was more effective in reducing fear (as measured by EMG activity) than either no treatment at all or the hierarchy presentation alone. The difference between mean SD and R-Y scores was in the predicted direction, lending further support to the selected effectiveness of systematic desensitization. One also should note the rather close correspondence with the effects previously reported for the FT, the only difference being that R-Y Ss reported significantly less fear during the BAT than either the NTC or H-Y Ss. The major implications to this point, then, with regard to treatment effects, appears to be that SD Ss not only reported less fear during the BAT than the other three groups, they also experienced less muscle tension as well. In contrast, R-Y subjects, although failing to report as strong a fear decrement as SD Ss, did report less fear than either NTC or R-Y Ss, even though they did not experience significantly less muscle tension. From every indication, SD Ss reported and experienced less fear during the BAT than any other group and were far more successful in approaching and handling the snake than either R-Y, H-Y or NTC Ss.

As predicted, there were significant differences between proximity points for this measure ($F=2.24$, $df=6/115$, $p < .01$). Duncan's New Multiple Range Test is presented in Table VI. A graphic presentation of the proximity effect is shown in Figure 3. The same essential pattern of startle

TABLE VI

DUNCAN'S NEW MULTIPLE RANGE TEST[1] FOR POST ELECTROMYOGRAM PROXIMITY EFFECT

Snake Proximity	7'	5'	3'	1'	TS	9'	TC
7 feet		1.54	10.18	11.04	27.00*	28.00*	31.23*
5 feet			8.64	9.50	25.50	26.46#	31.69*
3 feet				.86	16.86	17.82	23.05
1 foot					16.00	16.96	23.19
Touch Snake						.96	6.19
9 feet							5.03

*p <.05 +p <.06 #p <.08

[1]Standard error of single mean computed with n=20.

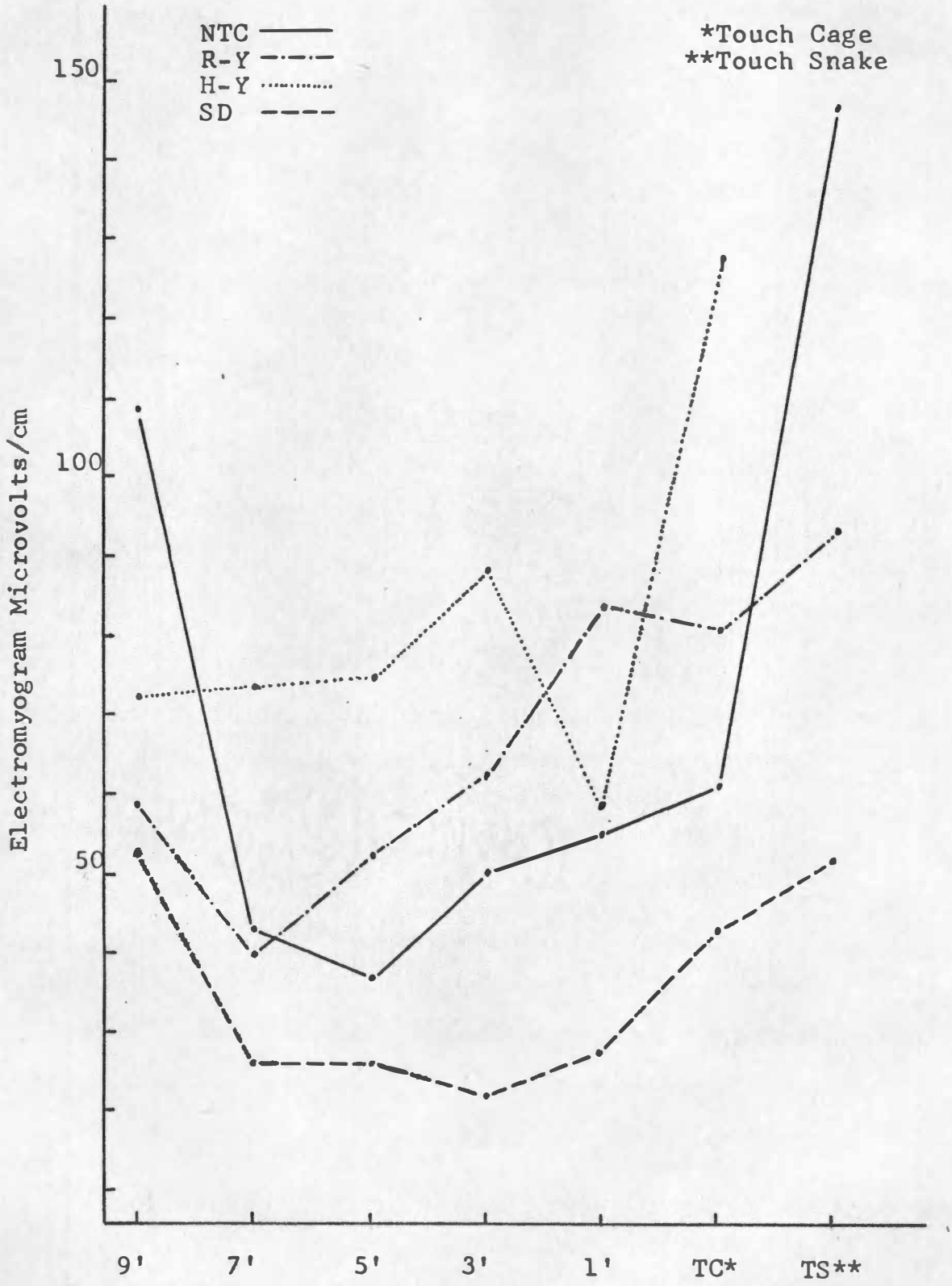

Figure 3. Mean electromyogram proximity scores for post Behavioral Approach Test.

reaction, recovery and increased activity seen during the first BAT is very much apparent. The differences across groups in treatment effects is also particularly dramatic. Of equal interest, however, is the significant interaction effect ($F=1.93$, $p < .06$) between snake proximity and treatments. Systematic desensitization was apparently more effective in producing a prolonged decrement in EMG activity over BAT intervals than any of the other three groups.

Skin Potential. A significant treatment effects ($F=3.74$, $p < .05$) was analyzed by Duncan's New Multiple Range Test. The results of this analysis are presented in Table VII. There was significantly less SP activity over the entire BAT run for SD Ss than for either R-Y, H-Y or NTC Ss ($p < .01$). There was no significant difference between R-Y and H-Y and NTC Ss on this measure. These results are virtually identical to the results reported for the EMG criterion measure.

As predicted, and as found for both the FT and EMG measures, the proximity effect was highly significant for the SP ($F=4.40$, $p < .001$). Duncan's New Multiple Range Test Test (Table VIII) revealed the same basic pattern found for this measure during the first BAT. An initial startle reaction is followed by an intermediate period of recovery before SP activity increases during the terminal phase of the BAT. This effect, as well as differential treatment differences, is graphically presented in Figure 4. Of particular interest

TABLE VII

DUNCAN'S NEW MULTIPLE RANGE TEST[1] FOR SKIN POTENTIAL TREATMENT EFFECT

Group	SD (n=42)	R-Y (n=35)	C (n=35)	H-Y (n=32)
SD		.59*	.63*	.98**
R-Y			.04	.39
C				.35

*p <.05 **p <.01

[1]Standard error of single mean computed with n=36.

TABLE VIII

DUNCAN'S NEW MULTIPLE RANGE TEST[1] FOR SKIN POTENTIAL PROXIMITY EFFECT

Snake Proximity	7'	5'	3'	1'	9'	TC	TS
7 feet		.13	.14	.64	2.19**	4.10**	5.22**
5 feet			.01	.41	2.06**	3.97**	5.09**
3 feet				.40	2.05**	3.96**	5.08**
1 foot					1.55**	3.46**	4.58**
9 feet						1.91**	3.03**
Touch Cage							1.12*

*p <.01 **p <.001

[1]Standard error of single mean computed with n=20

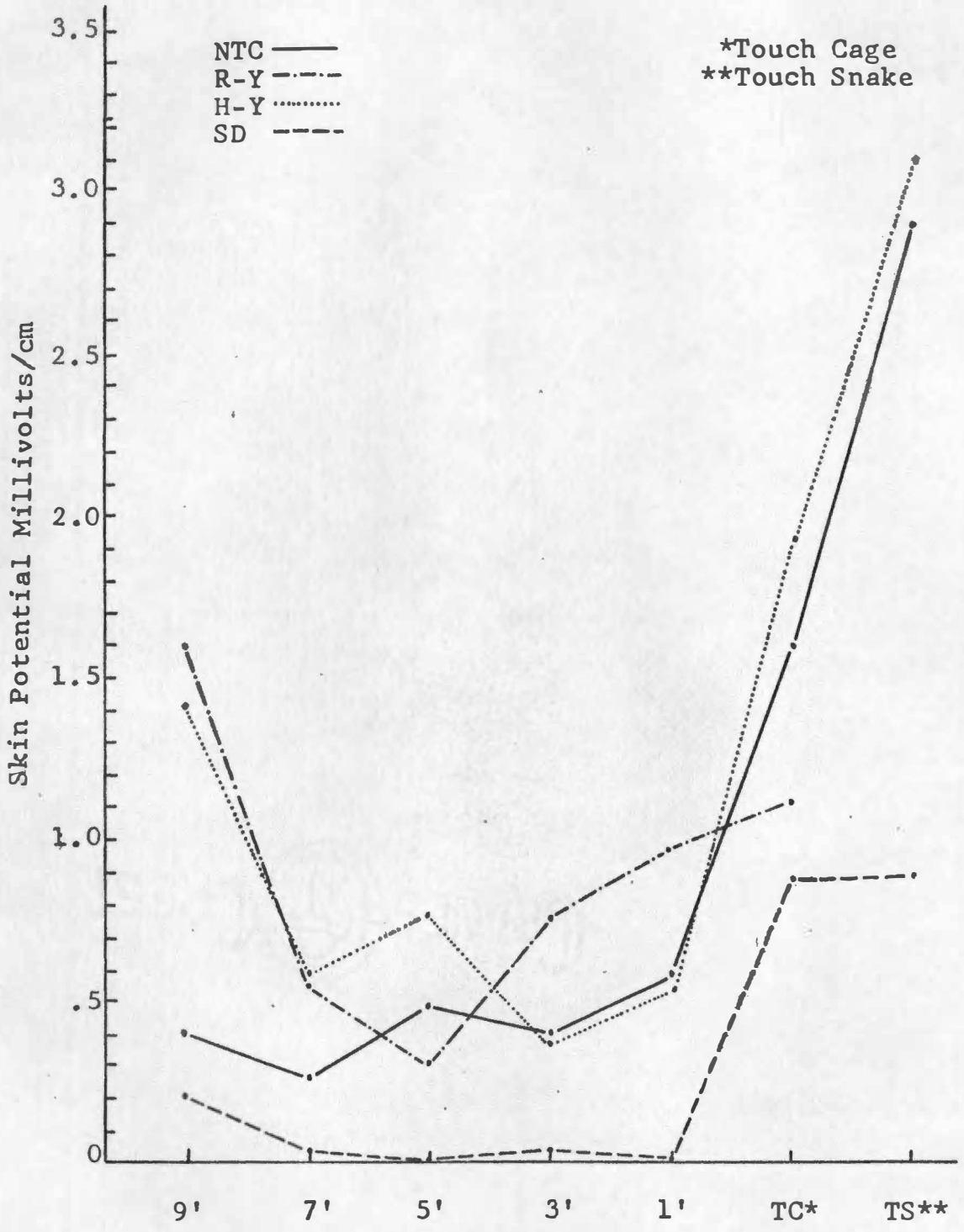

Figure 4. Mean skin potential proximity scores for Post Behavioral Approach Test.

again is the proximity x treatments interaction effect. Although not significant ($F=1.47$, $p < .11$), it is in the predicted direction, adding further support to the notion that systematic desensitization was more effective in producing prolonged decrements in fear during the BAT than either the R-Y or H-Y treatments. Review of Figure 4 makes this point clearer. As with the FT and EMG measures, the curve for SD Ss is particularly low and flat up to the point where S is instructed to touch the cage. This was not the case for any of these measures before treatment, nor was it the case for any of the R-Y, H-Y or NTC measures taken after treatment.

Heart Rate. Neither treatment, proximity or treatments x proximity effects were significant over the second BAT. It is extremely difficult to account for the lack of correspondence between this and the other measures discussed above. Paul (1968), for example, found HR to be an extremely reliable and effective measure for assessing treatment effects on autonomic activity level. Other investigators (e.g., Lacy, 1953; Deane, 1966) have found HR to be positively related to the intensity of a stressor stimulus. Lang, (1969) has more recently provided data which suggests a close correspondence between heart rate and graded anxiety scenes imagined by S. His graphic representation (p. 175) of HR is strikingly similar to our results for EMG and SP, even though his Ss approach the phobic stimulus in imagination while our Ss

approach *in vivo*. All one can say is that under our particular stressor condition, HR failed to differentiate treatment or proximity effects even though all of the other criterion measures were highly consistent in this respect.

Snake Activity

This measure was not significantly different across groups during the second BAT. Dusty rarely moved except when handled. Although we were very successful in reliably recording Dusty's level of gross activity (r=.95), we were not capable of recording more subtle movements like tongue-flicking. It was obvious to us that many of our Ss attended to and reacted to this kind of movement, possibly even more so than gross movements. The utility of our snake activity scale, therefore, remains open to question.

Criterion Inter-correlations

The correlations between criterion measures recorded during the first Behavioral Approach Test are presented in Table IX. The correlations are quite low as is usual for this type of data (Paul, 1968). Since they are based on means, their meaning is considerably obscured. That is to say, these mean scores were computed for each S by dividing the sum of the scores obtained from each minute interval of the BAT by the total number of intervals.

TABLE IX

CRITERION INTER-CORRELATIONS DURING PRE TREATMENT BEHAVIORAL APPROACH TEST

Criterion Measure	EMG	SP	HR
EMG	-	—	—
SP	.2549	—	—
HR	.0043	.3987	—
FT	.4733	.1037	.1480

CHAPTER IV

DISCUSSION

The results consistently demonstrate the superior effectiveness of systematic desensitization in reducing fear, whether measured at physiological, cognitive or motor levels. Relaxation training alone or hierarchy presentation alone was not sufficient to produce significant decrements in either motor or physiological estimates of fear.

Relaxation training, however, did produce significant reductions in subjective reports of fear, but this cognitive decrement itself was not associated with a significant reduction in avoidance behavior, nor does it appear to affect the level of physiological activity associated with the proximity of the phobic stimulus. Relaxation-Yoked Ss in this experiment were told that relaxation training would, in fact, make them feel more relaxed. They went through a series of operations which probably produced this "feeling" and helped to reinforce the experimenter expectancy of improvement already built in by E1. A significant reduction in reported fear was observed up to the point where snake proximity became most disturbing; i.e., the initial terminal point of the BAT run. It is at that point that pre-post cognitive differences disappeared. Most probably the decrement in reported fear during the initial phases of the second BAT run was due to an expectancy built into S

by El and positively reinforced with training in muscle tension reduction. If cognitive estimates of fear were compared only at the terminal points of the BAT, this initial fear decrement would not be observed. Other researchers (i.e., Lang and Lazovik, 1963; Paul, 1964, 1966; Davison, 1968; Leon, 1968; Nawas, 1970a, 1970b) have not reported a decrement in subjective estimates of fear for Ss receiving relaxation training alone. Paul (1968), however, has observed that relaxation training in and of itself can produce significant decrements in subjective fear when compared to a hypnotic treatment or no treatment at all.

Hierarchy-Yoked Ss in this experiment did not improve significantly on any measure after treatment. These results are in direct contradiction to recent research by Nawas et al., (1970a; 1970b) who found significantly less avoidance behavior after treatment in Ss exposed only to the anxiety-evoking scenes. These authors argue that progressive exposure to imagined phobic content does not produce significant increments in fear as Wolpe (1958) contends. Rather, they suggest that progressively more and more massed exposure produces a fear decrement, although not as rapidly or effectively as systematic desensitization. Lang (1969), however, has presented data which clearly shows a rather close correspondence between the aversiveness of imagined phobic content and heightened physiological activity. He also cites a number of studies which have reported fewer "signals" of

anxiety during scene presentations when paired with relaxation training than in the absence of such training. Folkins et al., (1968) investigating the same issue, report increased skin conductance when Ss either imagined frightening events or viewed the events on film. The results of the present study are, therefore, more consistent with a large body of research (e.g., Lang and Lazovik, 1963; Lamont and Edwards, 1967; Davison, 1968; Leon, 1968) indicating that massed exposure to graded phobic content will not produce significant decrements in fear. In our case, Hierarchy-Yoked Ss failed to exhibit physiological, cognitive or motor fear decrements.

Wolpe (1954; 1958) has contended that reciprocal inhibition is the basic mechanism underlying systematic desensitization. By pairing deep muscle relaxation with fear-evoking stimuli, parasympathetic activity mediated by muscle relaxation is said to reciprocally inhibit sympathetic activity of the autonomic nervous system. The bond between the phobic stimulus and fear is therefore severed and gradually replaced by a new bond between stimulus and response. The results of this experiment offer direct support for the reciprocal inhibition hypothesis. Only those Ss who received the contiguous pairing of anxiety-evoking scenes and deep muscle relaxation showed significantly less autonomic reactivity during the second BAT. As a result, all but one of these Ss were able to touch and handle the snake after treatment. They also reported significantly less subjective fear

during the BAT than the other three groups. When compared to five other Ss (NTC, and H-Y) who also "touched" the snake, SD Ss reported less fear and showed significantly less physiological activity as measured by both the EMG and SP. A particularly interesting interaction effect was also observed only for Ss treated with systematic desensitization. During the initial Behavioral Approach Test, rather clear but distinct reaction patterns developed for the physiological and cognitive measures. The introduction of the snake produced a marked startle response in the physiological channels which was not observed in the cognitive measure. As the proximity between phobic stimulus and subject increased, a brief recovery period could be observed in the reduction of physiological activity. Verbal estimates of fear, however, continued to rise as the snake came closer to S. Just prior to the terminal point of the Behavioral Approach Test, physiological activity again rose along with the continued rise in verbal estimates of fear until both physiological and cognitive levels peaked at the terminal point of the Behavioral Approach Test.

After treatment, only Ss receiving systematic desensitization deviated significantly away from the patterns discussed above. During the post treatment Behavioral Approach Test, systematic desensitization effectively reduced the initial startle reaction and produced a marked reduction in verbal fear reports when the phobic stimulus was introduced.

More interesting, however, was the fact that both physiological and verbal fear indices continued to remain low, even though the proximity of the phobic stimulus increased. Very little fear was observed in this group until Ss actually touched the cage housing the snake. This prolonged fear decrement was observed only in Ss receiving desensitization, suggesting that desensitization acts to suppress sympathetic activity which in turn leads to concomitant reductions in subjective estimates of fear and reduction in overt avoidance behavior. This effect was observed even though a clear proximity effect was observed during both Behavioral Approach Tests. The results of this research, then, offer considerable support to the reciprocal inhibition principle as the basic mechanism underlying systematic desensitization.

Before conducting the research, consideration was given to the nature of the relationship between physiological, cognitive and motor indices of fear. It was pointed out that a number of researchers have failed to report high positive correlations between the different measures. We also failed to demonstrate strong correlations between any of the five criterion measures. It was also pointed out, however, that the data were not really amenable to a statistical analysis of the relationships. The graphic data are felt to be much better indicators of the strength of the relationships between the physiological cognitive and motor measures of fear. The correlation between the electromyogram

and skin potential is strong and positive regardless of the proximity of the phobic stimulus. The relationship of these physiological measures to our cognitive measure, however, appears to be inversely related to the proximity of the phobic stimulus. The "intensity" of the fear as measured by physiological activity may or may not be related to subjective estimates of fear. It is hard to understand, for example, how a S could experience such marked physiological reactivity as was observed during the "startle" phase of the Behavioral Approach Test, and yet report only a mild fear increment. A positive correlation between physiological reactivity and verbal report did not begin to manifest itself until the proximity of the phobic object became extreme at the terminal point of each Behavioral Approach Test. One possible explanation for the lack of correspondence between verbal and physiological estimates of fear during the initial phase of the RAT might be an attempt by S to cope with her fear by "talking down" the reaction. This reaction was described by Freud as a reaction formation, a means of coping with anxiety by actively engaging in behavioral maneuvers which in effect help S to convince herself that the situation is not all that fearful. The classical example of this type of defensive posture is the frightened adult who whistles a merry tune while walking past a graveyard on a dark and windy night. This coping behavior would be expected to breakdown, of course, as the situation becomes increasingly

intolerable. One would also expect the initial startle effect to disappear after a number of stimulus presentations, bringing the physiological data much more into line with the verbal data that has been presented.

One must finally try to account for those five Ss (three NTC, two H-Y) who apparently did not know they were incapable of touching snakes. That a clear qualitative difference differentiated them from SD Ss has already been demonstrated. Other conditions obviously motivate people to carry on in the face of intense fear.

These five Ss all reported and indeed experienced extreme fear when they touched Dusty. Nothing E1 said could get them to touch the snake again. Why did they do it, particularly when they did not have to suffer as they did? Three of the five said they were tired of being "chicken." One other had accidentally run into one SD S who told her she had touched and handled the snake. To use her words, "If she can do it, I can do it." The other S just wanted to see what it was like. Even though these Ss "touched" Dusty, it is encouraging to note that our fear criterion measures reflected the intensity of their fear. Through their behavior, these five Ss helped to add support to the notion that proximity to a phobic stimulus and fear are strongly related, and that this relationship can be demonstrated empirically.

Conclusions. The research offers for the first time

clear evidence of regular reductions of levels of sympathetic and skeletal-motor activity during systematic desensitization. It was argued earlier that relaxation versus no relaxation (Rachman, 1968) should not be the central issue of the reciprocal inhibition-extinction controversy. Clearly, relaxation training can produce significant decrements in physiological and cognitive measures of fear (Paul, 1968). That other modalities may also produce similar effects certainly is possible, even probable, and remains to be demonstrated. Paul (1968) was able to show that hypnotic suggestion also effectively reduced physiological and cognitive measures of fear, but not as quickly or effectively as training in deep muscle relaxation. It is quite possible then, that assertive training (as Wolpe, /1958/ suggests) also serves to reciprocally inhibit sympathetic activity. Possibly, suggestions to simply remain calm and quiet are sufficient in some cases to produce significant theraputic effects, as Rachman (1968) and others (Nawas, et al., 1970a, 1970b) maintain. Muscle tension during scene presentations may also operate to produce decrements in some autonomic channels. Lamont and Edwards' (1967) SD subjects were, in fact, instructed to tense muscles during scene presentations and then relax after scene terminations, a procedure very similar to Nawas' et al., (1970b) AMT group. It is not unreasonable to propose that in both cases, Ss improved because these operations served to inhibit sympathetic activity.

Gillhorn (1964) suggests that muscle tension may help to instigate and maintain sympathetic arousal by providing proprioceptive stimulation of the posterior hypothalamus. The results of this research, however, suggest that control over muscle activity can produce decrements in sympathetic activity which are positively related to verbal and overt reductions in fear. It would appear then that experimental extinction, at least as Skinner (1953) defines that term, cannot adequately account for these results. That is to say, the presentation of a fearful stimulus without any real aversive consequences (or what Skinner used to call negative reinforcement) does not lead to a reduction in fear. The anxiety response did not decline simply through a process of stimulus repetition, even though S was led to believe that such would be the case and even though E verbally rewarded "successful" movement up the anxiety hierarchy.

The extinction process has been conceptualized by other researchers (e.g., Guthrie, 1952; Hull, 1943) as something more than a diminuition in response strength due to the lack of proper reinforcement. Extinction has been viewed as an active process of response substitution. Within this framework, the new response is said to inhibit the old response. Guthrie (1952) proposed that a response to a fearful stimulus might be extinguishable if S could be trained to do something else in the presence of the feared stimulus. Wolpe's (1958) "reciprocal inhibition" notion takes this

position one step further by placing the locus of response incompatability at a physiological level. Sympathetic activity is said to be inhibited through the elicitation of parasympathetic activity presumably mediated by muscle relaxation. Since this process is repeated a number of times in the presence of graded anxiety stimuli, the fear response is actively extinguished, creating a new bond between stimulus and response. The results of this research support the response-inhibition position and suggest rather strongly that changes in overt and verbal indices of fear during desensitization depend upon concomitant changes in autonomic activity. That "cognitive set is the controlling element, and that the physiological concomitants are a simple peripheral consequent" (Lang, 1969, p. 194) is also unlikely. All three treatment groups were given rationales which were highly plausible. Every effort was made to convince all Ss that their particular form of treatment had been successful with others and would be successful with them. What is not clear, however, is the S control component which may have something to do with the desensitization effect. In proper desensitization, S controls the frequency, length, and sequence of imagined scene presentations. Since Relaxation and Hierarchy Ss in this experiment were yoked to a Systematic Desensitization partner, they had no control over any of these factors. As Lang (1969) suggests, "In desensitization, the subject learns to control the presentations of stimuli

and perhaps in turn to control the responses that they evoke (p. 188)." Davison (1968) failed to find significant treatment effects for any of his yoked groups. Nawas, et al., (1970b) do report significant decrements in avoidance behavior for yoked AMT and ANT groups when compared to a Pseudo Systematic Desensitization group or NT controls. These results, however, are difficult to interpret, (see p. 10).

Perhaps additional light may be thrown on the subject from a little known but interesting piece of research done with animals. White (1968) conditioned fear responses to a tone in white rats and then assigned them to one of five treatment conditions: (1) Reciprocal Inhibition - animals in this condition ate food in the presence of a tone hierarchy; (2) Extinction - no food was available during the tone presentations; (3) Yoked Reciprocal Inhibition - treatment was identical to the RI category except that Ss were yoked to Ss in the E category; (4) Yoked Extinction - treatment was identical to the E category except Ss were yoked to Ss in the RI group; and (5) No Treatment. Using the number of boli defecated during and after treatment as his measure of fear, White reported the control group defecated significantly more than all treatment groups except the yoked-extinction group. This latter group, comparable to the hierarchy-yoked group in the present study, defecated significantly more after treatment than all other treatment groups.

More interesting, however, was the fact that the Extinction group showed as much improvement after treatment as the Reciprocal Inhibition group. The E group was purposely formed to evaluate the effect of S control on treatment success. The animals in this group were presented the same anxiety (tone) hierarchy as Ss in the RI group. They were not, however, yoked to the RI Ss as were the animals in the Yoked-Extinction group. Rather E Ss were presented a new hierarchy tone only when they had successfully demonstrated no fear to the preceding tone; i.e., no defecation. Ss in the E group in effect controlled their movement up the hierarchy and may, therefore, have learned to control the responses which were previously under stimulus (phobic) control. White (1968) concludes that relaxation may be important not because it inhibits anxiety, but because it permits S to control treatment progress.

> . . . the occurrence of the incompatible response serves as an indicator to the experimenter that extinction has taken place at the current hierarchy item, and it is possible to move on to the next item. This view is also the most parsimonious in that it does not depend upon the undemonstrated reciprocally inhibitory nature of these responses to anxiety (p. 12).

The question of subject control is intriguing and, as yet, little researched. The present study clearly indicates, however, that the contiguous pairing of relaxation with anxiety-evoking stimuli does produce decrements in autonomic activity. Nevertheless, it is possible that the decrements observed could have been the result of subject's control over

the number of stimulus presentations, sequence of presentations and duration of presentations. In our experiment, SD Ss were the only Ss which exerted control over treatment progression. No statement, therefore, can be made about the relationship of S control to treatment success.

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APPENDIXES

APPENDIX A

LIST OF TEN SNAKE RELATED FEAR ITEMS COMPRISING THE ANXIETY HIERARCHY

Sitting in a chair, comfortable and relaxed, 100 feet away from a caged, harmless snake.

Sitting in a chair, 50 feet from caged snake.

Sitting in a chair, 25 feet from caged snake.

Sitting in a chair, 12 feet from caged snake.

Sitting in a chair, 6 feet from caged snake.

Sitting in a chair, 3 feet from caged snake.

Sitting in a chair, 1 foot from caged snake.

Sitting in a chair with caged snake along side of your right arm.

Sitting in a chair, reach over and touch the cage housing snake.

Sitting in a chair, reach over, unlock the cage door and touch the snake.

APPENDIX B

LIST OF TEN SNAKE IRRELEVANT SCENES USED WITH RELAXATION-YOKED SUBJECTS

Standing on street corner, waiting for light to change.

Walking down a street.

Buying a book.

Painting a sign.

Reading the evening newspaper.

Making out a shopping list.

Getting gas in your car.

Talking to a friend.

Walking on campus between classes.

Watching television.

APPENDIX C

LIST OF TASKS HIERARCHY-YOKED SUBJECTS PERFORMED DURING FIRST THREE TREATMENT SESSIONS

Drank a glass of water.

Read out loud from introductory psychology text for ten minutes.

Counted backwards out loud from 100.

Drank a glass of water.

Performed a series of simple mathematical operations for five minutes.

Drew a circle, triangle, square, rectangle, pentagon, hexagon and octagon at one minute intervals.

Drank a glass of water.

Made statement about how they felt at that moment.

VITA

Vey Michael Nordquist was born in Seattle, Washington, attended high school in Los Gatos, California, and received the B.S. degree in psychology from the University of Washington in 1964. In the fall of 1964 he entered the graduate program in clinical psychology at The University of Tennessee. After three years of academic work, he left the University to intern for twelve months at the VA Hospital in Palo Alto, California. He returned to Tennessee in January 1969. After a brief sojourn with academia during the winter and spring months, he took a summer position in Kentucky working with retarded children in the Appalachian mountains. In the fall he accepted an offer to work with the Department of Child Development at The University of Tennessee as an assistant professor where he is now teaching and directing research.