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I am submitting herewith a dissertation written by Doris A. Abood entitled "The Effects of Acute Physical Exercise on the State Anxiety and Mental Performance of College Women." I have examined the final 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 Education, with a major in Health Education.

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THE EFFECTS OF ACUTE PHYSICAL EXERCISE ON THE STATE ANXIETY AND MENTAL PERFORMANCE OF COLLEGE WOMEN

A Dissertation

Presented for the

Doctor of Education

Degree

The University of Tennessee, Knoxville

Doris A. Abood

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3053652

DEDICATION

To my brother Charles,

in the hopes that his artistry and creativity

will someday be recognized

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ABSTRACT

The purpose of this research was to determine the effects of acute physical exercise on the state anxiety and mental performance of high and low anxious women. An additional objective was to analyze the contribution of fitness level to the relationship between the independent and dependent variables.

Subjects (n = 85) were undergraduate students enrolled in health and safety courses in the Division of Health and Safety at The University of Tennessee, Knoxville, during the Spring Quarter, 1981. State anxiety was assessed by the State-Trait Anxiety Inventory. The Digits Backwards subtest of the Wechsler Adult Intelligence Scale was used to measure mental performance. Following an initial administration of these tests, subjects were given either five minutes of bench-stepping activity or a quiet rest. A second assessment of anxiety level and mental performance was then taken. State anxiety and mental performance scores were analyzed for significant differences by using the Wilcoxon Matched-Pair Signed-Ranks test. The Kruskal-Wallis one way analysis of variance by ranks was employed to also determine whether significant differences existed in the state anxiety and mental performance of high and low anxious women comprising the high-, medium-, and low-fitness categories. Fitness level was based upon the individual's age, body weight, and post-exercise pulse rate. The results indicated that,

overall, physical exercise did not significantly reduce state anxiety in high anxious women. However, fitness level did appear to influence the extent to which exercise reduced the high anxiety state. In this regard, high- and medium-fit women experienced a significant reduction in state anxiety following exercise while low-fit women did not. With respect to mental performance, only quiet rest resulted in increased scores on the Digits Backwards test. For low anxious women, exercise increased state anxiety but not mental performance. It was concluded that exercise alone was not a sufficient predictor of the effects of exercise on high anxious women. Finally, it was suggested that for the somatic mechanisms influenced by high anxiety, physical exercise has some therapeutic value. For the cognitive mechanism affected by high anxiety states, a quiet rest is beneficial.

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CHAPTER I

INTRODUCTION

A growing number of health educators are directing their attention toward assisting man's creative adaptation to the high stress levels characteristic of twentieth century living. Physicians estimate that as much as 70 percent of medical practice is in treatment of malfunctioning and disease that is psychosomatic in origin (Oberteuffer, 1972). Studies reveal that 25 to 50 percent of the United States population are sufficiently maladjusted to require some systematic treatment (Cattell, 1961). Anxiety was emphasized as being of great importance in its relationship to a desirable emotional state by H. C. Lindgren (1959) when he stated:

> The major emotional problem faced by most of us is not that of controlling or coping with the more violent emotions of rage and fear but rather that of dealing with the more subtle emotion of anxiety.

There is general agreement that severe anxiety hinders the academic performance of students. It has been shown in a number of studies that anxiety inhibits test performance and increases the number of errors (Calvin, McGuigan, and Sullivan, 1957; McKeachie, 1958; McKeachie, Pollie, and Speisman, 1955; Harleson, 1962; and Pickrel, 1958). Kirkland (1971) generalized that a high level of anxiety caused impaired mental performance. Malmo (1959) and Taylor (1956) found an inverted U-function between

activation level and the performance of tasks of various levels of difficulty. That is, for low anxious students the amount of arousal present during regular course examinations was about optimum according to Malmo for high anxious students, however, the anxiety engendered by a regular course examination raised the total arousal level past the optimum point, thus impairing performance. It could be hypothesized then, that if the high arousal level present in the highly anxious student could be effectively reduced, mental performance may be improved as a result.

One popular means of anxiety reduction is physical exertion. The rationale for using exertion to lower anxiety is threefold. First, exertion is a competing or incompatible response of an active, assertive, and forceful nature. Secondly, exertion is the natural usage and consumption of physiological arousal and tension. Finally, sufficient exertion can partially exhaust and inhibit the capacity for further anxiety arousal in a process similar to that proposed by Rachman (1969) for implosive therapy (Lazarus, 1965).

With certain populations, however, exercise has prompted different effects. For low anxious individuals, exercise has been found to increase anxiety level (Wood, 1977). This occurrence does not appear to be problematic in light of the fact that anxiety level increases remained within normal levels. Thus, low anxious individuals may

experience a more heightened awareness as a result of physical activity.

It has been further reported that exercise may be contraindicated for certain types of individuals due to excessive lactate accumulation in the blood. Pitts (1969) and Pitts and McClure (1967) have proposed that lactate, an exercise metabolite, can provoke anxiety symptoms in anxiety neurotics. He has further stated that anxiety symptoms could occur in normal persons under stress as a result of excessive lactate accumulation. This may be due to the fact that a specified degree of activation (i.e. exercise) may induce heavy rather than moderate ranges of arousal depending upon the fitness level of subjects for the activity involved (Gutin and Digennaro, 1968a). Therefore, any consideration of the influence of physical exercise on an individual should include the fitness level of the individual for the particular activity involved.

Few would disagree with the importance of physiologic well-being in the maintenance of emotional health. Physical exercise has often been described as a method of controlling tension (Sessoms, 1965). In addition to serving as a method of preventing tension, this type of medical prescription has also been concerned with developing a higher stress tolerance level (Sessoms, 1965). Much of the research on exercise and its effects on psychological status--especially tension, anxiety, and depression--supports the conclusion

that exercise results in improved physical fitness and has psychological benefits for many adults. Exercise has been associated with an improved sense of well-being (McPherson, 1967), better sleep patterns (Baekelund, 1970), and reduced muscle tension (deVries, 1968). It has also been correlated with objective demonstration of reduced anxiety, depression, and hostility (Folkins, 1972).

Physical activity not only has a potential for anxiety reduction but many research studies suggest that mental performance may also be improved. Ellis (1927) conducted experiments which indicated that muscular exertion, induced by means of a hand dynamometer, positively affected the performance of various mental tasks such as learning paired associates or adding digits. More recently, Stockfelt (1968) and Davey (1973) have conducted studies using a dynamic form of physical exertion--riding a bicycle ergometer--to induce varying degrees of arousal. Stockfelt (1968) suggested that the performance of his subjects on simple addition and subtraction problems was related to the degree of arousal, which was consistent with the inverted U hypothesis. According to this hypothesis, complex tasks are performed best when one's arousal or motivation is relatively low; but optimal proficiency on simple tasks occurs when arousal is high. As arousal is increased so is performance, to a point. Continued increase in arousal level leads to poorer performance. Davey (1973) reported similar

results when using a task designed to measure mental performance. This task required the subjects to respond to audible digits when they were presented in a prescribed sequence. Mental performance scores improved after one-half, two, and four minute periods of exertion and deteriorated after six minute periods. These results suggest that mental performance was consistent with the inverted U hypothesis. McAdam and Wang (1967) studied the effect of mild physical exertion as a method of arousing an individual prior to a mental task. They used a combination of running, jogging, and walking to induce mild work but not fatigue. Immediately before and after exercise the 108 adult male subjects were administered a 10 minute symbol substitution task. The results, although non-significant, tended to favor exercise before the mental task.

If the stimulus of physical exercise can be shown to influence behavior, specifically, reduce high levels of anxiety with resultant improvement in mental performance, then health educators should be aware of the effects of such a relationship. The present study was conducted in order to provide more information toward the understanding of the effects of physical exercise upon anxiety and upon mental performance and explore the potential for practical application among health educators.

I. RATIONALE

Education is a function of the educatee (Oberteuffer, 1972). The educator can only provide students with opportunities to respond to new experiences and comprehend new ideas. Students suffering from some organic or functional disorder are handicapped not just physically but also socially and mentally. Psychological disturbances serve to reduce mental and social effectiveness. Psychological problems involving anxiety states, for example, have been estimated to involve 2 percent to 4 percent of the general population (Lader, 1972; Pitts, 1969; Wilkinson and Latif, 1974). Gaudry and Spielberger (1971) reported that "the most consistent general finding . . . is that high anxiety is associated with relatively low performance at both the school and university level" and "that at the college level, there is evidence that anxiety tends to be associated with lower grades and higher dropout rates." Furthermore, there is evidence that students who suffer from high levels of anxiety have other emotional problems. Gaudry and Spielberger (1971) reported several studies supporting claims that highly anxious children have poor self-images, that they are unpopular, and that teachers see them as being poorly adjusted.

Women in particular seem to possess a certain susceptibility to anxiety and have exhibited problems in mental performance as a result. Despite the great strides that

have been made in terms of women's equality and independence, a vast majority of women continue to function in American society with a passive-dependent attitude. In turn, greater dependency tends to make women more vulnerable to anxiety (Sherman, 1971). Maccoby (1966b) has reported that anxiety has a substantially negative influence on measures of aptitude or achievement for girls and women. Folkins, Lynch, and Gardner (1972) found that women were significantly less fit psychologically than men in a study using physical activity as a treatment for psychological disorders. Women were found to be more anxious, more depressed, less confident, and less well adjusted. After 15 weeks of running, however, the women showed significant improvement in all these areas. Thus, the prescription of physical exercise may provide women with at least temporary relief from the effects of anxiety while providing this population with the opportunity to take more personal responsibility for dealing with their problems.

Health educators do have professional roles in pupil and community mental health. It is doubtful that there will be enough mental health specialists to handle the growing numbers of people needing diagnostic or therapeutic services. Consequently, emphasis is being placed on attempts to prevent poor mental health by improving social environments and by teaching people to deal more effectively with their own problems. In these preventive and positive functions,

health educators have an important role in offering intervention techniques to their students and community.

The relationship between stress and disease seems indisputable. People will continually strive and press for high achievement in a society that measures individual success by high status and increased financial reward. Today, health educators are confronted with new demands not the least of which is improving an individual's ability to survive in as healthy a manner as possible. Physical exercise can be an extremely important tool in the individual's personal arsenal in controlling the effects of high anxiety. It then becomes the responsibility of health educators to become facilitators in the school and community for developing and providing techniques for controlling the deleterious effects of high anxiety.

There is a need to explore further the preventive and rehabilitative potential of physical exercise. Previous research has indicated that psychological problems involving anxiety states hinder academic performance and serve to reduce mental and social effectiveness. Yet, previous research efforts which have addressed the efficacy of physical exertion in the reduction of anxiety are equivocal. The present study was conducted in an attempt to provide new information about a person's ability to control anxiety through exercise. In this way, an effort was made to suggest an expansion of the boundaries of health education.

II. PURPOSE OF THE STUDY

The primary purpose of this study was to investigate the effects of acute exercise on the state anxiety and mental performance of high and low anxious college women.

III. STATEMENT OF THE PROBLEM

The present study was conducted to determine if acute exercise influenced the state anxiety and mental performance of high anxious and low anxious college women.

This study was designed to answer the following questions:

1. Does acute exercise decrease the state anxiety of high anxious women?

2. Is there a difference in the state anxiety scores of high anxious women comprising the high-, medium-, and low-fitness levels?

3. Does acute exercise increase the state anxiety of low anxious women?

4. Is there a difference in the state anxiety scores of low anxious women comprising the high-, medium-, and low-fitness levels?

5. Does acute exercise increase the mental performance of high anxious women?

6. Is there a difference in the mental performance scores of high anxious women comprising the high-, medium-, and low-fitness levels?

7. Does acute exercise increase the mental performance of low anxious women?

8. Is there a difference in the mental performance scores of low anxious women comprising the high-, medium-, and low-fitness levels?

IV. HYPOTHESES

The following research hypotheses were developed for this investigation:

1. Acute exercise decreases the state anxiety of high anxious women.

2. There is a difference in the state anxiety scores of high anxious women comprising the high-, medium-, and low-fitness levels.

3. Acute exercise increases the state anxiety of low anxious women.

4. There is a difference in the state anxiety scores of low anxious women comprising the high-, medium-, and low-fitness levels.

5. Acute exercise increases the mental performance of high anxious women.

6. There is a difference in the mental performance scores of high anxious women comprising the high-, medium-, and low-fitness levels.

7. Acute exercise increases the mental performance of low anxious women.

8. There is a difference in the mental performance scores of low anxious women comprising the high-, medium-, and low-fitness levels.

V. DELIMITATIONS

The present experiment was delimited to an investigation of the effects of acute physical exercise on state anxiety and mental performance of University of Tennessee women enrolled in undergraduate health and safety classes during the Spring Quarter, 1981. This study was also delimited to the scores on the State-Trait Anxiety Inventory and the Digits Backwards subtest of the Wechsler Adult Intelligence Scale. This study was delimited further to five minutes of bench-stepping which served as the physical exercise task.

VI. LIMITATIONS

Since subject participation was on a voluntary basis, the sample, and any findings, are not claimed to be representative of the entire population of female students enrolled at The University of Tennessee.

VII. BASIC ASSUMPTIONS

1. Individuals who participated in the study were cooperative and were motivated to present their true responses on the State-Trait Anxiety Inventory.

2. Individuals who participated in the study performed to the best of their ability on the mental performance test.

VIII. DEFINITION OF TERMS

1. Acute Physical Exercise refers to a short bout of physical activity. In this study, five minutes of bench-stepping served as the mode of exercise.

2. Attention is defined as an effortless, passive, unhampered contact with outside reality--a free receptiveness (Rapaport, 1968).

3. Bench-Step Test is defined as a procedure which measures an individual's level of physical fitness. It is a measure of the general capacity of the body, particularly the cardiovascular system, to adapt itself to hard work and to recover from what it has done.

4. Concentration is defined as an active relationship to outside reality. A conscious effort which is exerted to keep out of consciousness all material that is not directly pertinent (Rapaport, 1968).

5. Digits Backwards refers to a subtest of the Wechsler Adult Intelligence Scale which requires repetition in a backwards sequence of a series of numbers ranging from three to eight digits in length.

6. High Anxiety refers to a level of intense apprehension and fearfulness that approaches panic as measured

by the State-Trait Anxiety Inventory.

7. Low Anxiety refers to a state of relative calmness and serenity as measured by the State-Trait Anxiety Inventory.

8. Mental Performance is defined as the number of series of Digits Backwards correctly reproduced by an individual out of the six series given.

9. Physical Fitness Level refers to the general capacity of the body to adapt itself to hard work and to recover from what it has done. In this study, physical fitness level was measured by the bench-step test.

10. Standard Control Session refers to that session during which subjects in the control group rested in a comfortable chair for a period of five minutes.

11. State Anxiety may be conceptualized as a transitory emotional state or condition of the human organism that varies in intensity and fluctuates over time. This condition is characterized by subjective, consciously perceived feelings of tension and apprehension, and activation of the autonomic nervous system (Spielberger, 1971).

12. Trait Anxiety refers to relatively stable individual differences in anxiety proneness--that is--differences in the disposition to perceive a wide range of stimulus situations as dangerous or threatening, and in the tendency to respond to such threats with state anxiety reactions (Spielberger, 1971).

CHAPTER II

REVIEW OF RELATED LITERATURE

A thorough review of the related literature revealed a paucity of research dealing with the effects of physical exercise on anxiety and mental performance. The literature review is divided into five sections: 1) the concept of anxiety, 2) anxiety and its relationship to learning, 3) anxiety as it is affected by physical exercise 4) the effects of physical exercise on mental performance, and 5) the effects of effort and drive on visual perception. The first section provides information on the concept of anxiety as it is perceived by individual researchers. The second section examines the effects of anxiety on various learning tasks. The third section reviews the research conducted on the ability of exercise to reduce anxiety. The fourth section of the reviewed literature examines the effects of static as well as dynamic forms of exercise on mental performance. The fifth section reviews the available research on the effects of muscular induced exertion and anxiety on visual perception.

I. CONCEPT OF ANXIETY

Anxiety has been an extensively discussed and researched area. Ideas or conceptions about anxiety have covered a broad spectrum from the conceptual discussions

of Freud (1936) to Horney's (1945) "basic anxiety" to Sullivan's (1953) "state of tension" which results from the individual's threat, to Mowrer's (1950) feeling that anxiety was the result of an individual's guilt resulting from regretted actions. There have been many studies (approximately 3,500 from 1950-1964) conducted in this area (Spielberger, 1966) and many tests and measurements (approximately 120) constructed to measure it (Cattell and Sheier, 1958).

Research by Yerkes and Dodson (1908) indicated that there is a curvilinear relationship between anxiety and learning. In other words, high arousal levels on simple tasks facilitate or improve performance, but impede performance on complex tasks. High levels of anxiety distract or reduce task-relevant behavior, while low levels of anxiety help to focus or increase task-relevance.

Wolpe (1958) described a more objective definition of anxiety, which he described as an autonomic response pattern that was characteristically a part of the organism's response to noxious stimuli. Other researchers have hypothesized a two-factor theory of anxiety (Cattell and Sheier, 1961; Heath and Korchin, 1963; Lazarus, 1966; Spielberger, 1966). Typically, the first factor refers to a condition which Lazarus (1966) calls "chronic anxiety," and which Spielberger (1966) refers to as "trait anxiety." This chronic or trait anxiety is a learned perception

illustrated by the individual who perceives a wide range of typically non-threatening stimuli and exhibits various autonomic responses (Spielberger, 1966). A cyclical reaction pattern is then set off as the autonomic responses become stimuli or cues for further increases in anxiety (Lang, 1969).

The second factor refers to "acute anxiety" (Lazarus, 1966) or "state anxiety" (Spielberger, 1966). This factor is exemplified by subjective, consciously perceived feelings of anticipatory anxiety or tension which are elicited by a specific unidimensional stimulus or stimuli from either internal or external cues. This type of anxiety is more situational.

II. ANXIETY AND ITS RELATIONSHIP TO LEARNING

Anxiety has been associated with unpleasantness and disorganization. Despite these tendencies, it is an essential process, but one that does not always function in an optimally adaptive way.

Anxiety is generated when an individual is motivated to achieve a certain level of proficiency in performing a task. Anxiety is also induced in the learner when working under distracting conditions.

Research has shown that anxiety may help performance when an existing response is to be strengthened, but impede it when a new response is expected (Palermo, 1957)

Anxiety involves an intricate relationship between strength of motivation, degree of frustration, and personality variables. At certain times and in some cases, threat of failure strongly motivates the learner to work for success, thereby facilitating performance. In other cases, however, levels of anxiety are so disorganizing that performance is disrupted, producing "mental blocks" which distract the learner from his task (Castenada and Lipsitt, 1953).

It has been shown that anxiety can impede effective learning by reducing the individual's ability to discriminate clearly. In one study, subjects were tested for anxiety before participating in eyelid-conditioning experiments. All subjects were then given 60 conditioning trials in which a light appeared in the right-hand one of two windows. The light was invariably followed by an air puff delivered to the right eye.

Next, all subjects were given a series of discriminating trials in which light appeared sometimes in the right window, as before, and sometimes in the left one. An air puff always followed the light in the right window and never in the left window. The anxious subjects tended to blink in response to both lights, whereas the non-anxious subjects were more selective in their responses, blinking less often to the light on the left (Hilgard et al., 1953). Anxious individuals, who have a tendency to regard many situations

as threatening, are thus handicapped in new learning where precise discriminations are required.

The research of Pavlov (1928) further documents that high levels of anxiety interferes with discrimination. Pavlov produced experimental neuroses in dogs, a process entailing frustration, conflict, and anxiety. He produced this by establishing conditioned responses to two signals, one always reinforced and the other never reinforced by food. The two signals were then gradually made so similar that the animals disturbed behavior outwardly resembled a human anxiety state and they could no longer discriminate between the two signals.

Anxiety has been found to interfere with the learning of new material and material that contradicts previous learning more than it does with the learning of familiar material. Two groups of students, differing in their anxiety state level, learned two different types of paired-associate materials--meaningful words, such as man-boy, and inaccurate arithmetic combinations, such as "2 x 3 - 9." The performance of high anxiety and low anxiety subjects did not differ significantly on tasks involving familiar meaningful material with either immediate or delayed testing. However, on tasks involving contradictory material, the performance of high anxiety students was significantly lower and their learning rate was slower (Korchin and Levine, 1957).

Farber and Spence (1963) conducted a study utilizing 80 subjects in order to ascertain the relationship of complex learning and anxiety. The study was concerned with the performance of anxious and non-anxious subjects on a stylus maze. The authors predicted that the total performance of the non-anxious group would be superior to that of the anxious group in the relatively complex task. Two groups of 40 subjects each, whose scores were respectively within the upper and lower 20 percent of scores on the Taylor Anxiety Scale learned the maze. As predicted, the maze performance of anxious subjects was significantly poorer than that of the non-anxious subjects.

Lazarus, Duse, and Hamilton (1964) specifically studied the relationship between serial learning and personality variables under two conditions of stress produced by electric shock. Marked differences were found between groups characterized as having high and low anxiety. The basis of these differences was an impairment of performance by the high anxiety group under the stress condition. An analysis of variance of data showed the high anxiety groups consistently performing poorer than low anxiety groups.

Anxiety increases the length of time required for learning. Jones (1964) reported highly significant differences between mildly anxious groups and two sets of severely anxious groups in length of time required for

learning and in the proportion of stereotyped responses to the total number of responses. The 144 subjects, young men and women of similar socio-economic backgrounds, were divided at random into six groups and given a problem which could not be solved, with the intent of increasing frustration and anxiety. Members of these groups were told that performance in learning patterns such as these was a good test of intelligence and that they should be able to solve the problem in two minutes. Members of the other group were told that the experimenter was using them merely as a sample group to test the difficulty of the problem. After frustrating attempts, all groups worked on patterns which could be mastered. In the amount of time required to learn these solvable problems, there was a highly significant difference between the mildly anxious subjects and those deemed severely anxious. The severely anxious subjects required significantly more time to solve the problems.

When an individual is motivated to achieve, failure or threat of failure produces anxiety. Working under the pressure of time also induces anxiety in the learner. Lazarus and Erickson (1952) demonstrated this in a study involving a large group of college students who were informed that they were about to take an intelligence test which was an excellent predictor of college success and that the results would influence their status in school. The subjects were then administered a learning task from

the Wechsler-Bellevue Intelligence Scale. After the tests were collected, presumably for correction, the names of part of the group were read off and instructions given for these students to report to another room. The students remaining were then told that they had done very poorly on the intelligence test, whereas the other group had done satisfactorily. It was explained that failure was a serious matter and that they would therefore be given another chance. Following a stern warning presumably intended to place them under stress, subjects were given an alternate form of the test. Meanwhile, subjects in the other group were also given the alternate form of the test. This group was told that they had performed well on the first test and that they were to take the second test only to be sure that their true ability had been measured.

Unexpectedly, the average number of correct responses on the second test was the same for both groups. The students under stress and displaying high anxiety, however, made a greater number of total responses. They showed an increase in speed of performance as compared to the non-stress group, but this increase in speed occurred at the expense of accuracy.

III. ANXIETY AND PHYSICAL ACTIVITY

The reduction of anxiety following vigorous physical activity has been demonstrated by several investigations.

Byrd (1963) reported that 92 percent of 439 physicians surveyed prescribed physical activity for the relief of tension. In addition, Handlon (1963) found that bowling reduced anxiety in anxious subjects. deVries (1968, 1972) demonstrated in a series of investigations that muscular tension, as measured electromyographically, was reduced significantly following vigorous exercise. deVries further reported that the subjects in his exercise group had a greater reduction in tension than a group of subjects who received meprobamate, a frequently prescribed tranquilizer drug. Exercise is frequently prescribed as a method of controlling tension in rehabilitation facilities. Although there is a lack of direct causal evidence on the effect of exercise on tension level, there is little disagreement among the supervisors of rehabilitation facilities regarding the importance of physiological well-being in the maintenance of emotional health (Sessoms, 1965).

Pitts and McClure (1969) reported that physical activity may be contraindicated in certain types of individuals. The authors proposed that lactate, an exercise metabolite, can provoke anxiety symptoms and attacks in anxiety neurotics. Pitts further stated that anxiety symptoms could occur in normal persons under stress as a result of excess lactate accumulation. Also, Pitts stated that some of the symptoms of anxiety neurosis are similar to those produced by physical activity. Kelly et al. (1971)

and Fink et al. (1969) have supported the Pitts-McClure hypothesis. Furthermore, in the Pitts-McClure (1969) investigation, anxiety symptoms were found to covary with electroencephalographic changes usually present in patients during anxiety attacks.

However, the Pitts-McClure hypothesis has been refuted by Grosz and Farmer (1969) and Lassers and Nimmo (1969). Grosz and Farmer reported that the infusion of sodium DL-lactate does not reproduce the physiological changes which accompany vigorous exercise. Infusion of sodium DL-lactate produces a metabolic alkalosis which is quite different from the endogenous production of lactic acid, which brings about a drop in pH and, hence, acidity. Thus, the metabolic routes are quite different.

Vigorous physical activity has been reported as a useful "coping strategy" for reducing anxiety by Morgan and his associates. Morgan and Pollock (1976) report that acute and chronic physical activity of a vigorous nature offers a unique and effective method of reducing tension (state anxiety) and depression. However, the writers caution one to keep in mind that this improved sensation of well-being following acute and chronic exercise may have other causes. The point is that when one decides to make a change in one's lifestyle such as embarking on a regular exercise routine, this may influence one's psychological well-being in a positive manner. In addition, when one decides to exercise

regularly, changes in other habits such as eating and sleeping frequently occur, resulting in a generally more healthful life pattern overall.

In a recent investigation, Morgan and Bahrke (1978) utilized the STAI to evaluate the state anxiety of 75 adult males before a vigorous workout, immediately following, and 10 minutes after the activity. Significant decreases in anxiety were found in both post exercise settings.

Morgan and Horstman (1976) investigated anxiety reduction after vigorous physical activity. Participants exercised at 80 percent of their maximal aerobic power until complete exhaustion. In this investigation anxiety was evaluated during as well as immediately following exercise, with a modified four-item STAI (Spielberger, 1970). A motor-driven treadmill was used as the mode of exercise. Early in exercise anxiety increased significantly, reached an asymptote, then rapidly decreased following exercise. By the tenth minute following exercise, anxiety levels had dropped below the baseline levels. Anxiety reduction occurred for both "normals" and "clinically anxious" individuals.

An investigation by Mitchum (1976) revealed a significant decrease in state anxiety as a result of 15 minutes of racquetball activity by 20 adult males and 20 adult females. In his experiment, Mitchum also measured state anxiety levels with the STAI which has been the most widely

used inventory in studies described throughout this section.

Sime (1977) found that state anxiety levels were lowered following both exercise and meditation, but the decreases were not significant. The effect of treadmill exercise and Benson's Meditation was compared with a placebo treatment for reduction of resting heart rate, diastolic blood pressure, frontalis muscle tension, electrodermal response, and state anxiety. Exercise significantly reduced resting heart rate and electrodermal response but not state anxiety, diastolic blood pressure, or frontalis muscle tension.

Folkins, Lynch, and Gardner (1972) have also used physical activity as a treatment for psychological disorders with reported success. They used several adjective checklists to measure variables related to both depression and anxiety. Three college phsyical education classes formed the experimental and control groups; an archery class and a golf class were used as controls with a jogging class serving as the experimental group. Preliminary testing showed that the two groups differed on the psychological variables; the women in the experimental group were significantly less fit psychologically than the controls. They were more anxious, more depressed, less confident, and less well adjusted. After 15 weeks of running, these females had shown significant improvement in all these areas. The males also had improved but not to the same extent as the women. No changes were observed in the control group.

IV. THE EFFECTS OF PHYSICAL EXERTION ON MENTAL PERFORMANCE

The study of the effects of physical exertion on mental performance was begun by Bills (1927) which involved four female and five male advanced college students. His results showed that performance, as measured by the memorization of nonsense syllables, was facilitated by the squeezing of a hand dynamometer.

Inconsistent results, however, were found by other investigators. Zartman and Cason (1934) studied six male and twelve female subjects to further investigate the effects of exertion on mental performance. The subjects were administered 48 short arithmetic problems. Twenty-four of them were answered while the subject depressed a pedal, with his right leg, which required a force of 25-40 pounds. The results showed neither a definite increase nor decrease in the efficiency of solving arithmetic problems.

Duffy (1932) tested 18 children between the ages of 2 years and 11 months, and 3 years and 11 months on a task chosen to measure their ability to press a key when pictures of an automobile were shown among other randomly arranged pictures. At the same time hand dynamometers were held. She found that the results obtained from children who exerted a high degree of muscular tension while holding the dynamograph were usually associated with a performance of poor quality although she further suggested that good

performance most frequently occurred when the dynamograph was held with moderate to low degrees of muscular tension.

Stauffacher (1937) tested 40 university students in a study which covered a range of muscular tensions generated by lifting weights with an arm. Treatment conditions ranged from zero through one-quarter and one-half to three-quarters of the maximum weight that the subject could lift. He found that the learning of nonsense syllables was facilitated, and that the best results were obtained at one-half the maximum tension. Tensions of less than this, however, gave little or no evidence of facilitation of learning. In this experiment the orders of the treatments were randomized and one was administered daily for four consecutive days.

A more recent study was conducted by Wood and Hokanson (1965) who divided the range of muscular exertion into five treatment conditions. Treatment conditions ranged from zero through three-quarters of the maximum weight that the subject could lift. This task consisted of lifting weights with the arms and supporting them at the side while performing a digit-symbol substitution task. The results indicated that tension, induced by one-half the maximum weight lifted, allowed for optimal performance while greater or lesser amounts resulted in sub-maximal performance. The subjects were 40 male and 60 female undergraduate students who had a normal basal heart rate between 72 and

92 beats per minute. Heart rate was also monitored and used as an indicator of arousal.

These studies were all interpreted as being consistent with the inverted U hypothesis which predicts that performance on a learning task would be facilitated by increased levels of induced tension up to some maximum point, after which it would begin to fall off with further increases in tension.

Up to this point researchers have been concerned with the effects of static muscle tensions as a method of inducing arousal and the test of mental performance has been administered concurrently with the treatment condition of physical exertion. This design does not allow for the analysis of the effects of interactions between the execution of the performance task and the exertion task. More specifically, decrements in performance, which have been reported to have occurred after some optimum has been reached, may have been due to attention being directed towards execution of the physical exertion task and not due to further increases in levels of arousal.

More recently an alternative design in experimentation has been included in the investigations. Arousal has been induced by a variety of dynamic methods including running, bench-stepping, and riding a bicycle ergometer, and tests of mental performance have been administered. In addition to reducing possible artifacts arising from the

simultaneous execution of the performance task and the exertion task, this design has enabled the investigation of the prolonged effect of physical exertion on arousal over a period of several minutes.

McAdam and Wang (1967) studied the effect of mild physical exertion as a method of arousing an individual prior to a mental task. They used a combination of running, jogging, and walking to induce mild work but not fatigue. Immediately before and after exercise the 108 male adult subjects were administered a 10 minute symbol substitution task. The results, although non-significant, tended to favor exercise before the mental task.

Gutin (1966) conducted a study to test his hypothesis that increased physical fitness would have a positive effect on the ability to perform mental tasks after a period of physical and mental stress. The subjects were 55 male college students. After a pretest consisting of physical and mental stress (Indiana motor fitness index II, push-ups, chin-ups, standing broad jump, long addition, and subtraction), the subjects were administered mental tests in verbal comprehension, visual pursuit, verbal reasoning, and symbolic reasoning. During the following 12 weeks the test group underwent a physical development program designed to raise their fitness levels. At the end of this period both test and control groups were tested in the same fashion as before. Gutin found no significant differences between his

control group and the experimental group in ability to perform complex mental tasks. However, there was evidence of a moderate relationship between the degree of fitness improvement and mental task ability following stress.

A subsequent study by Gutin and DiGennaro (1968a) tested three treatment conditions to study the effects of physical exertion on mental performance. The treatments consisted of rest, one minute of bench-stepping, and five minutes of simple addition. The 58 male college students participating in this experiment were divided into two groups: those enrolled in a physical development class who were accustomed to step-ups and those not performing bench-stepping regularly. These groups were then divided into the three treatment groups.

The investigators found, among the subjects accustomed to step-ups, that the one minute group scored significantly slower than the zero minute group and the five minute group in speed of addition. There was also a trend, although non-significant, towards the conditioned subjects improving in accuracy of addition but the unconditioned group doing more poorly overall.

These results are difficult to explain in terms of the inverted U hypothesis, however, Gutin and DiGennaro suggested the possibility that subjects accustomed to the exercise may have found the five minutes of step-ups to have induced moderate rather than heavy ranges of activation. A

specified degree of activation may, therefore, result in different degrees of activation depending upon the fitness level of the subjects for the activity involved. They could not offer any explanation as to why the one minute bench-step group was slowest of all in speed of addition.

A second study by Gutin and DiGennaro (1968b) investigated the effect of a treadmill run to exhaustion on the performance of long addition. Each of the subjects, 72 college students, acted as his own control. The experimental treatment consisted of a run to exhaustion on a treadmill while the control activity involved no exertion. These treatments were administered on alternate days. The test of performance--addition of 10 digit columns--was given prior to, and after, the treatment condition for a period of four minutes during which time subjects were scored for both speed and accuracy. The results showed that the exertion had a significant negative effect on accuracy for the total four minute test period as well as for the second and fourth minute of the test.

Apart from the expected finding that numerical accuracy was hindered when preceded by heavy muscular exertion, two other interesting factors were observed. First, the effect was not found to be negative during the first minute after exercise suggesting that exertion had a latent negative effect. Second, there was no trend observed showing improvement during recovery which would

parallel the cardiovascular recovery. This was illustrated during the fourth minute after exertion when negative results were still observed. Fitness was again used as a variable when analyzing the data. It was found that the low-fitness groups were more affected by the exertion than either high- or medium-fitness groups. Speed of addition, however, was not affected by exertion.

A range of physical exertion levels was studied in an experiment conducted by Stockfelt (1968). Treatments consisted of 0, 25, 45, 65, 85, and again 0 percent of the maximum exertion that the individual could induce while pedaling a bicycle ergometer. Three groups of subjects were tested: physiologically "poorly trained" students, and physiologically "poorly trained" non-students who were not accustomed to mental work. In each group there were eight males and eight females between 20 and 25 years old. The tests of mental performance were 5 series of 40 mathematical problems each, comprised of simple addition and subtraction. The order of the treatment conditions was randomized for each of the subjects except that the 0 percent exertion trials were administered first and last. Between trials the subject rested until the heart pulse rate decreased to less than 100 beats per minute, or for at least five minutes.

The results showed that there was a tendency for the well-trained students to score lower on the 85 percent exertion level, as opposed to the other exertion levels.

The difference in mental performance for the other exertion levels among the well-trained students were not significant. For non-students and poorly-trained students there were significant differences in mental performance between the different exertion levels. Stockfelt summarized the findings observed among all three groups in terms of the inverted U hypothesis. That is, maximum mental performance occurred at the level of 45 percent exertion and minimum mental performance occured at the level of 85 percent exertion. Further investigation revealed that the scores for the final 0 percent trial are higher than the initial 0 percent trial. This indicated that there may be an accumulated arousal effect despite rest periods. Therefore, different results may have been obtained if each of the trials had been on a separate day.

Davey (1973) conducted a study to further examine the effects of physical exertion on mental performance. He also introduced the factors of introversion and extraversion, and neuroticism and stability to determine the effect, if any, that these individual difference variables might have on arousal induced by physical exertion. Eighty subjects were divided into four groups of twenty based on their extreme scores on the Eysenck Personality Inventory, a test measuring personality in terms of extraversion and introversion, and neuroticism and stability.

Each subject was required to perform a series of

treatment conditions involving zero, one-half, two, four, and six minutes of riding on a bicycle ergometer after which the mental performance of the subjects was measured. This involved short term memory recall of random digits and the Brown and Poulton test which required the subject to listen to a series of random digits and detect sequences which occurred in the order of odd number, even number, odd number.

The short term memory scores were found to deteriorate significantly after the four and six minute exercise conditions but remained constant with exertion of less than four minutes. The mental performance scores, as measured by the Brown and Poulton test, however, improved after one-half, two, and four minutes of exertion and deteriorated after six minutes of exertion. These results suggest that mental performance was consistent with the inverted U hypothesis, but short term memory was not shown to be facilitated by physical activity.

Some interaction effects between personality variables were found to be significant. Introverts, with the same amount of exertion, seemed to deteriorate more, in mental performance, than extroverts. This finding is consistent with Eysenck's theory that introverts are more highly aroused, in a resting state, than extroverts, and introverts reach their optimum level of performance earlier with increased arousal. There was no significant differences

between stable subjects or those who tended to be more neurotic. Davey did not, however, consider the prolonged, or carry-over effects of induced arousal. His treatment conditions were administered in order from the least to the most strenuous. Furthermore, only a brief period of 30 seconds of rest was allowed between the test and the following treatment condition. Verification of his results by experiments which attempted to control the possible prolonged effects of exertion arousal would, therefore, be desirable.

V. THE EFFECTS OF EFFORT AND DRIVE ON VISUAL RECOGNITION

A thorough review of the literature identified only one study which investigated the effects of physical exertion, anxiety, and mental performance. Shore (1958) studied the effect of effort (induced muscularly) and drive level (manifest anxiety) on visual recognition. Standard photographic resolution targets were utilized as the stimuli, and the effort conditions were varied systematically by induction of muscular tension. Differences in drive level were determined by the Taylor Manifest Anxiety Scale (MAS).

From their scores on the MAS, low, medium, and high anxiety groups were formed consisting of six males per group. Subjects were required to identify experimental targets while squeezing a Smedley hand dynamometer. Each

target was presented for .002, .004, .006, .008, .010, .012, .014, and .016 seconds. The fractional dynamometer pressures used were 0, 1/8, 1/4, 3/8, 1/2, and 3/4 of the maximum pressure for the day. The order of presentation of the six fractional pressures was counterbalanced for each anxiety group. The subjects score for the day was the number of targets correctly recognized. The data used in the analysis consisted of the scores of six daily sessions taken from the three groups of subjects.

Results of the investigation revealed that the three anxiety groups responded quite differently to the increase in induced muscular effort. Induced muscular effort interacted with manifest anxiety to produce differences in perceptual efficiency. Subjects with high MAS scores showed an increase in efficiency of recognition. Those with low MAS scores showed a slight decrease in efficiency as effort was increased. Subjects with medium MAS scores showed a rise in efficiency to an optimal level, then a gradual decline with increased physical effort.

VI. SUMMARY

The concept of anxiety is not a new one. Many have defined it and many continue to struggle with it. Anxiety is generated particularly in situations where individuals are motivated to achieve success at one thing or another. One setting which centers around achievement among

individuals is that of a learning setting. In some learning situations, threat of failure strongly motivates the learner to achieve success, thereby facilitating performance. In other cases, however, the level of anxiety is too high causing disorganization and disruption of performance. Studies have shown that anxiety impedes discrimination, learning of new and complex material, and increases the length of time required for learning.

One means of anxiety reduction which appears to hold great therapeutic value is physical exercise. According to various investigations, if one is plagued with problems of anxiety, physical exercise of a vigorous nature may be employed with positive effects. Reportedly, if one continues to exercise on a regular basis, this may influence one's psychological well-being in a positive way.

Investigations of the effects of physical exercise on mental performance have revealed evidence to support the inverted U hypothesis. The inverted U hypothesis predicts that performance on a learning task would be facilitated by increased levels of induced tension up to some maximum point, after which it would begin to fall off with further increases in tension. For highly anxious individuals, arousal level may be well beyond the optimal point for effective mental performance. Physical exercise may stall or reverse this arousal build-up and permit the highly anxious individual to function more effectively on mental

performance tasks. For certain low anxious individuals, arousal level may never reach the optimal point necessary for effective mental performance. These individuals may benefit from the increased arousal state brought on by exercise.

One is left to speculate about relationships of this nature as research into the area of anxiety reduction with simultaneous improvement in mental performance among high and low anxious individuals is sparse. It is the intent of this investigation to offer new and additional information to the literature in this area and to provide help for individuals beset by the deleterious effects of anxiety.

CHAPTER III

METHODS AND PROCEDURES

I. SELECTION OF SUBJECTS

The population for this study consisted of female students enrolled in undergraduate health and safety classes offered by the Division of Health and Safety in the Spring Quarter, 1981, at The University of Tennessee, Knoxville. Subjects were selected for participation in the study who scored in the upper and lower 40 percent on the State-Trait Anxiety Inventory (STAI). The upper 40 percent were randomly assigned to either the experimental or control groups, as were the lower 40 percent. Other criteria included being of college age (18-22 years) and having no history of coronary heart disease. Those individuals having to take special medications were excluded.

II. INSTRUMENTATION

Anxiety Measurement

The State-Trait Anxiety Inventory (STAI) represents an efficient, reliable, and valid way to assess individual differences for both anxiety proneness and phenomenological experience of anxiety in normal as well as patient populations. In addition, the STAI allows for the division of items into two parallel forms when independent repeated measures are desired (Hedburg, 1972).

The STAI consists of 40 brief items--20 to assess "how you feel right now, that is, at this moment"--and 20 to assess "how you generally feel" (see Appendix A). Subjects respond to each scale item (e.g. "I lack self-confidence") by checking one of the following: Almost Never, Sometimes, Often, Almost Always. The STAI State Scale consists of 20 statements which ask the subject to describe how he or she feels now; subjects respond to each state item by rating themselves on the following four point scale: 1) Not at All, 2) Somewhat, 3) Moderately So, 4) Very Much So. The essential qualities that are evaluated by the STAI State Scale involve feelings of tension, nervousness, worry, and aprehension. The STAI State Scale defines a continuum of increasing levels of state intensity, with low scores indicating states of calmness and serenity, intermediate scores indicating levels of tension and apprehensiveness and, high scores reflecting states of intense apprehension and fearfulness that approach panic. To measure changes in the intensity of transitory anxiety over time, the STAI State Scale may be given on each occasion for which a state measure is needed (see Appendix C).

Test-retest reliabilities for the A-Trait Scale for male and female college undergraduates over a six month period are .73 and .77 respectively, indicating that the trait measure is quite stable. Test-retest reliabilities for the A-State measure are low as might be expected since

the state measure conceptually does not measure a persistent characteristic of the individual. Alpha reliability coefficients for the normative sample (high school juniors, college freshman, introductory psychology students) range from .83 to .92 for state scores and .86 to .92 for trait scores; alpha coefficients are considered more suitable reliability indicators of the state form than test-retest coefficients (Hedburg, 1972).

Validity data lend good support to the theoretical basis of the A-Trait and A-State constructs. Concurrent validity with other A-Trait measures, the Manifest Anxiety Scale, and the IPAT yields correlations between .75 and .85 for college students and for psychiatric patients. Construct validity is demonstrated by the fact that the A-State items consistently vary with different experimental states of stress while A-Trait items do not (Hedburg, 1972).

Mental Performance

The Digit Span subtest of the Wechsler Adult Intelligence Scale consists of two parts: the first requires repetition of series ranging from three to nine digits in length, as called out by the examiner; the second requires repetition in a backwards sequence of series from three to eight digits in length. On any missed series an alternate is given, and if passed, the item is credited. The raw score on this subtest is the sum of the number of digits in the longest series passed forward and backward.

Digit Span may be considered a test of attention and concentration. Attention is considered an effortless, passive, unhampered contact with outside reality--a free receptiveness. For example, if a person can devote himself/herself freely to obtaining impressions, read so that one goes with the stream of a book without being carried into other streams of thought or fantasy, or can listen to and absorb a lecture without effort and without suddently discovering that one has been "absent," then this person's attention is considered to be excellent and unimpaired. This free receptiveness appears to be hampered, however, if the subject's affects and anxieties are not well controlled and get out of balance (Rapaport, 1968).

It is helpful here to make a distinction between attention and concentration since the two terms are frequently used interchangeably. Concentration may be characterized as an active relationship to outside reality. For example, when one finds himself/herself unable to take in freely what the flow of a book, a lecture, or a conversation brings to mind, one may exert a conscious effort to keep out of consciousness all material that is not directly pertinent. This is concentration.

Attention suffers first from increased state anxiety, which may cause an individual to be emotionally overloaded with fantasies, obsessions, or delusions. As long as concentration is relatively well preserved, the individual is

able to replace the impaired free receptiveness by voluntary effort or concentration. This assumption is corroborated by experience; it is only too common for human beings of our civilization to replace natural effortless living by effortful concentration upon achievement (Rapaport, 1968).

Digit Span achievement is highest if intake is effortless and free. Subjects who take it in a "matter-of-fact" way perform better than those who try very hard. On occasion, subjects use the ploy of grouping the digits, which helps to increase the subjects digit span score. This changes the nature of the task by introducing "meaning" into it in the sense of patterning the numbers with intervals of hundreds, tens, and units. The introduction of meaning changes the function underlying Digit Span performance and in part makes it dependent on concentration. Thus, it appears that attention plays a major role in the Digit Span score. Concentration, if relatively well preserved, may be employed if attention fails.

As mentioned in the preceding section, the Digit Span subtest consists of a digits forwards and a digits backwards section. A markedly lower score on digits backwards than on digits forwards is considered a sign of seriously impaired attention. Thus, Wechsler (1958) considered performance on the digits backwards to be particularly sensitive to anxiety level. In addition, digits backwards (DB) is a task that has been used extensively in studies dealing

with anxiety and mental performance (Hodges and Spielberger, 1969; Matarazzo, 1955; Moldawsky and Moldawsky, 1952; Pyke and Agnew, 1963; and Walker and Spence, 1964). Hodges and Spielberger (1969) adapted Wechsler's DB subtest so as to allow for repeated measurements and this method was selected for use in the present investigation.

Standard procedures for the DB subtest determine the subject's limit, that is, the level at which the subject twice fails to repeat a series of a specified number of DB. Hodges and Spielberger (1969) supplemented this procedure by giving the subject two additional practice series, each, one digit less than his limit, followed immediately by six more series of digits of the same length. The number of series correctly reproduced out of the six that were given was the subject's Performance (pretest) score. Following whatever treatment is prescribed, six more series of digits of the same length are then given to obtain a Test (posttest) score for each subject.

Validity and Reliability

The validity and reliability of the Digit Span (DS) subtest of the Wechsler Adult Intelligence Scale (WAIS) is well documented (Rapaport, 1945). However, use of the subtest in isolation, that is, not in conjunction with other subtests of the WAIS, does not lend itself to mathematical indices of validity and reliability. Several studies, however, have utilized the DS subtest in isolation with

high and low anxious individuals. Griffiths (1958) and Moldawsky and Moldawsky (1952) induced anxiety (presumably A-state) by telling subjects they were doing poorly on a test of mental ability. For subjects exposed to this stressful experimental condition, significant decrements in DS performance were obtained as compared to non-stress control groups. In two other studies in which the anxiety measures could be reasonably interpreted as indicants of A-state, decrements in DS performance were also found to be associated with increases in A-state (Pyke and Agnew, 1963; Walker and Spence, 1964). Hodges and Spielberger (1969) investigated the relationship between measures of state and trait anxiety and performance on the Digits Backwards (DB) section of the DS subtest. Subjects were randomly assigned to either a failure (stress) or control (non-stress) condition. The stress condition produced decrements in performance on the DB task for subjects with high levels of A-state but no relationship was found between A-trait scores and performance.

Thus, while not lending itself to mathematical indices of validity and reliability when used in isolation, the DS subtest has been used extensively by clinical researchers to measure the effects of anxiety on mental performance. Therefore, it can be concluded that the Digit Span subtest of the Wechsler Adult Intelligence Scale is an acceptable measure of mental performance.

Physical Task

Bench-stepping is a general body exercise that requires no special skill. It is an exercise that utilizes the large muscles and, therefore, gives the heart, lungs, and blood vessels a great deal of work to do. In addition, it is a technique that requires little equipment and no special technical skill in administration (Gallagher and Brouha, 1943). Furthermore, bench-stepping can be a simple method of measuring the level of physical fitness for muscular work. That is, bench-stepping can be a measure of the general capacity of the body, in particular the cardio-vascular system, to adapt itself to hard work and to recover from what it has done.

For the purposes of the present study, it was necessary to use a physical task which allowed easy measurement and which could be maintained for the desired length of time. The experiment also required that the change from physical exertion to mental performance not interfere with performance on the latter task. Bench-stepping satisfied these requirements and was, therefore, used to induce physical exertion.

The procedure requires the subject to step up on and down from a 13 inch platform 30 times a minute for 5 minutes, or, if unable to maintain this pace, to proceed as fast as possible until the five minutes are completed. After the five minute period, the subject sits down. The investigator records the carotid pulse beginning 15 seconds after

exercise and stopping 30 seconds after exercise. The actual number of heart beats counted during the 15 seconds after exercise is recorded (Sharkey, 1974).

Scoring the test requires utilization of fitness index tables established especially for use with the step test using a 13 inch bench (Sharkey, 1974). A fitness index for the subject is determined based upon the individual's body weight and post-exercise pulse rate. Since the step test relies on the use of the pulse rate to predict aerobic capacity, and because maximal pulse declines with age, it is necessary to adjust the score for age. Therefore, the index score is multiplied by the appropriate age correction factor. This score is then used to determine the individual's fitness level according to the following values: superior, excellent, very good, good, fair, and poor. In the present study, these values were collapsed to form three fitness categories--high, medium, and low--for statistical purposes.

III. PROCEDURE

Screening

Since the investigation was concerned with high anxious and low anxious women, it was necessary to first identify those individuals. Spielberger (1971) described persons who are high in trait anxiety as those individuals who tend to perceive a larger number of situations as dangerous or threatening than persons who are low in trait

anxiety and to respond to threatening situations with state anxiety elevations of greater intensity. The State-Trait Anxiety Inventory Form X-2 (Spielberger, 1970) has been used extensively to identify high and low trait anxious individuals and was, therfore, utilized in this study.

A total of eight undergraduate health and safety classes were utilized for trait anxiety assessment. The investigator explained to the classes that a project was being undertaken which involved completion of a self-evaluation questionnaire (Form X-2) (see Appendix A), a short bout of exercise, a quiet rest period, and a simple mental task involving numbers. Time was given to answer any questions relating to the project and the undergraduate students willing to participate signed informed consent documents (see Appendix C). Those students participating were asked to read the directions silently while the investigator read them aloud. The validity of the STAI rests upon the assumption that the examinee has a clear understanding of the "trait" instructions which require the reporting of how the examinee <u>generally</u> feels.

Based upon the STAI Form X-2 scores, women falling in the upper and lower 40 percent were identified. Subjects were then randomly assigned to either the experimental or the control group. These subjects were then contacted and informed that 10 points extra credit would be provided if they were willing to participate. Appointments were then

made for further participation in the study. Scheduling of subjects was arranged so that on any given day subjects from both the experimental and control group met with the investigator either in the morning or afternoon on a rotating basis.

Very early in the data collection process it was discovered that the Trait-Form (X-2) of the STAI was not as stable a predictor of the state anxiety of individuals as was purported by the literature. Of the 35 women who were identified as high trait anxious, 27 proved to be high state anxious when pretested with the STAI State Form during the conduction of the experiment. The remaining eight women proved to be low state anxious. Of the 50 women identified as low trait anxious, 36 proved to be low state anxious when pretested with the STAI State Form during the experiment. The remaining 14 women proved to be high state anxious. Despite these inconsistencies, data were collected from 41 high state anxious women and 44 low state anxious women.

A possible explanation for the inconsistencies which resulted between trait and state measurements could be the individual's perception of threat of the testing situation. It may be recalled that all subjects were informed before their participation in the experiment, that a mental task involving numbers would be administered. Perhaps those women who were identified as low trait anxious anticipated not having the requisite skills and background to perform

well, and consequently came into the testing situation with a feeling of anxiety. In such situations high state anxiety scores would not be surprising. Subjects were also informed that they may be required to bench-step for a period of five minutes. Such a task may not have been perceived as threatening by certain high trait anxious women who were confident in their ability to perform the task. This perhaps would account for their low state anxiety scores. Thus, while measures of trait anxiety provide useful information regarding the probability that high or low levels of state anxiety will be likely, the impact of any given situation on a particular person can best be ascertained by taking actual measurements of state anxiety in that situation.

Experimental Group

Immediately upon entering the testing room the subject was seated at a table and asked to complete the STAI Form X-1 (see Appendix B). The subject was informed that what she was about to fill out was a self-evaluation questionnaire similar to the one completed previously. The subject was further informed that this questionnaire required her to report how she feels at this moment. The validity of the STAI rests upon the assumption that the examinee has a clear understanding of the "state" instructions which require her to report how she feels at this moment. Therefore, each subject was asked to read the

directions silently while the investigator read them aloud and allowed the subject to raise questions if necessary. If specific questions arose in a testing session, the investigator responded in a noncommital manner. A response such as, "Just answer according to the way you feel right now" was given if a question was raised by the subject. Subjects were instructed not to omit any item.

Upon completion of the STAI the subject was then instructed to listen carefully to some numbers which the subject was to orally repeat after they were said to them. The digits were given at a rate of one per second. Each subject started with the three digit series. If the subject repeated Trial 1 of a series correctly, it was scored plus and the next higher series was given. If the subject failed on Trail 1, she was given Trial 2 of the same series. The subject's limit was that level at which she twice failed to repeat a series of a specified number of Digits Backwards (DB). She was then given two practice series; each, one digit less than her limit, followed immediately by six more series of digits of the same length. The number of series correctly reproduced by a subject out of the six that were given to her was her Performance (pretest) score.

After the Performance score for the DB was obtained, the subject was taken to that area of the room where the platform was placed for the bench-stepping. The subject

was instructed to step up and down at the rate of 30 times a minute on the platform, the height of which was 13 inches from the ground. The subject was instructed to stand in front of the platform, step up placing both feet fully on the platform, straighten her legs and back and then immediately step down again, one foot at a time. The pace was counted by utilizing a tape recording of a metronome set at 120 beats per minute along with voice commands of "up, two, three, four." The subject continued this specific activity for five minutes. Those unable to keep up with the count were verbally encouraged to continue stepping up and down as quickly as possible so that every subject was active for the entire five minutes. At the end of the five minute exercise, the subject was seated in a chair. A notation was made of the duration of the exercise and recordings of the carotid pulse were taken beginning 15 seconds after exercise and stopping at 30 seconds after exercise. The actual number of heart beats counted during the 15 second period in recovery was recorded and a physical fitness index was read directly from a table computed for these purposes (Sharkey, 1974). Following this measurement the subject was allowed to rest for five minutes in a comfortable chair and was provided with various fashion magazines as well as a copy of the daily university newspaper to read during this period if they so desired. The magazines and newspaper contained no articles relating to

mental performance, relaxation, exercise, or anxiety. A second measure of state anxiety was then taken as well as six more series of digits backwards of the same length as the pretest, and the number of series correctly reversed defined the subjects Test (posttest) score.

Control Group

Subjects in the control group met with the investigator in the testing room and were administered the STAI Form X-1 as well as the Digits Backwards task with the same instructions given the experimental group. Immediately following these measurements, subjects were instructed to rest quietly for five minutes in a comfortable chair, and were provided with the same reading material as was provided for subjects in the experimental group. The control group subjects were left alone in the testing room for this five minute period. At the end of five minutes the control group subjects were again assessed for levels of state anxiety and performance on the Digits Backwards task.

IV. STATISTICAL PROCEDURES

Statistical treatment of the data was designed to describe the data collected and to test the stated hypotheses. The Statistical Package for the Social Sciences (SPSS) was chosen to provide standardized statistical handling of data. Data were sorted, coded, and transferred onto University of Tennessee Computer Center (UTCC) Data

Sheets for computerization and subsequently keypunched onto computer cards. All computer computations were done using an IBM 3031 computer.

The data collected consisted of state anxiety and mental performance pretest to posttest differences. The statistical technique selected for use in this study was the Wilcoxon Matched-Pair Signed-Ranks Test (Hays, 1973) which determined if the differences in anxiety and mental performance scores constituted a departure from what would be expected by change at a particular level of significance ($P \leq .05$). In addition, the Kruskal-Wallis one way analysis of variance by ranks (Hays, 1973) was used to determine if significant differences existed in the state anxiety and mental performance scores of high and low anxious women comprising the high-, medium-, and low-fitness levels.

CHAPTER IV

RESULTS

This chapter is concerned with the presentation of experimental findings. Specifically it describes the responses of subjects on the State-Trait Anxiety Inventory (STAI) and the Digits Backwards subtest of the Wechsler Adult Intelligence Scale. The Wilcoxon Matched-Pair Signed-Ranks test (Hays, 1973) was employed to determine whether exercise caused significant differences in the state anxiety and mental performance of high and low anxious women. The criterion z used for these tests was 1.65 at the .05 level of confidence. In addition, the Kruskal-Wallis one way analysis of variance by ranks (Hays, 1973) was used to determine whether state anxiety and mental performance scores differed significantly among high and low anxious subjects comprising the high-, medium-, and low-fitness levels.

I. STATE ANXIETY

Descriptive statistics for state anxiety scores of high anxious women in the experimental and control group are presented in Table 1.

Inspection of these results indicates that both the experimental and control groups had lower scores on the post-STAI than on the pre-STAI. The experimental group,

however, experienced more of a reduction in state anxiety than the control group.

Table 1. State anxiety mean scores and percentiles for high anxious women in the experimental and control groups, The University of Tennessee, Knoxville, 1981.

	Pre-STAI	Percentile	Post-STAI	Percentile
Experimental n = 21	42.1	80	39.8	71
Control n = 21	41.9	76	40.9	74

Research Question #1: DOES ACUTE EXERCISE DECREASE THE STATE ANXIETY OF HIGH ANXIOUS WOMEN?

The Wilcoxon Matched-Pairs Signed-Ranks test was applied to the differences in state anxiety scores of high anxious women in the experimental and control groups. Table 2 presents the results of the Wilcoxon test on the differences in the state anxiety scores of high anxious women in the exercise group.

As noted in Table 2 and illustrated in Figure 1, state anxiety appeared to decrease among high anxious women in the exercise group. The Wilcoxon test, however, showed an overall computed value of $z = -1.269$. Therefore, according to this finding, there was no basis for rejecting the

Table 2. Wilcoxon Matched-Pair Signed-Ranks test on the differences in state anxiety of high anxious women in the exercise group, The University of Tennessee, Knoxville, 1981.

Subject	Pre-STAI	Post-STAI	Difference	-Ranks Mean	+Ranks Mean	z	$z_{.05}$
1	66	46	20	9.93	11.83	-1.269	1.65
2	55	51	4				
3	39	28	9				
4	37	40	-3				
5	38	39	-1				
6	43	38	5				
7	35	32	3				
8	40	22	3				
9	38	32	6				
10	35	51	-16				
11	39	32	7				
12	38	25	7				
13	44	41	3				
14	40	38	2				
15	37	54	-17				
16	45	29	15				
17	39	48	-9				
18	40	40	0				
19	42	29	13				
20	42	60	-18				
21	53	46	7				

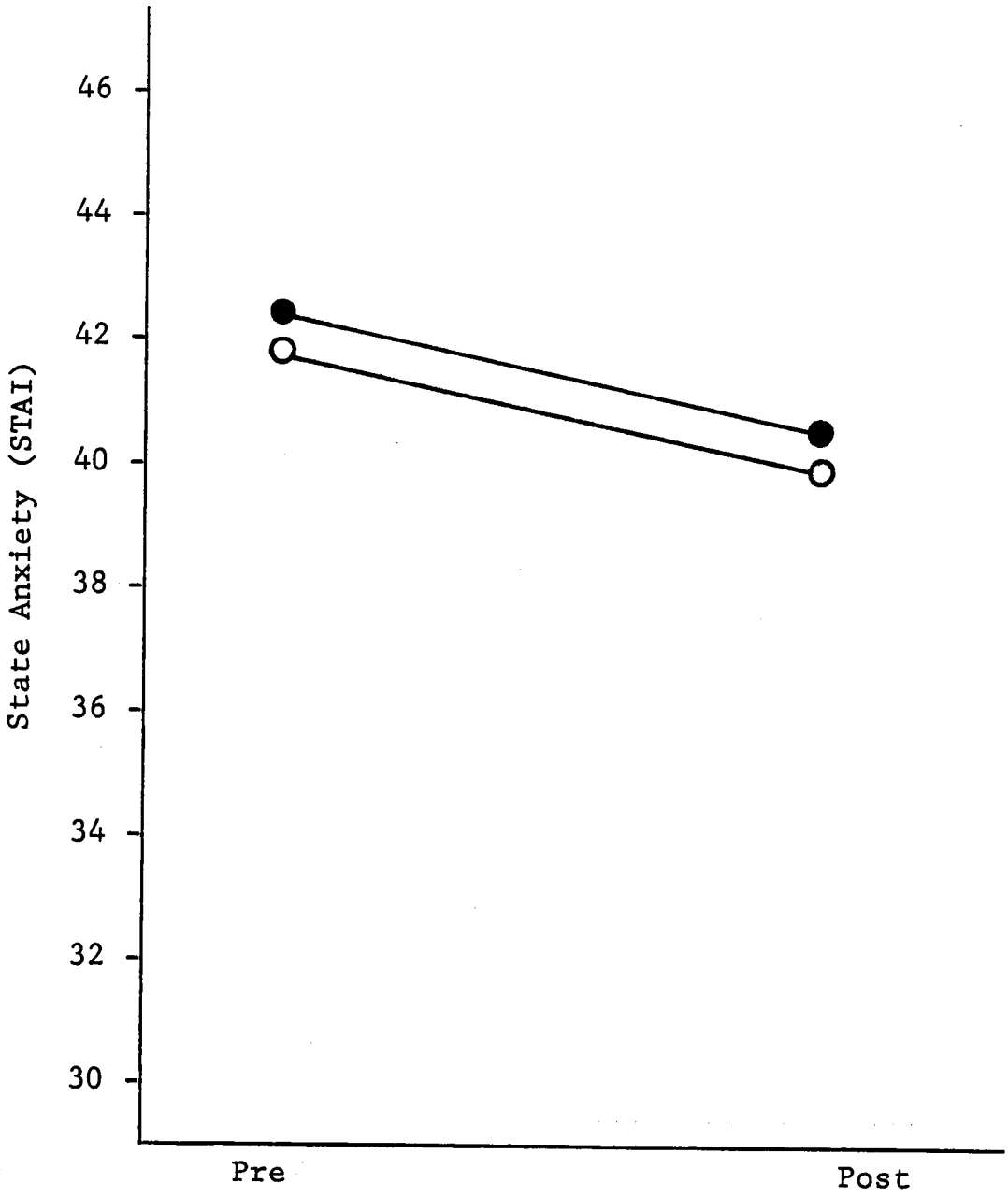


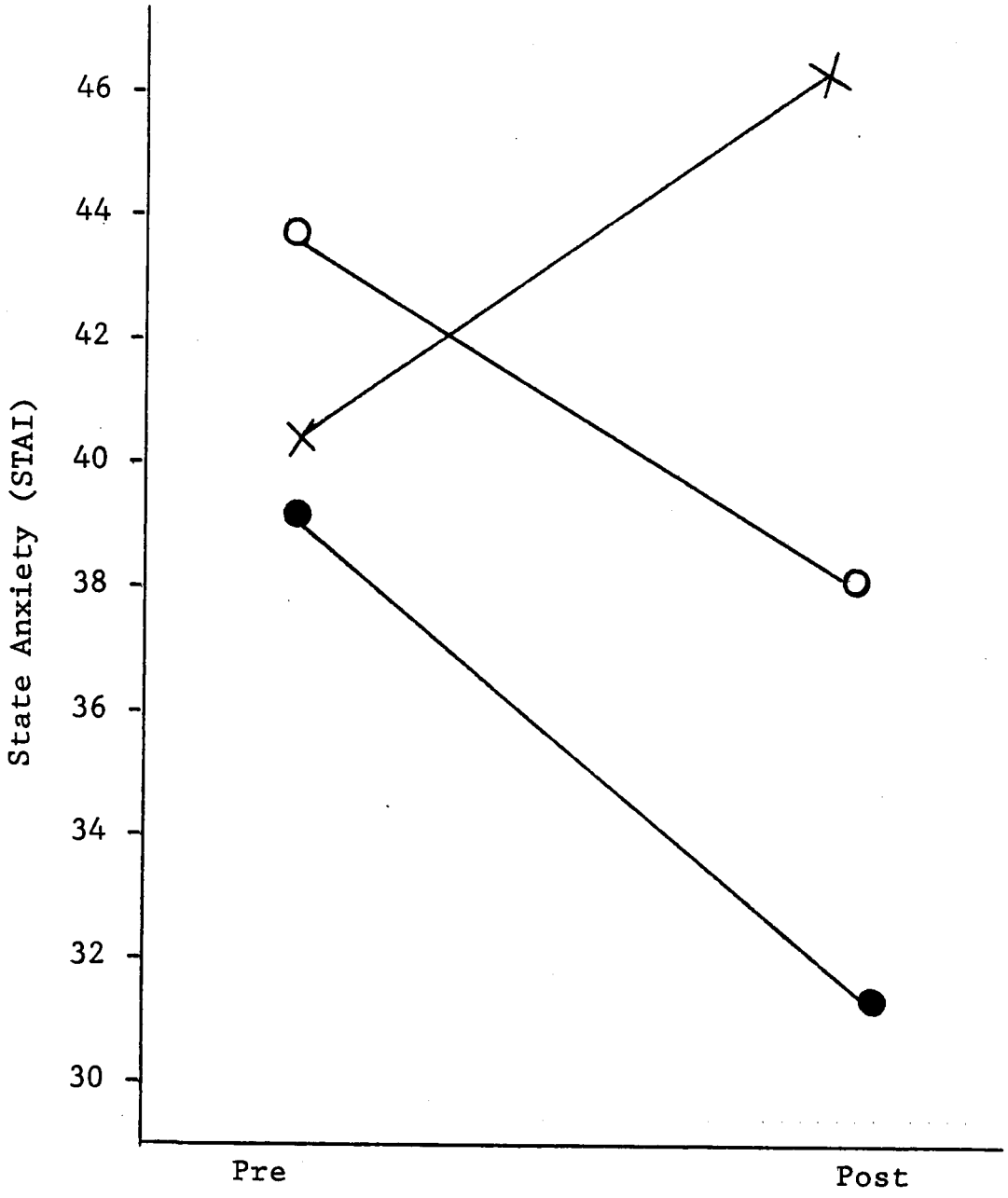
Figure 1. State anxiety mean scores for high anxious (HA) women in the experimental and control groups.

null hypothesis that acute exercise does not decrease state anxiety in high anxious women.

While state anxiety levels were not significantly decreased overall, an interesting picture emerged when the scores of high anxious subjects within the exercise group were separately analyzed as a function of fitness level. As Figure 2 illustrates, state anxiety levels decreased in both the high- and medium-fit subjects. Low-fit subjects, on the other hand, experienced a mean increase in state anxiety. The Wilcoxon test on the differences in anxiety for high anxious/high-fit subjects ($n = 3$) revealed a value of $z = -1.604$. This decrease was significant at the .10 level of confidence. The Wilcoxon test on the differences in anxiety for high anxious/medium-fit subjects ($n = 10$) revealed a value of $z = -2.293$. This decrease was significant at the .02 level of confidence. The Wilcoxon test on the differences in anxiety for high anxious/low-fit subjects ($n = 8$) revealed a non-significant value of $z = -1.183$.

Research Question #2: IS THERE A DIFFERENCE IN THE STATE ANXIETY SCORES OF HIGH ANXIOUS WOMEN COMPRISING THE HIGH-, MEDIUM-, AND LOW-FITNESS LEVELS?

To determine if significant differences existed among these three groups, the Kruskal-Wallis one way analysis of variance by ranks was applied. Table 3 presents the results of the Kruskal-Wallis test for the differences in anxiety scores of high anxious women comprising the high-, medium-,



●= HA high-fit* O= HA medium-fit** ✕= HA low-fit

*Significant at .10 level of confidence.

**Significant at .02 level of confidence.

Figure 2. State anxiety mean scores for high anxious (HA) women comprising the high-, medium-, and low-fitness levels.

and low-fitness levels in the exercise group. A non-significant effect was obtained in this analysis, $\chi^2 = 3.57$. The criterion χ^2 for 2 degrees of freedom at the .05 level of confidence is 5.99. Therefore, there was no basis for rejecting the null hypothesis that there is no difference in the state anxiety scores of high anxious women comprising the high-, medium-, and low-fitness levels.

Table 3. Kruskal-Wallis one way analysis of variance by ranks on the differences in anxiety scores of high anxious women comprising the high-, medium-, and low-fitness levels, The University of Tennessee, Knoxville, 1981.

	Sum of Scores	Expected Under H_0	Standard Deviation Under H_0	Mean Score
High-Fit n = 3	45.50	33.00	9.95	15.17
Medium-Fit n = 10	121.50	110.00	14.20	12.15
Low-Fit n = 8	64.00	88.00	13.81	8.00

$\chi^2_{.05} = 5.99$ $\chi^2 = 3.57$ DF = 2 Prob > $\chi^2 = 0.1681$

Table 4 presents the results of the Wilcoxon test on the differences in the state anxiety scores of high anxious women in the control group.

As noted in Table 4 and illustrated in Figure 1, state anxiety appeared to decrease for the control group.

Table 4. Wilcoxon Matched-Pair Signed-Ranks test on the differences in state anxiety of high anxious women in the control group, The University of Tennessee, Knoxville, 1981.

Subject	Pre-STAI	Post-STAI	Difference	-Ranks Mean	+Ranks Mean	z	$z_{.05}$
1	38	36	2	9.83	11.50	0.485	1.65
2	38	37	+2				
3	37	36	+1				
4	37	40	-3				
5	42	52	-10				
6	37	53	-16				
7	41	42	-1				
8	39	30	+8				
9	38	30	+8				
10	50	60	-10				
11	38	38	0				
12	39	37	+2				
13	38	32	+6				
14	48	35	13				
15	49	54	-5				
16	41	32	+9				
17	41	51	-10				
18	44	26	+14				
19	39	35	+4				
20	44	41	+3				
21	63	46	+17				

However, the Wilcoxon test for differences in state anxiety among high anxious women in the control group showed an overall computed value of $z = 0.485$. Therefore, high anxious women in the control group did not experience a significant reduction in state anxiety.

Descriptive statistics for state anxiety scores of low anxious women in the experimental and control groups are presented in Table 5.

Table 5. State anxiety mean scores and percentiles for low anxious women in the experimental and control groups, The University of Tennessee, Knoxville, 1981.

	Pre-STAI	Percentile	Post-STAI	Percentile
Experimental n = 21	28.6	23	32.0	45
Control n = 22	27.5	17	28.0	23

From Table 5 it is clear that both the experimental and control groups had higher scores on the post-STAI than on the pre-STAI. The experimental group, however, appeared to experience more of an increase in state anxiety than the control group.

Research Question #3: DOES ACUTE EXERCISE INCREASE THE STATE ANXIETY OF LOW ANXIOUS WOMEN?

The Wilcoxon test was applied to separately analyze

the differences in pretest and posttest anxiety scores of low anxious women in the experimental and in the control groups. Table 6 presents the results of the Wilcoxon test for the exercise group.

As noted in Table 6 and illustrated in Figure 3, state anxiety increased among low anxious women in the exercise group. The Wilcoxon test for differences in state anxiety among low anxious women in the exercise group showed an overall computed value of $z = 2.213$. Therefore, the decision was made to reject the null hypothesis that acute exercise does not increase the state anxiety of low anxious women.

When the state anxiety scores of low anxious women in the exercise group were separately analyzed as a function of fitness level (Figure 4), increases were found from pretest to posttest for both low anxious/medium-fit and low anxious/low-fit subjects. There were no low anxious/high-fit subjects to be included in the analysis. The Wilcoxon test on the differences in anxiety for low anxious/medium-fit subjects ($n = 16$) revealed a value of $z = 2.040$. This increase was significant at the .05 level of confidence. While, for the most part, low-fit/low anxious subjects ($n = 5$) demonstrated an increase in state anxiety after exercise, the results of the Wilcoxon test were not significant ($z = 0.944$).

Table 6. Wilcoxon Matched-Pair Signed-Ranks test on the differences in state anxiety of low anxious women in the exercise group, The University of Tennessee, Knoxville, 1981.

Subject	Pre-STAI	Post-STAI	Difference	-Ranks Mean	+Ranks Mean	z	$z_{.05}$
1	31	41	-10	6.67	11.54	2.213	1.65
2	34	24	+10				
3	26	21	5				
4	34	37	-3				
5	32	36	-4				
6	31	31	0				
7	30	27	3				
8	33	36	-3				
9	28	43	-15				
10	27	26	1				
11	31	38	-7				
12	32	42	-10				
13	22	27	-5				
14	30	25	5				
15	32	35	-3				
16	23	30	-7				
17	33	48	-15				
18	33	40	-7				
19	24	32	-8				
20	27	21	6				
21	28	24	4				

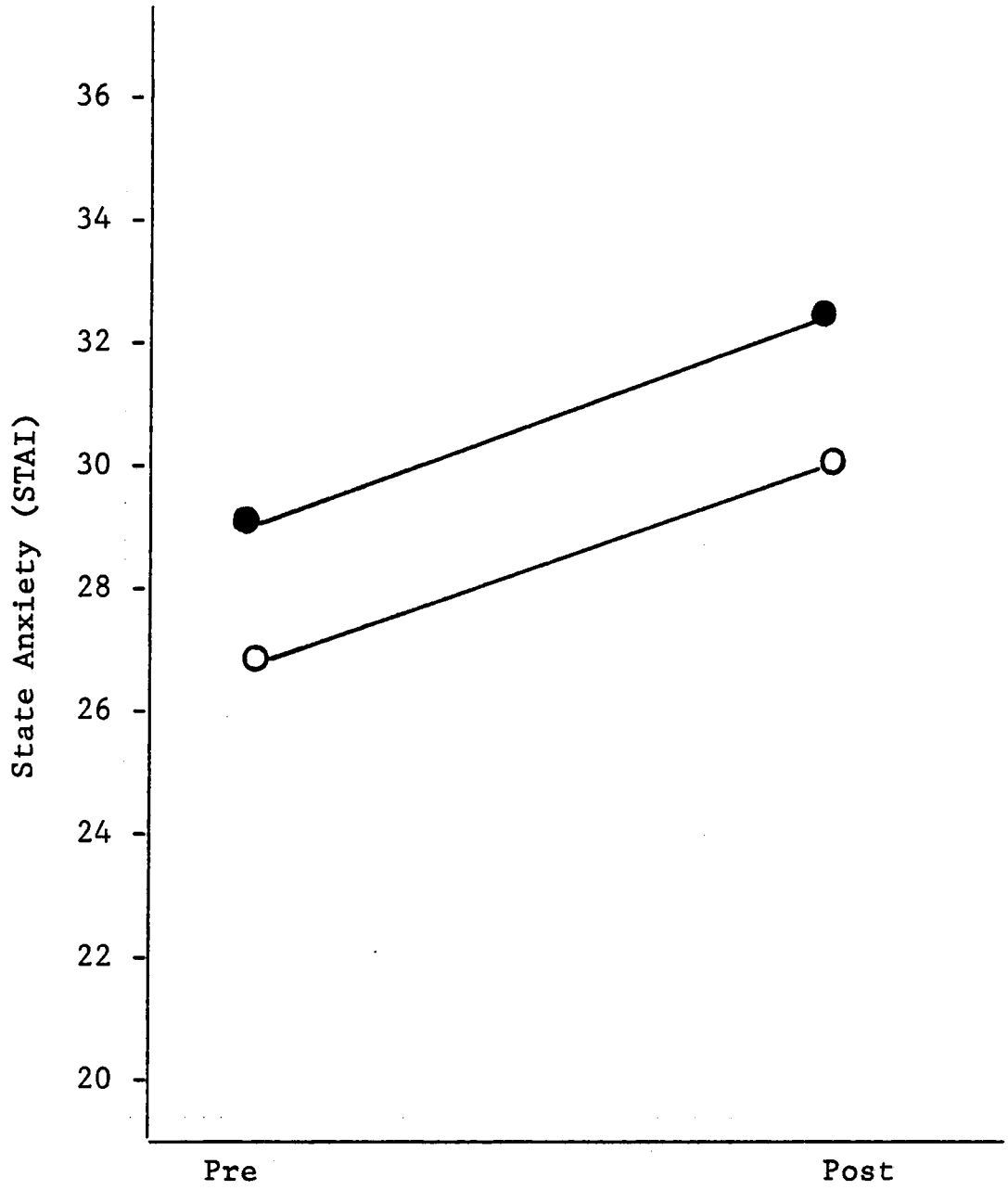


Figure 3. State anxiety mean scores for low anxious (LA) women in the experimental and control groups.

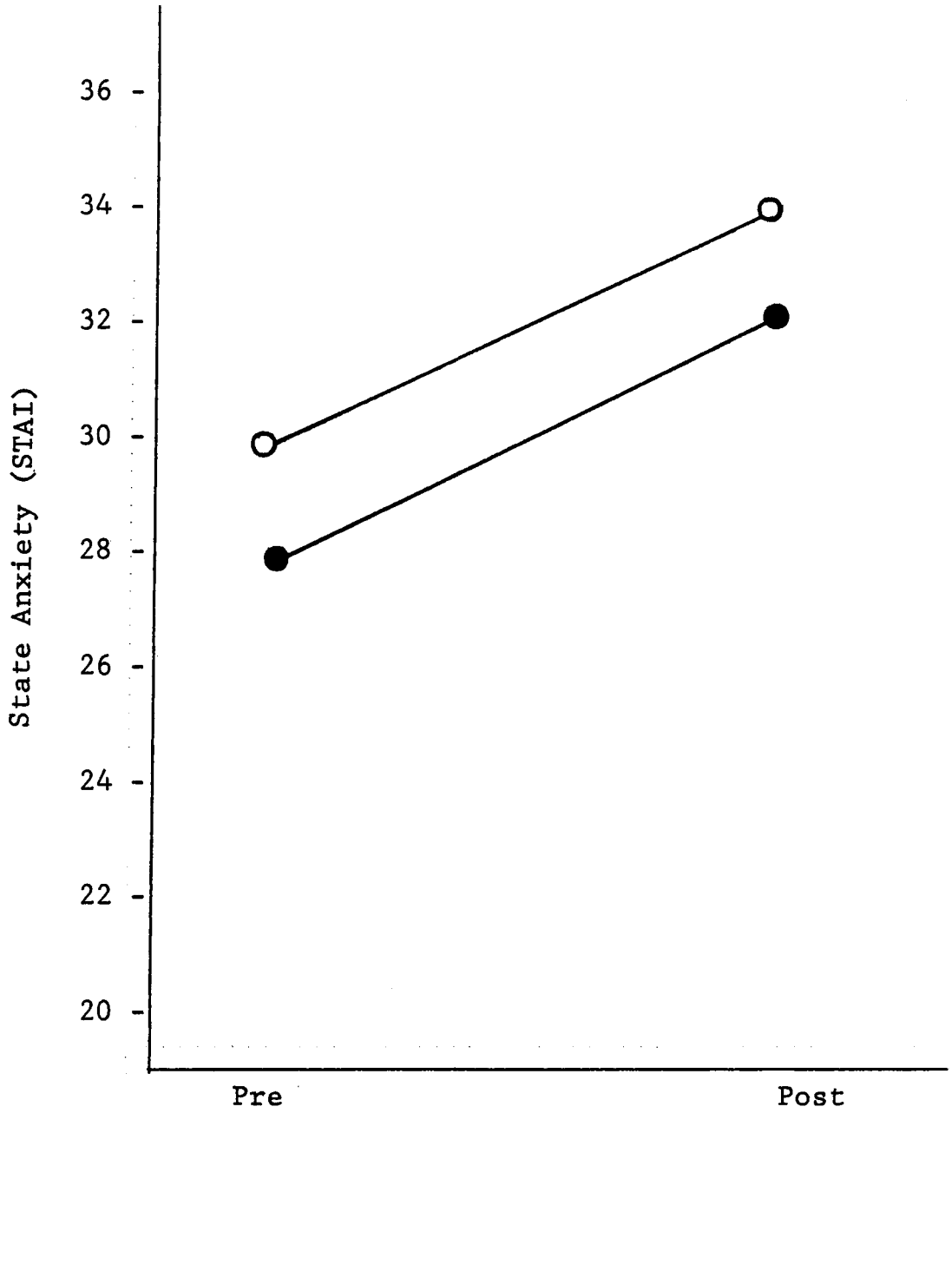


Figure 4. State anxiety mean scores for low anxious (LA) women comprising the medium- and low-fitness levels.

Research Question #4: IS THERE A DIFFERENCE IN THE STATE ANXIETY SCORES OF LOW ANXIOUS WOMEN COMPRISING THE HIGH-, MEDIUM-, AND LOW-FITNESS LEVELS?

To determine if significant differences in state anxiety existed among these two groups the Kruskal-Wallis one way analysis of variance by ranks was applied (Table 7). As indicated in Table 7, the mean score of the two groups was identical. Not surprisingly, therefore, the overall computed χ^2 value was 0.00. The criterion χ^2 for 1 degree of freedom at the .05 level of confidence is 3.84. Therefore, the decision was made to accept the null hypothesis that there is no difference in the state anxiety of low anxious women comprising the medium- and low-fitness levels.

Table 7. Kruskal-Wallis one way analysis of variance by ranks on the differences in state anxiety of low anxious women comprising the medium- and low-fitness levels, The University of Tennessee, Knoxville, 1981.

	Sum of Scores	Expected Under H_0	Standard Deviation Under H_0	Mean Score
Medium-Fit n = 16	176.00	176.00	12.11	11.00
Low-Fit n = 5	55.00	55.00	12.11	11.00

$\chi^2_{.05} = 3.84$ $\chi^2 = 0.00$ DF = 1 Prob > χ^2 = 1.0000

Table 8 presents the results of the Wilcoxon test for the control group.

As noted in Table 8 and illustrated in Figure 3, state anxiety appeared to increase among low anxious women in the control group. However, the Wilcoxon test for differences in state anxiety among low anxious women in the control group showed an overall computed value of $z = 0.174$.

II. MENTAL PERFORMANCE

Descriptive statistics for mental performance scores of high anxious women in the experimental and control groups are presented in Table 9.

From Table 9 it is clear that experimental and control groups performed the same on the Digits Backwards pretest. Only the control group, however, experienced an increase in performance on the posttest.

Research Question #5: DOES ACUTE EXERCISE INCREASE THE MENTAL PERFORMANCE OF HIGH ANXIOUS WOMEN?

The Wilcoxon test was applied to the differences in mental performance scores of high anxious women in the experimental and control groups. Table 10 presents the results of the Wilcoxon test on the differences in mental performance scores of high anxious women in the exercise group.

As noted in Table 10 and seen in Figure 5, mental performance did not change after exercise. The Wilcoxon

Table 8. Wilcoxon Matched-Pair Signed-Ranks test on the differences in state anxiety of low anxious women in control group, The University of Tennessee, Knoxville, 1981.

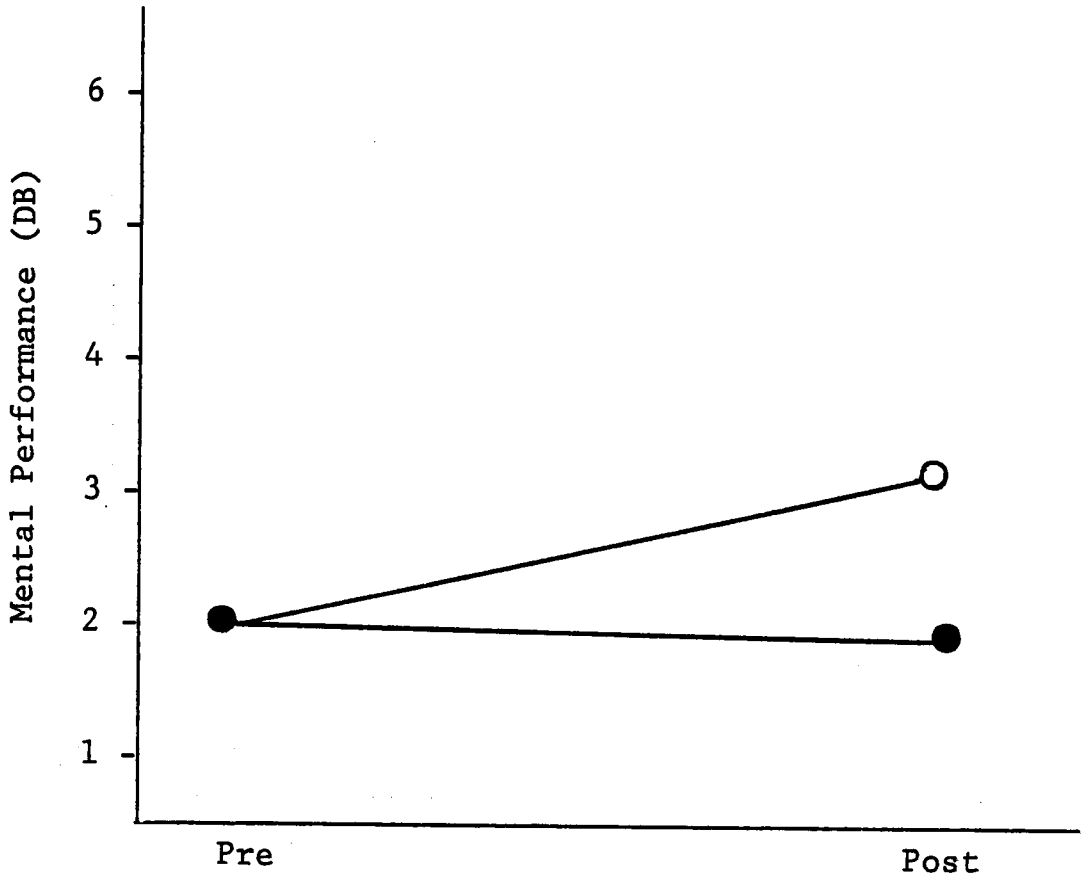
Subject	Pre-STAI	Post-STAI	Difference	-Ranks Mean	+Ranks Mean	z	$z_{.05}$
1	26	26	0	7.46	13.58	0.174	1.65
2	31	30	1				
3	33	32	1				
4	28	40	-12				
5	24	24	0				
6	27	20	7				
7	33	41	-8				
8	29	25	4				
9	24	20	4				
10	27	26	1				
11	22	26	-4				
12	30	30	0				
13	27	20	7				
14	28	41	-13				
15	21	23	-2				
16	27	27	0				
17	22	20	2				
18	22	21	1				
19	30	29	1				
20	32	34	-13				
21	31	26	5				
22	31	25	6				

Table 9. Mental performance (DB) mean scores for high anxious women in the experimental and control groups, The University of Tennessee, Knoxville, 1981.

	Pre-(DB)	Post-(DB)
Experimental n = 21	2.0	2.0
Control n = 21	2.0	3.0

Table 10. Wilcoxon Matched-Pair Signed-Ranks test on the differences in mental performance for high anxious women in the exercise group, The University of Tennessee, Knoxville, 1981.

Subject	Pre- (DB)	Post- (DB)	Difference	-Ranks Mean	+Ranks Mean	z	$z_{.05}$
1	2	2	0	9.75	8.59	0.852	1.65
2	1	3	-2				
3	3	4	-1				
4	1	3	-2				
5	3	4	-1				
6	2	4	-2				
7	5	5	0				
8	4	1	3				
9	4	6	-2				
10	3	5	-2				
11	5	2	3				
12	4	2	2				
13	0	2	-2				
14	0	1	-1				
15	2	2	0				
16	0	0	0				
17	4	1	3				
18	4	3	1				
19	0	3	-3				
20	1	0	1				
21	1	5	-4				



●= HA experimental ○= HA control

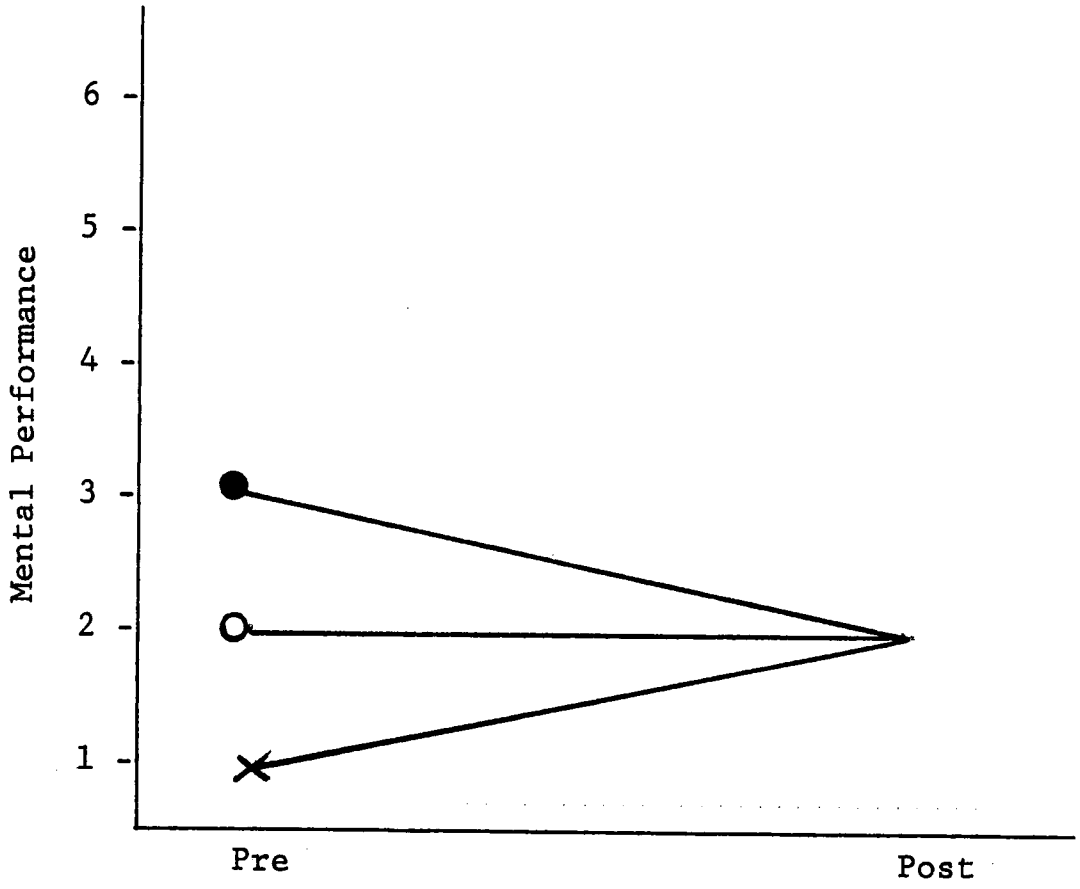
Figure 5. Mental performance means scores for high anxious (HA) women in the experimental and control groups.

test for differences on the mental performance among high anxious women in the exercise group showed an overall computed value of $z = 0.852$. Therefore, there was no basis to reject the null hypothesis that acute exercise does not increase the mental performance of high anxious women.

While performance was not improved overall after exercise, it is interesting to note the differences in mental performance which emerged when scores of high anxious subjects were analyzed separately as a function of fitness level. As Figure 6 illustrates, high-fit subjects performed best initially on the Digits Backwards task. However, they were not only unable to maintain this performance, but performed less well after exercise. Low-fit subjects did not experience any change in mental performance after exercise. It may also be seen in Figure 6 that the medium-fit subjects experienced an increase in mental performance. The Wilcoxon test on the differences in mental performance for high anxious subjects comprising the high-, medium-, and low-fitness levels revealed that only medium-fit subjects ($n = 10$) experienced a moderately significant increase in mental performance, $z = 1.659$, $p \leq .10$.

Research Question #6: IS THERE A DIFFERENCE IN THE MENTAL PERFORMANCE SCORES OF HIGH ANXIOUS WOMEN COMPRISING THE HIGH-, MEDIUM-, AND LOW-FITNESS LEVELS?

The Kruskal-Wallis one way analysis of variance by ranks was applied to the scores of high anxious experimental



●= HA high-fit ✕= HA medium-fit ○= HA low-fit

Figure 6. Mental performance mean scores for high anxious (HA) women comprising the high-, medium-, and low-fitness levels.

group (Table 11) to determine whether significant differences existed among high-, medium-, and low-fitness levels.

Table 11. Kruskal-Wallis one way analysis of variance by ranks on the differences in mental performance scores of high anxious women comprising the high-, medium-, and low-fitness levels, The University of Tennessee, Knoxville, 1981.

	Sum of Scores	Expected Under H_0	Standard Deviation Under H_0	Mean Score
High-Fit n = 3	47.00	33.00	9.95	15.67
Medium-Fit n = 10	87.50	110.00	14.20	8.75
Low-Fit n = 8	96.50	88.00	13.81	12.06

$\chi^2_{.05} = 5.99$ $\chi^2 = 3.25$ DF = 2 Prob > $\chi^2 = 0.1973$

In Table 11, the Kruskal-Wallis test showed an overall computed value of $\chi^2 = 3.25$, which was not significant. The criterion χ^2 for 2 degrees of freedom at the .05 level of confidence is 5.99. Therefore, there was no basis to reject the null hypothesis that there is no difference in the mental performance scores of high anxious women comprising the high-, medium-, and low-fitness levels.

Table 12 presents the results of the Wilcoxon test on the differences in mental performance scores of high anxious women in the control group.

Table 12. Wilcoxon Matched-Pair Signed-Ranks test for differences in mental performance among high anxious women in the control group, The University of Tennessee, Knoxville, 1981.

Subject	Pre- (DB)	Post- (DB)	Difference	-Ranks Mean	+Ranks Mean	z	$z_{.05}$
1	2	3	-1	5.50	8.05	2.260	1.65
2	0	4	-4				
3	1	1	0				
4	2	3	-1				
5	1	2	-1				
6	2	2	0				
7	0	5	-5				
8	3	5	-2				
9	3	3	0				
10	0	0	0				
11	4	4	0				
12	5	4	+1				
13	3	5	-2				
14	4	6	-2				
15	5	6	-1				
16	2	1	1				
17	4	2	2				
18	3	3	0				
19	0	0	0				
20	1	3	-2				
21	4	6	-2				

As noted in Table 12 and seen in Figure 5, mental performance increased among high anxious women in the control group. The Wilcoxon test for differences in the mental performance among high anxious women in the control group showed an overall computed value of z = 2.260. Therefore, high anxious women in the control group experienced a significant increase in mental performance.

Descriptive statistics for mental performance scores of low anxious women in the experimental and control groups are presented in Table 13.

Table 13. Mental performance (DB) mean scores for low anxious women in the experimental and control groups, The University of Tennessee, Knoxville, 1981.

	Pre-(DB)	Post-(DB)
Experimental n = 21	2.0	3.0
Control n = 22	2.0	3.0

It can be seen from this table that both the experimental and control groups performed the same on the Digits Backwards pretest as well as on the posttest.

Research Question #7: DOES ACUTE EXERCISE INCREASE THE MENTAL PERFORMANCE OF LOW ANXIOUS WOMEN?

The Wilcoxon test was applied to the differences in

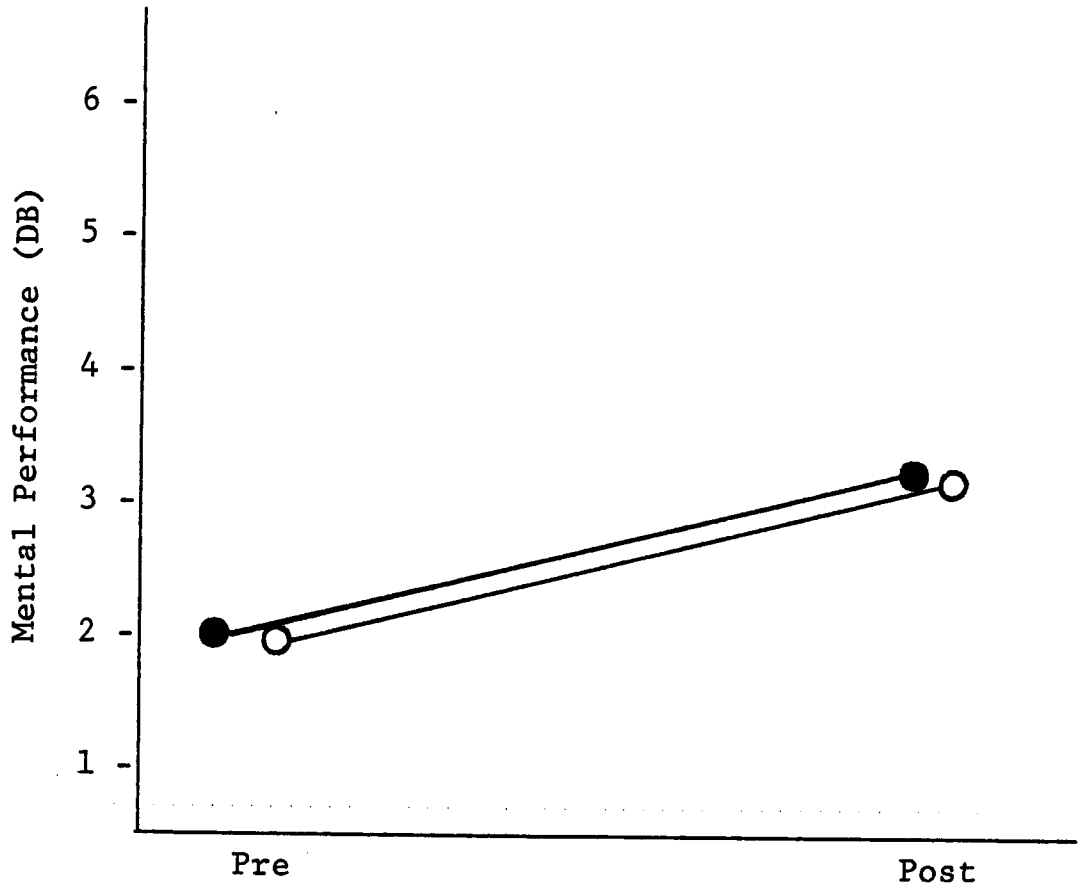
mental performance scores of low anxious women in the experimental and control groups. Table 14 presents the results of the Wilcoxon test on the differences in mental performance scores of low anxious women in the experimental group.

As noted in Table 14 and illustrated in Figure 7, mental performance increased in low anxious women after exercise. The Wilcoxon test for differences in mental performance scores showed an overall computed value of $z = 2.357$. Therefore, low anxious women assigned to the experimental group experienced a significant increase in mental performance.

When the mental performance scores of low anxious women in the exercise group were separately analyzed as a function of fitness level, an interesting picture was revealed. As Figure 8 illustrates, only low anxious/medium-fit subjects appeared to demonstrate an increase in mental performance. There were no low anxious/high-fit subjects to be included in the analysis. For the most part, the mental performance scores of low anxious/low-fit subjects did not change. The Wilcoxon test on the differences in mental performance for low anxious/medium-fit subjects ($n = 16$) revealed a value of $z = 2.271$. This increase was significant at the .02 level of confidence.

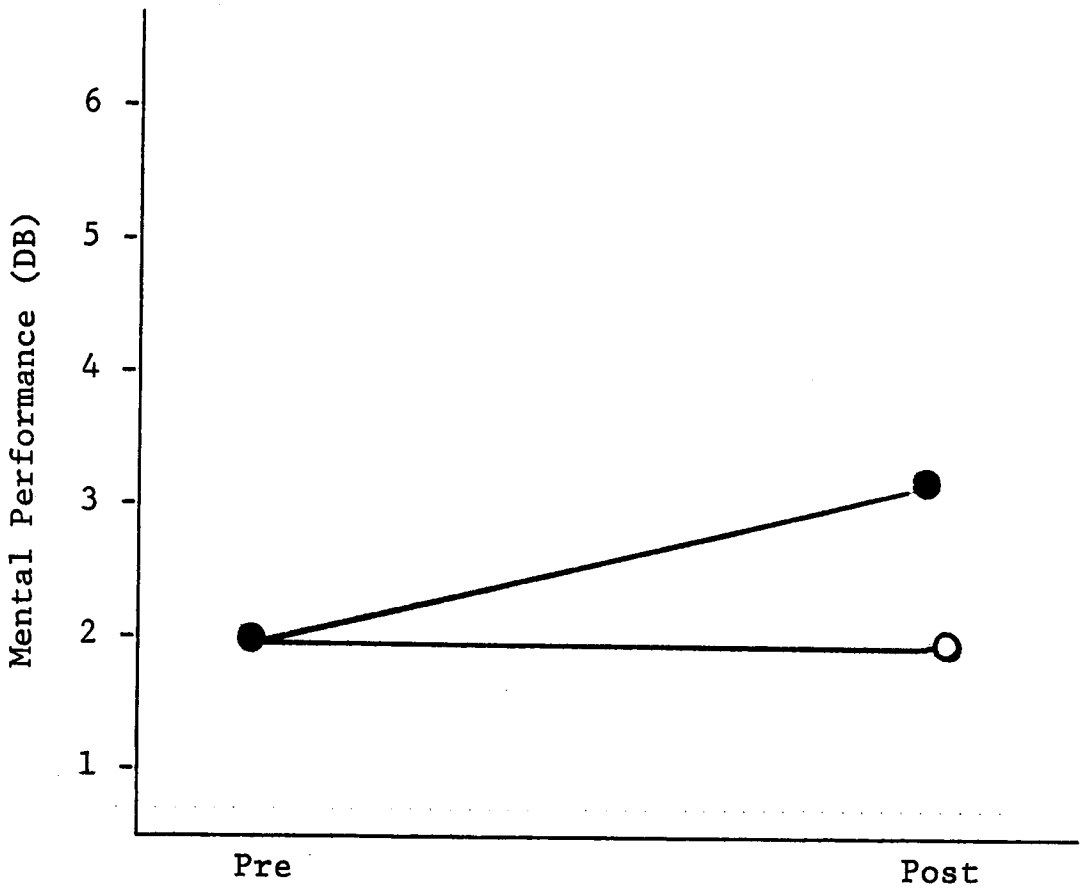
Table 14. Wilcoxon Matched-Pair Signed-Ranks test on the differences in mental performance of low anxious women in the exercise group, The University of Tennessee, Knoxville, 1981.

Subject	Pre- (DB)	Post- (DB)	Difference	-Ranks Mean	+Ranks Mean	x	$z_{.05}$
1	3	4	-1	9.25	7.81	2.357	1.65
2	4	6	-2				
3	0	0	0				
4	0	0	0				
5	2	2	0				
6	3	4	-1				
7	2	5	-3				
8	2	5	-3				
9	1	3	-2				
10	3	4	-1				
11	4	5	-1				
12	0	2	-2				
13	3	3	0				
14	2	1	1				
15	4	4	0				
16	2	2	0				
17	2	3	-1				
18	2	4	-2				
19	1	3	-2				
20	2	5	-3				
21	4	0	4				



●= LA experimental ○= LA control

Figure 7. Mental performance mean scores for low anxious (LA) women in the experimental and control groups.



● = LA medium-fit ○ = LA low fit

Figure 8. Mental performance mean scores for low anxious (LA) women comprising the medium- and low-fitness levels.

Research Question #8: IS THERE A DIFFERENCE IN THE MENTAL PERFORMANCE SCORES OF LOW ANXIOUS WOMEN COMPRISING THE MEDIUM- AND LOW-FITNESS LEVELS?

To determine if significant differences in mental performance existed between these two groups the Kruskal-Wallis one way analysis of variance by ranks was applied (Table 15). As can be seen in Table 15 the mean score of the medium-fit group was lower than that of the low-fit group. This difference proved to be significant, $\chi^2 = 4.43$. The criterion χ^2 for 1 degree of freedom at the .05 level of confidence is 3.84. Therefore the decision was made to reject the null hypothesis that there is no difference in the mental performance scores of low anxious women comprising the medium- and low-fitness levels.

Table 15. Kruskal-Wallis one way analysis of variance by ranks on the differences in mental performance of low anxious women comprising the medium- and low-fitness levels, The University of Tennessee, Knoxville, 1981.

	Sum of Scores	Expected Under H_0	Standard Deviation Under H_0	Mean Score
Medium-Fit n = 16	150.50	176.00	12.11	9.41
Low-Fit n = 5	80.50	55.00	12.11	16.10

$\chi^2_{.05} = 3.84$ $\chi^2 = 4.46$ DF = 1 Prob > $\chi^2 = 0.0352$

Table 16 presents the results of the Wilcoxon test on the differences in mental performance scores of low anxious women in the control group.

As noted in Table 16 and illustrated in Figure 7, mental performance increased in the control group of low anxious women. The Wilcoxon test for the differences in mental performance scores of low anxious women in the control group showed an overall computed value of $z = 2.201$. The criterion z was 1.65 at the .05 level of confidence. Therefore, low anxious women in the control group experienced a significant increase in mental performance. Due to the fact that both low anxious women in the experimental and control groups experienced a significant increase in mental performance, there was no basis for rejecting the null hypothesis that acute exercise does not increase the mental performance of low anxious women.

Table 16. Wilcoxon Matched-Pair Signed-Ranks test on the differences in the mental performance of low anxious women in the control group, The University of Tennessee, Knoxville, 1981.

Subject	Pre- (DB)	Post- (DB)	Difference	-Ranks Mean	+Ranks Mean	z	$z_{.05}$
1	3	3	0	10.00	8.97	2.201	1.65
2	0	3	-3				
3	1	3	-2				
4	1	3	-2				
5	2	6	-4				
6	2	3	-1				
7	0	0	0				
8	0	0	0				
9	2	3	-1				
10	2	5	-3				
11	4	3	1				
12	2	3	-1				
13	1	2	-1				
14	2	6	-4				
15	3	4	-1				
16	1	2	-1				
17	5	6	-1				
18	5	2	3				
19	5	5	0				
20	4	2	2				
21	4	4	0				
22	1	2	-1				

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

I. SUMMARY

The primary purpose of this study was to investigate the effects of acute physical exercise on the state anxiety and mental performance of high and low anxious college women.

Specifically, the research questions tested were: 1) Does acute exercise decrease the state anxiety of high anxious women? 2) Is there a difference in the state anxiety scores of high anxious women comprising the high-, medium-, and low-fitness levels? 3) Does acute exercise increase the state anxiety of low anxious women? 4) Is there a difference in the state anxiety scores of low anxious women comprising the high-, medium-, and low-fitness levels? 5) Does acute exercise increase the mental performance of high anxious women? 6) Is there a difference in the mental performance scores of high anxious women comprising the high-, medium-, and low-fitness levels? 7) Does acute exercise increase the mental performance of low anxious women? 8) Is there a difference in the mental performance scores of low anxious women comprising the high-, medium-, and low-fitness levels? Low anxious women who were classified as medium-fit experienced a significant improvement in mental performance while low anxious/low-fit women did not.

The participants in this study were 85 undergraduate

female students enrolled at The University of Tennessee, Knoxville, during the Spring Quarter of 1981. The State-Trait Anxiety Inventory (STAI) was administered to classify subjects as high or low anxious and to measure changes in anxiety. The Digits Backwards subtest of the Wechsler Adult Intelligence Scale was administered to measure changes in mental performance during the experiment. Five minutes of bench-stepping was employed to provide an indication of the fitness level as well as the exercise for the treatment group.

The statistical methods used in the analysis of the data included: the Wilcoxon Matched-Pairs Signed-Ranks test to determine if there were significant differences in the state anxiety and mental performance of high and low anxious women after exercise; the Kruskal-Wallis one way analysis of variance by ranks to determine if there was a difference in the state anxiety and mental performance scores among high and low anxious women comprising the high-, medium-, and low-fitness levels.

II. FINDINGS

Based on the analysis of the data in this study, the findings were as follows:

1. Acute exercise did not significantly reduce state anxiety in high anxious women.

2. There was no difference in the state anxiety scores of high anxious women comprising the high-, medium-, and low-fitness levels.

3. Acute exercise significantly increased the state anxiety of low anxious women.

4. There was no difference in the state anxiety scores of low anxious women comprising the medium- and low-fitness levels.

5. Acute exercise did not increase the mental performance of high anxious women.

6. There was no difference in the mental performance scores of high anxious women comprising the high-, medium-, and low-fitness levels.

7. Acute exercise did not increase the mental performance of low anxious women.

8. There was a difference in the mental performance scores of low anxious women comprising the medium- and low-fitness levels.

III. CONCLUSIONS

Based upon the findings of this study, the following conclusions were drawn:

1. Anxiety level alone is not a sufficient predictor of the effects of exercise on high anxious women. Fitness level has an influence on the effect of exercise on this population.

2. Among high anxious women, high-fit and medium-fit individuals will experience reductions in state anxiety. Low-fit individuals will not experience any change in state anxiety after exercise.

3. Acute exercise increases the state anxiety of low anxious women. These increases, however, remain within normal levels.

4. Acute exercise does not increase the mental performance of high anxious women. However, a quiet rest may promote increases in mental performance.

5. Acute exercise does not increase the mental performance of low anxious women.

IV. RECOMMENDATIONS

The following are recommendations for further study of the effects of exercise on the state anxiety and mental performance of women:

1. It is recommended that an investigation of this nature be repeated using a more strenuous bout of exercise and additional physiological measurements such as galvanic skin response, heart rate, and frontalis muscle tension in order to further assess the effects of exercise on physiological indicators of anxiety.

2. In that a quiet rest improved the mental performance of high anxious women on task requiring attention and concentration, a further study is needed to compare the effects of acute physical exercise and a quiet rest on other aspects of the mental performance of high anxious women such as visual perception, reading, comprehension, and complex learning.

3. In that there is no way of knowing if the observed improvement in mental performance among low anxious women in the experimental and control group was, in fact, due to personality characteristics of serenity and calmness, a study should be conducted with this population employing more strenuous exercise to see if differences in mental performance emerge.

4. Since high anxious/low-fit women experienced an overall increase in state anxiety following exercise, a study is needed to determine the effects of different durations and intensities of exercise on the anxiety levels of this population. In this manner, thresholds may be established which would enable helping professionals to deal with highly anxious women. More specifically, such information would allow the professional to better customize an exercise prescription so as to control to some extent the physical and mental discomfort which may result due to poor physical fitness.

5. It is recommended that for future use with the STAI, a large pool of subjects be utilized in order for true extremes in anxiety scores to emerge.

CHAPTER VI

DISCUSSION AND IMPLICATIONS

Every astute citizen of twentieth century American society realizes, on the basis of personal experience as well as observations of other people, that anxiety is a pervasive and profound phenomenon. There is ample documentation that high levels of anxiety serve to reduce one's mental as well as social effectiveness (Lader, 1972; Pitts, 1969; Wilkinson and Latif, 1974; Spielberger, 1971). Today emphasis is being placed on attempts to prevent and control poor mental health by teaching people to deal more effectively with their problems. The purpose of this investigation was to explore the effectiveness of physical exercise as a tool in an individual's personal arsenal for controlling the effects of high anxiety, and to explore the potential of exercise for the enhancement of mental performance.

I. STATE ANXIETY

This study found that, overall, a short bout of physical exercise did not significantly reduce state anxiety in high anxious women. This result may be attributed to a number of factors. First of all, the degree of physical exercise may not have been sufficient to produce reductions in the level of state anxiety. Sime (1977) was also unable

to demonstrate a significant decrease in anxiety following moderate exercise. The intensity of exercise employed in Sime's study as well as that in the present investigation may be described as moderate. Secondly, the differences in anxiety level may have been too subtle to have been detected by the STAI. Thirdly, a lack of a decrease in the anxiety levels of high anxious subjects may have been due to the counteractive effect of the results of low-fitness subjects. It may be recalled that when the scores of high anxious subjects were analyzed by fitness level, medium-fit subjects experienced a significant reduction in anxiety (.02 level of confidence) and high-fit subjects a significant reduction (.10 level of confidence). On the other hand, there was a mean increase in the scores of low-fit subjects although this difference was not significant.

The lack of a decrease in state anxiety levels among low-fit/high anxious subjects after exercise supports the conclusion of Pitts and McClure (1967) and Pitts (1969) that physical activity may be contraindicated in certain types of individuals. Pitts stated that anxiety symptoms could occur in normal persons under stress as a result of excessive lactate accumulation. This may be due to the fact that a specified degree of activation (i.e. exercise) may induce heavy rather than moderate ranges of arousal depending upon the fitness level of the individual for the activity involved (Gutin and DiGennaro, 1968a). Another

possible explanation for the lack of decrease in low-fit subjects is that even moderate exercise (i.e. bench-stepping) may create an emotional uneasiness due to the difficulty such subjects have in executing and enduring the physical task. Finally, it may be that physical exercise was the medium through which high anxious low-fit individuals were confronted with the fact that they were in poor physical condition and this knowledge created an emotional tension. This emotional tension may be regarded as beneficial only if it prompts the high anxious/low-fit individual to make a positive change in lifestyle.

As predicted, low anxious women experienced a significant increase in state anxiety as a result of exercise. Wood (1977) also found that low anxious women experienced an increase in anxiety level after exercise. Ostensibly, these findings parallel the Pitts-McClure data until one realized that even though physical exercise increased the level of anxiety in low anxious women in this investigation as well as in Wood's, the scores were still within normal levels. Thus, low anxious women might be expected to experience a more heightened arousal state even after a short bout of exercise.

II. MENTAL PERFORMANCE

High anxious women, overall, did not experience a significant improvement in mental performance after

exercise. One might conclude from this finding that had high levels of anxiety been reduced significantly overall, perhaps mental performance would have been facilitated. Another consideration is that perhaps physical exercise is not effective in improving mental performance among high anxious individuals on tasks which specifically require attention and concentration. Shore (1958) demonstrated that on tasks requiring visual perception, high anxious subjects performed better than medium or low anxious subjects with increases in induced muscular effort. Shore, however, utilized a static form of exercise, i.e. a hand dynamometer. Another consideration which leads one to conclude that physical exercise may not be effective in improving mental performance on tasks requiring attention and concentration is that high anxious women in the control group experienced a significant improvement in mental performance. Thus, it might be contended that simply taking "time out" may be a more effective measure for improving mental performance among high anxious individuals than a short bout of exercise. It is conceivable that "time out" therapy in the form of simple rest breaks, may represent the effective ingredient in therapies designed to control test anxiety. There are, naturally, many questions which should be addressed before adopting the view that "time out" therapy is just as effective as more traditional therapies. The duration of the rest period and the decay of the response following

various rest treatments must be explored. Another important consideration relates to the target population; that is, "time out" may differentially influence individuals who have adopted various lifestyles. The present evidence leads one to recognize the need for added research in this area.

The low anxious women in both the experimental and control groups experienced a significant increase in mental performance. Since exercise apparently played no unique role in the increase in mental performance, one is left to consider factors relating to anxiety states. Since Digits Backwards achievement is highest if intake is effortless and free (Rapaport, 1968), one can conclude from these findings that low anxious women, overall, perform better on a task of this nature than high anxious women due to the relative calmness and serenity that characterizes low anxious individuals. That is, due to their low arousal level, low anxious women tend to be more "matter-of-fact" in their performance on the Digits Backwards task.

While in the present investigation exercise did not produce a significant reduction in the state anxiety of high anxious individuals, there was the suggestion of a trend in that direction. With a larger sample size, it is possible that significant reduction may have been observed. Nonetheless, the present findings along with those of Morgan and Bahrke (1978), Morgan and Horstman (1976), and deVries (1968, 1972) suggest support for the widely held belief

that exercise is capable of reducing anxiety in high anxious persons. It remains to be determined whether exercise causes reductions in tension or whether physical exertion is simply associated with lowered anxiety states. While the assumption appears to be one of a causal function in the exercise literature, there has been no direct evidence to support the notion of causality.

Nevertheless, the question of causality continues to have major theoretical as well as applied implications. The therapeutic basis, for example, resulting from exercise may not rest in the physiological changes produced by such a procedure, but perhaps in the diversional aspects of such an activity. Morgan and Bahrke (1978), for example, found significant reductions in state anxiety among regularly exercising men after acute physical exercise, meditation, and a quiet rest. All three of these treatments represent a departure from daily activities, i.e. a "time out" period, and all three proved equally effective in reducing state anxiety. The present investigation points to the beneficience of "time out" therapy when it is recalled that high anxiety states were lowered after exercise (significantly among high- and medium-fit subjects) and mental performance increased in high anxious subjects in the control group. The quiet rest period which characterized the control group activity emerged as more of a "treatment" due to the positive effect it had on mental performance. Both "conditions"

(exercise and a quiet rest) represent two forms of diversions from daily activities and both produced positive results. Thus, it seems that for the somatic mechanisms influenced by high anxiety, a short bout of physical exercise seems therapeutic. For the cognitive mechanisms influenced by high anxiety, a quiet rest seems to offer more therapeutic value.

The therapeutic value of both physical exercise and a quiet rest which emerged from this study has certain implications for health educators. As the research on stress and disease increases, the relationship between certain pathogenic states and prolonged untreated stress becomes clearer (Pelletier, 1977). Thus, it becomes increasingly more important that health educators play an active role in helping people to critically evaluate how they live and to help direct revisions of lifestyle and behavior patterns.

Through the years we have seen the relation between the psychic and somatic aspects of health gain greater acceptance. In turn, a more "holistic" approach in achieving optimal health has emerged. With these movements in health involving both consumers and providers, the therapeutic value of diversional activities (i.e. physical exercise and relaxation techniques) has received greater attention as practical and positive health practices. It then becomes the responsibility of the health educator,

dedicated to maximizing the quality of life of individuals, to not only increase their knowledge of certain therapeutic techniques but to apply these techniques where appropriate. In this manner, new preventive health behaviors may be integrated into the lives of individuals who are particularly beset by many of life's stresses.

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APPENDICES

APPENDIX A

TRAIT FORM (X-2) OF THE STATE-TRAIT ANXIETY INVENTORY

SELF-EVALUATION QUESTIONNAIRE

Date_____ Name_____

DIRECTIONS: A number of statements which people have used to describe themselves are given below. Read each statement and then circle the appropriate number to the right of the statement to indicate how you generally feel.

There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

		Almost Never	Sometimes	Often	Almost Always
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 cannot 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

		Almost Never	Sometimes	Often	Almost Always
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

STATE FORM (X-1) OF THE STATE-TRAIT ANXIETY INVENTORY

SELF-EVALUATION QUESTIONNAIRE

Date_____ Name_____

DIRECTIONS: A number of statements which people have used to describe themselves are given below. Read each statement and then circle the appropriate number to the right of the statement to indicate how you feel right now, that is, at this moment.

There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

		Not at All	Somewhat	Moderately So	Very Much So
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 feel 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 worrying 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 overexcited and "rattled"	1	2	3	4
19.	I feel joyful	1	2	3	4
20.	I feel pleasant	1	2	3	4

APPENDIX C

INFORMED CONSENT

INFORMED CONSENT

I am conducting a project involving a short bout of exercise, a simple mental task involving numbers, and a short self-evaluation questionnaire. I would like you to volunteer to participate in my project, and I will now outline actual requirements of the project.

If you volunteer to participate in the project it will be necessary for you to attend one testing session in Room 381 which is located on the third floor of the HPER Building. This session will last approximately forty (40) minutes. Volunteers will be assigned at random to either an 1) exercise group or 2) rest group. Should you be assigned to the exercise group you will be required to step up and down a 13 inch bench, thirty times a minute, for a period of five minutes. Should you be assigned to the test group, you will be required to rest in a comfortable chair for a period of five minutes.

Your agreement to participate will include the completion of a short self-evaluation questionnaire as well as participation in a simple mental task involving numbers, before and after the session. This self-evaluation questionnaire is of the paper-pencil type in which you check responses to questions. All results will be treated in a confidential manner. The numbers task simply requires your verbal responses.

Although participation in the project will be useful, you may not receive any personal benefit other than a moderate workout or a quiet rest.

If you are interested in taking part in this project, and have any questions regarding your participation or the procedures to be used, I will be pleased to answer these at this time.

Thank you,

Doris A. Abood
Doctoral Student
Division of Health and Safety
The University of Tennessee

I have been informed of the nature and requirements of this project, questions concerning my participation have been answered, and I consent to take part in this project with the understanding that I may withdraw from participation in this investigation at any time.

Signature of Subject_____

Date_____

VITA

Doris A. Abood was born in Jacksonville, Florida, on October 27, 1950. She attended elementary school in that city and was graduated from Bishop Kenney High School in 1968. Following high school she remained in Jacksonville, attended and graduated from Florida Junior College, and received an Associate of Arts degree in 1970. She attended Florida State University in Tallahassee and graduated in 1972, when she received a Bachelor of Science degree in Elementary Education. Following graduation, she taught all subjects at the fifth and sixth grade levels for two years at St. Paul's School, Jacksonville Beach, Florida. She then traveled to California, Europe, and the Middle East before entering the University of Florida, Gainesville, in June of 1977 to pursue graduate work in Health Education. She received a graduate scholarship in Health Education from the American Cancer Society, Florida Division, Inc., in September, 1978. The Master of Arts in Health Education degree was conferred in March, 1979. In August of 1979, she entered The University of Tennessee, Knoxville, to pursue the Doctor of Education degree in Health Education and was awarded a graduate teaching assistantship. She received the Doctor of Education degree in Health Education in August, 1981.