

THE INTERACTING EFFECTS OF ANXIETY LEVELS, TASK
COMPLEXITY, AND WARM-UP CONDITIONS ON
LEARNING A SERIAL TYPE MOTOR TASK

APPROVED:

Graduate Committee:

L. Fred Thomas

Major Professor

John E. Dentlitt

Minor Professor

Dan W. Casey

Committee Member

Kevin J. Kennelly

Committee Member

Luane Kingery

Dean of the College of Education

Robert B. Toulouse

Dean of the Graduate School

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LEARNING A SERIAL TYPE MOTOR TASK

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By

Bruce P. Craig, B. S., M. Ed.

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CHAPTER I

INTRODUCTION AND STATEMENT OF PROBLEM

It is a common experience for some people to have pre-game jitters. It is also common for this uneasiness or apprehension to disappear once the game action has begun. The tranquilizing effect of movement, in and of itself, is widely accepted by physical educators. Still, there are times when an individual's performance is marred by his being too tight or trying too hard. Physical educators are familiar with this latter problem when introducing new motor skills to students. Tenseness, overaction, and overreaction slow the progress of many students in acquiring a desired skill level. An understanding of the interacting factors of task complexity, overt movement, and anxiety would be beneficial for those concerned with teaching or learning motor skills.

Statement of the Problem

The problem of this study was to find out the effects of anxiety, warm-up condition, and task complexity on the learning of a simple motor skill task.

Purposes of the Study

The major purpose of this study was to determine the effects of manifest anxiety, task complexity, and warm-up

conditions on learning a two-phase serial type motor task. Another purpose was to consider the implications of these effects for physical educators, coaches, and others interested in improving educational practices and securing optimum performance levels.

Hypothesis

To carry out the purposes of this study the following hypothesis was formulated.

There will be a triple interaction among manifest anxiety levels, task complexity, and warm-up conditions when individual differences in general motor ability are used as a covariate control such that (a) under the no warm-up condition, the high manifest anxiety group will score significantly higher than the low manifest anxiety group on the simple task, but will score significantly lower than the low manifest anxiety group on the complex task; and (b) under the warm-up condition, the high manifest anxiety group will score significantly higher than the low manifest anxiety group on the simple task, but will not score significantly different than the low manifest anxiety on the complex task.

Definition of Terms

The terms used in this study are defined as follows:

1. Manifest anxiety is the level of general uneasiness and apprehension, as well as drive level to achieve, as reflected by scores on the Taylor Manifest Anxiety Scale.

2. High manifest anxiety represents a level of manifest anxiety traits as reflected by scores of twenty-one or more on the Taylor Manifest Anxiety Scale.

3. Low manifest anxiety represents a level of manifest anxiety traits as reflected by scores of seven or less on the Taylor Manifest Anxiety Scale.

4. Warm-up condition is a series of general motor exercises performed prior to attempting a task and are generally unrelated to the movements required by the task.

5. No warm-up condition consists of sitting passively for a length of time equal to that required for the warm-up condition prior to attempting a motor task.

6. General motor ability is an individual's level of ability in a wide range of motor activities as reflected by his score on the Barrow Motor Ability Test Indoor Battery.

7. Task complexity is the relative difficulty of the two phases of the serial type motor task used in this study and are known separately as the simple task and the complex task.

8. Simple task as used in this study consists of two five-cent coins tossed from the back of a hand into the air and grasped one at a time from above with the tossing hand in two distinct motions while the coins are air-borne.

9. Complex task as used in this study consists of three five-cent coins tossed from the back of a hand into the air and grasped one at a time from above with the tossing hand in three distinct motions while the coins are air-borne.

Background and Significance

Anxiety is a somewhat nebulous term used quite frequently to describe several phenomena. Cattell exemplifies this when he says,

To add to the difficulties, the subject (anxiety) has also been trodden into a sematic morass; for some writers equate anxiety with fear, some with neurosis, others merely with conflict, and yet others make a masterpiece of confusion by making it synonymous with drive or motivation of any kind:¹

Taylor² found that subjects high in manifest anxiety traits performed better than subjects low in manifest anxiety traits in a simple task involving eyelid conditioning response. This finding demonstrates that anxiety could well be a determiner of drive level and be an indicator of motivation.

Anxiety has been described also as a disorganizer of effective action. Studies by Taylor and Spence,³ and Farber and Spence⁴ had findings that indicated this to be true when the task was more complex than the simple conditioned eyelid response. Also, it was found that high anxiety subjects

¹Raymond B. Cattell, Personality and Motivation Structure and Measurement, (New York, 1957), p. 657.

²Janet A. Taylor, "The Relationship of Anxiety to the Conditioned Eyelid Response," Journal of Experimental Psychology, XLI (February, 1951), 81-92.

³Janet A. Taylor and Kenneth W. Spence, "The Relationship of Anxiety Level to Performance in Serial Learning," Journal of Experimental Psychology, XLIV (August, 1952), 61-64.

⁴I. E. Farber and Kenneth W. Spence, "Complex Learning and Conditioning as a Function of Anxiety," Journal of Experimental Psychology, XLV (February, 1953), 120-125.

needed more trials to reach a criterion level than did the low anxiety subjects in learning the more complex task.

Ryan and Lakie⁵ conducted a study concerning performance scores of high and low anxiety level subjects in relation to competitive and noncompetitive conditions. The results indicated the high anxiety subjects did well in the noncompetitive situation, but that the pressure of the competitive situation tended to interfere with their performance.

General muscle tension is often mentioned as a manifestation of high anxious people. Cattell amends this, however, when he states

General muscle tension did not correlate in the way a tense person might expect from introspection. What correlated with the anxiety factor was tension in the trapezius, the large muscle that runs from the shoulder to the back of the head . . .⁶

The effects of muscle tension upon accuracy is reported in a study by Russell.⁷ His findings indicated that the degree of accuracy and the degree of tension are inversely related and that there is more variability in scores under tension conditions than under relaxed conditions.

⁵E. Dean Ryan and W. L. Lakie, "Competitive and Non-competitive Performance in Relation to Achievement Motive and Manifest Anxiety," Journal of Personality and Social Psychology, I (April, 1965), 342-345.

⁶Raymond B. Cattell, "The Nature and Measurement of Anxiety," Scientific American, CCVIII (March, 1963), 98.

⁷James T. Russell, "Relative Efficiency of Relaxation and Tension in Performing an Act of Skill," Journal of General Psychology, V-VI (April, 1932), 330-343.

A survey of studies concerning the effects of warming up prior to criterion performance indicates specificity to the individual, the task to be performed, and whether the warm-up was related or unrelated to the task. A summary of these studies is reflected in Ulrich's statement:

A number of researches have indicated that physiologically there is no need to warm-up the muscle before exercise and further evidence has indicated warm-up is much more related to psychological expectations than to physiological changes induced by activity.⁸

Ulrich continued with a practical suggestion, ". . . don't put girls through a gymnastic drill before their basketball or hockey game--if you insist that they must warm-up, make sure that they do so by practicing basketball or hockey skills." These statements reflect the general nature of the findings regarding warm-up.

Thompson⁹ conducted a study concerning the effects of related and unrelated warm-up in several activities. His findings were that unrelated warm-up did not improve performance in sprint swimming, endurance swimming, typing for speed, typing for accuracy, and leg strength. Related warm-up did facilitate performance in sprint swimming, endurance

⁸Celeste Ulrich, "The Tomorrow Mind--Implications of Research for Teaching," Anthology of Contemporary Readings, edited by Howard S. Slusher and Aileene S. Lockhart (Dubuque, 1966), p. 318.

⁹Hugh Thompson, "Effect of Warm-up Upon Physical Performance in Selected Activities," The Research Quarterly, XXIX (May, 1958), 231-236.

swimming, and basketball free throw shooting. Related warm-up did not facilitate typing for either speed or accuracy.

Mathews and Snyder¹⁰ conducted a study of performance in the 440-yard dash under a no warm-up condition and a warm-up condition that was both related and unrelated to the task of running. They found no significant differences in the times of running the dash under the warm-up conditions.

Tuttle,¹¹ in a study of the effects of heat and cold on muscle, found that cooling was more effective in slowing down the relaxation time after a muscle contraction than in slowing down the time of muscle contraction. Under certain conditions, this seems to indicate that warming of muscles would facilitate movement efficiency where movements of alternately flexion and extension are required in rapid sequence. A cool muscle, at that instant when it should relax, would act as an antagonistic muscle out of harmony with the desired movement.

The foregoing separate studies concerning manifest anxiety, task complexity, and warm-up conditions form the core of the scope and results relevant to this study. It was felt the results of the present study would aid in clarifying the role of unrelated physical activity on learning various motor tasks for approximately 40 per cent of the students enrolled

¹⁰Donald K. Mathews and H. Alan Snyder, "Effects of Warm-up on the 440-Yard Dash," The Research Quarterly, XXX (December, 1959), 446-451.

¹¹W. W. Tuttle, "The Physiologic Effects of Heat and Cold on Muscle," Athletic Journal, XXXIII (1933), 1-10.

in physical education classes. Also it was felt that the findings from this study would have implications for the widely held concept as expressed by Ulrich ". . . that movement in and of itself may be the best ataraxic or tranquilizer available to man."¹²

Limitations of the Study

This study was limited to male students enrolled in regular physical activity classes at North Texas State University meeting on Tuesday and Thursday of each week.

A post-hoc limitation was the difficulty of the two levels of the task used in the study. The simple task was more complex than was anticipated and the difficulty level of the complex task limited the distribution range of performance scores.

Basic Assumption

It was assumed that students selected as subjects would be cooperative, honest, and serious during all parts of the experiment.

Procedures for the Study

The Taylor Manifest Anxiety Scale under the title of Biographical Inventory was administered to 306 male students meeting Physical Education 116 classes on a Tuesday and Thursday schedule of each week. Students scoring twenty-one

or more and seven or less were designated high manifest anxiety subjects and low manifest anxiety subjects respectively.

The Barrow Motor Ability Test Indoor Battery was administered to all qualified high and low manifest anxiety subjects. The individual scores obtained on this battery were transformed to T-scores and summed for use as a covariate to equate all subjects statistically on general motor ability.

Four groups, two of them designated as high manifest anxiety and two of them designated as low manifest anxiety, were formed. One of two warm-up conditions was assigned to each of the four manifest anxiety groups so that one high manifest anxiety group had one condition assigned and the other high manifest anxiety group had the other condition. The two low manifest anxiety groups also had the two warm-up conditions assigned in a similar manner. These warm-up conditions were performed prior to the attempts at the simple and complex coin toss and grasp tasks. The subjects' scores obtained on the two levels of task complexity were computed to test the tenability of the research hypothesis parts. The .05 level of significance was used to reject hypothesis parts stated in the null form.

CHAPTER II

REVIEW OF THE RELATED RESEARCH

This study was concerned with the interacting effects of anxiety levels, task complexity, and warm-up conditions on learning a serial type motor task for male college students. A review of the related research provided the basis for the development of the study and the formation of the hypothesis. The review of the related research was confined primarily to the general areas of anxiety and warm-up as they pertained to performance and learning of motor tasks with some kindred studies reviewed as they pertained to these basic areas.

Anxiety and Motor Behavior

The review of the research concerning anxiety revealed an abundance of studies; however, research on the more specific concern of this study was limited. Particularly limited were research studies on the relationship of manifestations of anxiety and the more overt types of motor performance and motor learning.

Research Studies on Anxiety

The review of studies on anxiety and its effects on responses in varying circumstances included studies of manifestations associated with anxiety. General muscle tension

is often reported by people considered to be highly anxious, but Cattell¹ amends this somewhat by localizing the tension to the trapezius muscle of the neck and shoulders.

The effects of muscle tension on the performance of a motor skill as compared to more relaxed performance was investigated by Russell.² He used forty college undergraduate males and females as subjects in an experiment where the performance accuracy of the subjects was measured on a tennis ball toss at a target task under relaxation, tension, and natural tossing circumstances. The order of the toss attempts by matched groups was regulated so that all subjects had all conditions for the same number of tosses. The results obtained warranted the experimenter to draw the conclusion, restricted to the conditions of the experiment, that the degree of accuracy and the degree of tension are inversely related. Another conclusion drawn from the findings of this study was that the degree of variability is a direct function of the degree of tension.

A similar relationship to the amount of tension in anxious individuals is the situation of competition and non-competition and its effects on high and low anxious individuals as reported

¹Raymond B. Cattell, "The Nature and Measurement of Anxiety," Scientific American, CCVII (March, 1963), 98.

²James T. Russell, "Relative Efficiency of Relaxation and Tension in Performing an Act of Skill," Journal of General Psychology, V-VI (April, 1932), 330-343.

in a study conducted by Ryan and Lakie.³ This study utilized male college students as subjects and they were obtained from a physical education program on the basis of extreme scores, both high and low, on the Taylor Manifest Anxiety Scale.⁴ Forty qualified subjects performed a task involving the transfer of colored washers from one peg to another as fast as they could using the reflection in a mirror instead of direct vision. Each subject was tested individually and was told that his score was very good regardless of the time involved. The procedure called for each subject to accept a challenge from a confederate experimenter, which all of the subjects accepted, to try an additional five trials to see who was the faster at the task. The results of this study gave evidence that the high anxious individual did well in the noncompetitive situation but that his performance was affected adversely by his anxiety or fear of failure in the competitive situation.

The relationship of tension levels, both inherent and induced, with manifest anxiety was investigated by Lovaas.⁵

³E. Dean Ryan and W. L. Lakie, "Competitive and Non-competitive Performance in Relation to Achievement Motive and Manifest Anxiety," Journal of Personality and Social Psychology, I (April, 1965), 342-345.

⁴Janet A. Taylor, "A Personality Scale of Manifest Anxiety," Journal of Abnormal and Social Psychology, XLVIII (April, 1953), 285-290.

⁵O. Ivar Lovaas, "The Relationship of Induced Muscular Tension, Tension Level, and Manifest Anxiety in Learning," Journal of Experimental Psychology, LIX (March, 1960), 145-152.

Anxiety was determined by a short form of the Taylor Manifest Anxiety Scale⁶ in 110 male college students. Inherent muscle tension was assumed to be reflected in the subjects' eyelid blink rate. Induced muscle tension was accomplished by the use of a dynamometer which was connected to the circuits of the paired word association screen for preset tension levels. The tension level, when reached, activated the lamp to project the paired words of the task. These paired words were either high associated, low associated, or had competing association. It was hypothesized that manifest anxiety scores, general muscle tension, and induced muscle tension were related to each other as a generalized drive and could be interchangeable in their effect on performance or could be summated for total effect on performance greater than any one by itself. The results indicated no support for a summative relationship between manifest anxiety score and induced muscle tension; but that there was support for a summative and interchangeable relationship between muscle tension and induced muscle tension.

Another form of stress, in the form of time pressure, was investigated by Castaneda and Lipsitt⁷ to determine the

⁶A. W. Bendig, "The Development of a Short Form of the Manifest Anxiety Scale," Journal of Consulting Psychology, XX (October, 1956), 384-385.

⁷Alfred Castaneda and Lewis P. Lipsitt, "Relation of Stress and Differential Position Habits to Performance in Motor Learning," Journal of Experimental Psychology, XVII (January, 1959), 25-30.

relationship of this form of stress to performance in a motor-learning task. The subjects for this study were 108 fifth-grade boys and girls randomly assigned to stress and non-stress groups. The non-stress group members were permitted to respond to a light-stimulus, switch-response task arrangement as quickly as they could with no time limit requirements specified. The stress group had exactly the same sequence and number of trials as the non-stress group, but they were instructed that for the trial to be counted as a correct response it had to be made within one second of the onset of the light-stimulus. Actually, the stress group was permitted two seconds to respond. Each subject in both groups had ten trials at each of eight light-switch combinations. A console with two horizontally parallel rows of eight lights and eight switches were utilized for the task. Four of the light-switch combinations had the appropriate switch directly under the light, while the other four light-switch combinations had the appropriate switch either one switch to the left or right of the switch that was directly under the light. It was interpreted from the results that stress facilitated performance in those instances where the response switch was directly under the stimulus light, but that stress interfered with performance where the response required more discrimination as in finding the appropriate switch that was either to the right or left of the switch directly under the stimulus light. This experiment was with a random sample and did not take into account

anxiety levels of the subjects but it does show the results of induced stress on simple and more complex task performance.

Feshbach and Loeb⁸ conducted a study to obtain evidence bearing upon the mechanism underlying the relationship between measures of anxiety and performance on learning tasks. This study more specifically was an effort to see which theory the results would support; the drive-facilitation theory or the theory which stresses the effects of the interference produced by the responses made to anxiety. Forty-five elementary psychology student volunteers were selected as subjects on the basis of their high scores on the Taylor Manifest Anxiety Scale.⁹ The first part of the experiment required the subjects to learn a list of six pairs of nonsense syllables of low associative value to a criterion of two correct trials. The instructions for this task were given in an informal and relaxed manner. After this initial learning task the subjects were randomly assigned to an ego-threat group or to a control group. Both groups were given a new list of nonsense syllables which included the initially learned pairs of syllables interspersed among new pairs. The control group was given instructions for the new task in the friendly, informal, and reassuring tone as in the initial task instructions while the

⁸Seymour Feshbach and Armin Loeb, "A Further Experimental Study of a Response-Interference Versus a Drive-Facilitation Theory of the Effect of Anxiety Upon Learning," Journal of Personality, XXVII (December, 1959), 497-506.

⁹Taylor, op. cit., pp. 285-290.

ego-threat group had instructions given in a rather grave and serious tone. The results of the data were interpreted as being incompatible with the drive-facilitation hypothesis, but it was also difficult to support the interference explanation without a modified view. A post hoc categorization of subjects was found in which the subjects who learned the initial list of nonsense syllables the fastest also recalled more of the list under the ego-threat conditions than did the moderate rate of learning subjects.

Mandler and Sarason,¹⁰ advocates of the response-interference theory, conducted a study in which they investigated anxiety and learning as reflected by the scores of thirty-three Yale students serving as subjects on intelligence test type tasks. These subjects were obtained from 154 students on the basis of extreme anxiety scores on an instrument specially designed for this study. Fifteen low anxious subjects and eighteen high anxious subjects were randomly divided into three subgroups; success, failure, and neutral. After the completion of the first stage of the experiment the subjects were told that they did very well, did very badly, or merely to proceed to the next stage of the experiment. In the next part of the experiment all subjects were given trials on different versions of the same type test. The findings of

¹⁰George Mandler and Seymour B. Sarason, "A Study of Anxiety and Learning," Journal of Abnormal and Social Psychology, LIII (April, 1952), 166-173.

this study warranted the experimenters to make several conclusions. One conclusion was that the mean time scores of the low anxious group were better than those of the high anxious group for the first five trials of the test. Another of the several conclusions drawn was that anxiety drive of the high anxious group tended to facilitate learning as the learning process proceeded. Still another conclusion from the results of this study was that knowledge of results in the form of intervening reports of either success or failure facilitates the low anxious group's performance but depressed the high anxious group's performance.

Shephard and Abbey¹¹ conducted a study designed to investigate the relationship between manifest anxiety and performance on a complex perceptual-motor task. Two groups of subjects differing in degree of manifest anxiety were obtained and from each of these two groups twenty-eight male and female college students were selected so that four groups could be formed with all four groups differing on sex and manifest anxiety. The task performed was trials on the Toronto Complex Coordinator which was reported as a double-light assembly arranged in nine rows of nine lights each with the alignment of lights accomplished by the movement of an airplane type control stick. The complexity of the task was

¹¹A. H. Shephard and D. S. Abbey, "Manifest Anxiety and Performance on a Complex Perceptual-Motor Task," Perceptual and Motor Skills, VIII (December, 1958), 327-330.

manipulated for blocks of time for a standard task and the reverse of the standard task in which the movement of the control stick to the right moved the flashing light sequence to the left. The reverse of the standard task also changed the relationship of the forward and backward movement of the control stick to the corresponding lights. The results of the experiment were in keeping with other experiments involving anxiety and complex task performance. It was found that the non-anxious subjects were superior in terms of both a higher number of matches and a lower error-match ratio. It was also found that males showed superior performance on both the standard and reverse standard tasks.

Studies such as the foregoing Shephard and Abbey study where visual perception is a factor raises the question of the relationship of manifest anxiety and visual acuity. A study was conducted by Calhoun and Johnston¹² that investigated this relationship. The Taylor Manifest Anxiety Scale¹³ was administered to 381 college males and females to obtain subjects representing both high and low extremes of manifest anxiety traits. After obtaining possible subjects by this means and eliminating those students with impaired vision, there were four females and seventeen males in the low anxious group

¹²Jo Anne Calhoun and James O. Johnston, "Manifest Anxiety and Visual Acuity," Perceptual and Motor Skills, XXVII (December, 1968), 1177-1178.

¹³Taylor, op. cit., pp. 285-290.

and eleven females and ten males in the high anxious group. The test of visual acuity for all members of both groups utilized a stimulus chart containing thirty-three fine-line circles one inch in diameter on a white background. Six of these circles were completely closed while the remaining twenty-seven circles had a tenth of an inch gap. These gaps were located in one of the four positions, top, bottom, right, or left. The chart was illuminated in an otherwise dark room by a twenty-five watt flood light and each subject was seated seven feet from the chart and asked to describe each circle as completely closed or open at one of the four positions. The results of the experiment confirmed that high anxious subjects make significantly more errors than low anxiety subjects on the visual task.

Another factor investigated in conjunction with anxiety was reaction time. Nash and others¹⁴ investigated the relationship of manifest and induced anxiety on simple reaction time. Thirty-six female college students were placed in low, medium, or high anxiety groups based on the ranking of their scores on the Taylor Manifest Anxiety Scale.¹⁵ From this grouping arrangement, one-half of the subjects in each group were randomly selected for stress or no-stress conditions

¹⁴Ed L. Nash and others, "Effects of Manifest and Induced Anxiety and Experimenter Variability on Simple Reaction Time," Perceptual and Motor Skills, XXII (January, 1966), 483-487.

¹⁵Taylor, op. cit., 285-290.

while performing trials of simple reaction time on a key release-light stimulus apparatus. It was found that under the stress condition of induced shock, simple reaction time was slower than the no-stress condition, but that simple reaction time is not affected by the level of manifest anxiety. In a study by Grice,¹⁶ and reported by Nash and others,¹⁷ discriminative reaction time and anxiety were found to be negatively correlated.

Taylor and Spence¹⁸ conducted an investigation of the relationship of anxiety to the performance of a task that required serial learning. Subjects for the study were obtained from an introductory psychology course class on the basis of extreme scores on the anxiety scale devised by Taylor.¹⁹ Twenty high anxious and twenty low anxious subjects representing the upper and lower 15 per cent of the class distribution were selected as subjects. A memory drum type apparatus was used that exposed the words "right" or "left" at a uniform rate in a sequence that was to be memorized by each subject. A criterion level of two successive faultless

¹⁶R. G. Grice, "Discrimination Reaction Time as a Function of Anxiety and Intelligence," Journal of Abnormal and Social Psychology, L (January, 1955), 71-74.

¹⁷Nash and others, op. cit., 483-487.

¹⁸Janet A. Taylor and Kenneth W. Spence, "The Relationship of Anxiety Level to Performance in Serial Learning," Journal of Experimental Psychology, XLIV (August, 1952), 61-64.

¹⁹Taylor, op. cit.

series was used with a record kept of the number of errors and the number of trials required to reach the criterion level for each subject. The results were in agreement with the expected outcome in that the high anxious individuals had significantly more errors and required a larger number of trials to reach the criterion level of performance. The record of errors indicated that the points of choice that were most difficult provided the greatest differences between the two groups of subjects.

Anxiety has been described as a disorganizer of effective action. Studies by Taylor and Spence,²⁰ and Farber and Spence²¹ had findings that indicated this to be true when the task was more complex. These studies found that high anxiety subjects needed more trials to reach a criterion level than did the low anxiety subjects in learning the more complex task.

Warm-up and Motor Performance

The review of the research concerning the value of preliminary exercise on motor performance is not consistent. Often similar studies have contradictory conclusions drawn from findings that should be more closely related if there is a pattern for the value of warm-up.

²⁰Taylor and Spence, op. cit., pp. 61-64.

²¹I. E. Farber and Kenneth W. Spence, "Complex Learning and Conditioning as a Function of Anxiety," Journal of Experimental Psychology, XLV (February, 1953), 120-125.

Research Studies on Warm-up

Three studies are reported by Karpovich and Hale²² concerning the effect of warming-up prior to motor performance. They classify warm-ups as being of two types, general and formal. General warm-up was defined as exercises involving large groups of muscles, massages, hot showers, or other means to raise the temperature of the body. Formal type warm-up consists of the movements that are used in the actual performance. The first study reported was designed to compare the effects of deep massage with that of preliminary exercise upon the time of running 440 yards. Light digital stroking was used as a control and to detect any psychological effect from massage. Seven track athletes of Springfield College were used as subjects and all of them were members of the freshman or varsity track teams. Sixty test runs were made; twenty after massage, twenty after preliminary exercises, and twenty after the placebo digital stroking. All warm-up conditions lasted for ten minutes. Three afternoons per week for three weeks were used to make the time measurements on a rotated schedule for the subjects such that each day all warm-up conditions were utilized. The results of the study showed no significant difference in the running times after deep massage, preliminary exercises, and digital stroking.

²²Peter V. Karpovich and Creighton J. Hale, "Effect of Warming-up Upon Physical Performance," The Journal of the American Medical Association, CLXII (December, 1956), 1117-1119.

The experimenters also concluded that since there was no significant difference in the running times, the psychological effect of massage was not discernible.

The second study reported by Karpovich and Hale was a follow up to the first study. The results obtained in the first experiment showed that performances were equally good after deep massage, preliminary exercises, and digital stroking; therefore, the second experiment was designed to compare running times after digital stroking with those of no preliminary warm-up. The investigation was to determine the psychological value, if any, of the placebo digital stroking. Five college track athletes were used as subjects. Each of the subjects was tested four times--twice after digital stroking and twice after no preliminary warm-up. The 440-yard run on an indoor track was the activity used for testing. The results of the no warm-up condition running time was an average of 59.2 seconds while the average time attained after digital stroking was 59.5 seconds. Statistical computation indicated no difference between the effects of these two conditions. The results were also interpreted by the experimenters to mean that whatever the psychological effect of digital stroking could be, it did not affect the running times.

The third experiment reported by Karpovich and Hale was a follow up to the first two experiments in an effort to control a possible variable of warm-up activity prior to the

onset of the experiment. Three college students were used as subjects and were assumed to be in excellent condition physically for the experiment because of their experience over a period of several months on the bicycle ergometer in another study. The bicycle ergometer was used in this experiment with the performance of thirty-five pedal revolutions in the shortest possible time being the task. This number of pedal revolutions at a prescribed work load was deemed to be equivalent to running 100 meters. Twenty-four test rides were made; twelve after no warm-up and twelve after warm-up consisting of sixty pedal revolutions per minute for five minutes with a load of 5.5 pounds. The average time for the task without warm-up was 14.2 seconds, and 13.7 seconds with warm-up. Computation using a t -ratio showed that the warming-up did not have a significant beneficial effect on the bicycle ergometer ride times. The muscle temperature of the men in this experiment was measured and the range of temperature in the subjects in the cold state was 97.5 to 98.6 degrees Fahrenheit while the temperature in warm-up subjects was in the range of 99.7 to 101.1 degrees Fahrenheit. The experimenters pointed out these temperature measures to show that similarity between performance time with and without preliminary exercise cannot be explained by assuming that subjects who were scheduled to have a cold run were warmed-up by walking to the laboratory.

Tuttle²³ reports the results of a series of experiments involving the effects of heat and cold on muscle. The procedure for one experiment was to pack the gastrocnemius muscles of a group of subjects in ice for various periods of time and, then compare the activity of the cooled muscles with their activity at normal body temperature. The results of this comparison showed that cooling the intact gastrocnemius muscle for five minutes increased the contraction process time by 50 per cent. The data showed that while the contraction time was slowed by cooling the muscle, the relaxation time is slowed more markedly. Concerning this slowed relaxation time, the experimenter was of the opinion that pulled muscles may be explained by the failure of muscles to relax at the proper time in movements of rapid extension and flexion.

In another experiment by Tuttle, heat produced by short-wave diathermy was applied to the intact gastrocnemius muscles of twenty subjects selected at random. The effect of the heat on the activity of these muscles was studied and compared to the activity of muscles rested for the same length of time as the heating procedure. The data revealed that resting a muscle has no significant effect on the duration of contraction and relaxation, but that the muscle heated for twenty minutes significantly decreased the contraction and

²³W. W. Tuttle, "The Physiologic Effects of Heat and Cold on Muscle," Athletic Journal, XXIV (November, 1943), 45.

relaxation time. It was pointed out that, similar to the cooling of muscle experiment, the most significant effect was on the period of relaxation. The results of the two experiments together indicate that cooling is more effective in slowing down muscle activity than heating has on accelerating activity.

Mathews and Snyder²⁴ conducted a study to determine if physical warm-up affects the running time of high school boys participating in the 440-yard dash and to record injuries, if any, during the experimental period. Fifty high school students with limited track experience were selected as subjects from two consecutive class periods. The experiment was conducted over a period of four weeks with the time trials made during the first four days of each week. The subjects in the first period were divided so that there were ten subjects in the experimental group and fifteen in the control group. The second period subjects were divided so that there were fifteen subjects in the experimental group and ten in the control group. During the second week the subjects' assignments were reversed. Weeks three and four procedures were repeats of weeks one and two. Each subject ran the 440 yards a total of sixteen times, eight times as a member of the control group and eight times as a member of the experimental group. The experimental group had no preliminary warm-up prior to

²⁴Donald K. Mathews and H. Alan Snyder, "Effects of Warm-up on the 440-Yard Dash," The Research Quarterly, XXX (December, 1959), 446-451.

running for time while the control group performed a warm-up sequence composed of jogging and calisthenics. The results of the data obtained indicated that within the limitations of the study warming up prior to performing the 440-yard dash did not significantly improve the time over running the same distance without preliminary warm-up. There were no injuries reported or observed during the experiment.

A study of the comparative effects of rest, exercise, and cold spray upon performance in spot-running was conducted by Sills and O'Riley.²⁵ Eighteen men who were college students served as subjects. Each subject initially performed five ten-second bouts of spot-running with a ten-second rest between bouts after warming up for ten minutes on an indoor track by walking and jogging. Each spot-running bout was monitored by a Sills electric contactor that counted the number of steps taken by the right foot. After the initial five bouts of spot-running each subject on one day rested, on another day exercised, and on still another day had a cold spray applied to his abdomen prior to performing five more ten-second bouts of spot-running. The subjects were divided into three groups and the order of the treatments prior to each day's spot-running was rotated so that six subjects had one treatment, six subjects had another treatment, and six

²⁵Frank D. Sills and Vernon E. O'Riley, "Comparative Effects of Rest, Exercise, and Cold Spray Upon Performance in Spot-Running," The Research Quarterly, XVII (May, 1956), 217-219.

subjects had still another treatment. For the rest period, the subjects lay in a supine position for eight minutes. The exercise treatment required the subjects to walk and jog for ten minutes. For the cold application, the subjects had their abdomen sprayed for eight minutes with water with a range of temperature of 44 to 48 degrees Fahrenheit. On the basis of the findings in this study, physical performance as measured by spot-running is improved more by cold applications than by the rest or exercise conditions used, and more by rest than by exercise. The experimenters further concluded that if the difference in measures from the initial and final bouts is considered to be a measure of the recovery from fatigue, cold applications are more effective than either rest or exercise for recovery from fatigue.

DeVries²⁶ conducted a study concerning the effect of several different warm-up conditions on swimming for speed for 100 yards by competitive swimmers. The subjects were highly skilled, competitive swimmers who swam a total of 195 time trials under five warm-up conditions. Each subject had three time trials using his competitive swimming stroke with no warm-up and three time trials after each of four warm-up conditions; 500-yard swim, six minute hot shower, calisthenics, and massage. The group as a whole showed significant

²⁶Herbert A. DeVries, "Effects of Various Warm-up Procedures on 100-Yard Times of Competitive Swimmers," The Research Quarterly, XXX (March, 1959), 11-20.

improvement only following the 500-yard swim warm-up, whereas the breast-strokers and dolphin swimmers as a group had their best and significant improvement following the calisthenics warm-up. The free stylers as a group showed a significant decrease in speed in their trials after performing the calisthenics warm-up.

Another study with three experiments was conducted by Carlile²⁷ using swimming performance and warm-up conditions as the variables. In the first experiment the experimenter was the lone subject. The experimenter-subject set up trials daily and swam 220 yards either after an eight minute hot shower or with no warming up of any kind. A record of the trial conditions and times was kept and was computed for statistical probability regarding the better times obtained under the warm-up condition. The 1.5 per cent better time obtained under the warm-up condition was significant at the .01 level.

The second experiment reported in Carlile's study utilized ten swimmers swimming a total of 230 time trials for 40 yards with and without preliminary hot showers. A method of rotation was used in performing the warm-up condition so that each subject served as his own control. The results of this experiment were reported to be highly significant for

²⁷Forbes Carlile, "Effect of Preliminary Warming on Swimming Performance," The Research Quarterly, XXVII (May, 1956), 143-151.

the difference in times with the better times obtained under the hot shower warm-up condition.

The third experiment was an extension of the other two experiments. The purpose was to determine the effects of hot shower warm-ups of one minute and eight minutes duration on swimming 40 yards. Ten subjects swam fifty-six trials with each subject serving as his own control by a system of warm-up condition rotation. The results of the difference in times under these two warm-up conditions was significant at the .01 level favoring the eight minute shower warm-up condition over the one minute shower warm-up condition.

Thompson²⁸ investigated the effects of formal and informal warm-up on performance in several activities. The purposes of this study were to determine whether warm-up affected speed in swimming a thirty yard sprint and endurance in swimming for a five minute period, accuracy in basketball free throw shooting, accuracy in bowling, speed and accuracy in typing, and strength of the legs. Formal warm-up was defined as exercises in which the movements are those that imitate the activity for which the performer is getting ready, and informal warm-up was defined as exercises in which the movements are the general, free movements undertaken solely for raising the temperature of the muscles.

²⁸Hugh Thompson, "Effect of Warm-up Upon Physical Performance in Selected Activities," The Research Quarterly, XXIX (May, 1958), 231-246.

The swimming experiment used thirty-four sprint swimmers and twenty-six endurance swimmers obtained from five college physical education classes as subjects. Four weeks were used in testing the subjects of both groups so that each group was tested six times with no warm-up, three times with a formal warm-up, and three times with an informal warm-up. Statistical consideration of the data obtained from the testing led to the conclusion that formal warm-up does improve speed in swimming thirty yards, but that informal warm-up does not improve speed in swimming thirty yards. It was concluded that endurance swimmers improve in the number of laps swum in five minutes by participating in a formal warm-up prior to testing, but that they do not improve in the number of laps after participating in an informal warm-up.

Twenty freshman basketball players served as subjects in the basketball free throw experiment. Each subject had sixty free throw attempts under each of the two warm-up conditions; no warm-up and formal warm-up. The procedure used was for each subject to have twenty attempts each testing day. The two warm-up conditions were alternated for each day's activities. On the days requiring no warm-up the subjects were tested as soon as they were suited up for basketball practice. On the days requiring the formal warm-up condition, the subjects had ten minutes of general floor shooting, ball passing for three minutes, and the shooting of ten free throws prior to testing. Formal warm-up before being tested improved the

accuracy in free throw shooting over no warm-up prior to free throw shooting. A critical ratio was obtained in statistical computation which was beyond the .01 level of significance.

In the experiment concerning bowling, fifty-six experienced league bowlers' scores were obtained from league records. The first two games in the series of games played over a period of ten days were used to organize the date. The first game on each of the ten days was used as the task under no warm-up while the second game was considered to the task after a formal warm-up; namely, the first game. The scores were computed and the conclusion was made that accuracy is improved in bowling when bowlers participate in a formal type warm-up.

Typing for speed and accuracy was another experiment conducted under three warm-up conditions: no warm-up, formal warm-up, and informal warm-up. Thirteen female college typing students with a minimum of one previous semester of typing were used as subjects. Each subject was tested each day for speed and accuracy on a five minute typing test after a warm-up condition was performed. The warm-up conditions were alternated so that each subject had six tests under the no warm-up condition, three tests under the formal warm-up condition, and three tests under the informal warm-up condition. All tests were scored for standard words per minute and marked for the number of errors. Under the conditions of this experiment it was concluded that typists do not improve in speed

or in accuracy of typing after participating in an informal or a formal warm-up prior to performance.

A study concerning the effect of specific warm-up conditions on speed, strength, and accuracy was conducted by Skubic and Hodgkins.²⁹ Thirty-one women physical education majors participated in a series of tests preceded by conditions of no warming-up, a general warm-up, and a related warm-up. The test for speed was a sprint ride of .10 mile on a bicycle ergometer. The strength test was the maximum distance a subject could throw a softball. Accuracy was tested by the number of successful attempts in basketball free throwing. The subjects were divided into three groups and each group was assigned an activity to be tested on under the various warm-up conditions. A total of 360 tests were used to compute the differences in performance scores under the warm-up conditions. The results indicated no significant differences among the several means of scores but that there was a slight tendency toward better scores in tests preceded by related type warm-ups.

Somewhat contradictory results regarding the effects of warm-up on the softball throw for distance was reported by Michael, Skubic, and Rochelle.³⁰ The study utilized

²⁹Vera Skubic and Jean Hodgkins, "Effect of Warm-up on Speed, Strength, and Accuracy," The Research Quarterly, XXVIII (May, 1957), 147-152.

³⁰Ernest Michael, Vera Skubic, and Rene Rochelle, "Effect of Warm-up on Softball Throw for Distance," The Research Quarterly, XXVIII (December, 1957), 357-363.

seventy-seven male college physical education students to investigate the effects of no warm-up, related warm-up, and unrelated warm-up on the softball throw for distance. The related and unrelated warm-ups were comparatively more strenuous than the short duration exercises used in another study undertaken in part by Skubic and Hodgkins.³¹ In the present study the subjects were divided into three groups and assigned the warm-up conditions on a rotated basis for testing. The results from these tests showed no significant difference between the performances under the related and unrelated warm-up conditions but that both were significantly better than the performance under the no warm-up condition.

Pacheco³² conducted a two part study concerning preliminary exercise and its effect on jumping ability. The first experiment had ten experienced subjects perform ninety or more vertical jumps preceded by one of four warm-up conditions: no warm-up, isometric stretching, isotonic running in place, or knee bends. The performances following the three preliminary exercises were significantly better than the performance after no preliminary exercise.

The second experiment disguised the purpose of the tests and had fifty men jumping ten times each under the same

³¹Skubic and Hodgkins, op. cit., pp. 147-152.

³²Betty A. Pacheco, "Improvement in Jumping Performance Due to Preliminary Exercise," The Research Quarterly, XXVIII (March, 1957), 55-63.

warm-up conditions as in the first experiment. The findings of this second experiment were in accord with those of the first experiment in that significant improvement was obtained in performances under the warm-up conditions as compared to the no warm-up condition. The improvements in performances were reported to range from 2.9 to 7.8 per cent.

Lotter³³ used twenty college men to perform two tests involving speed of arm movement under two conditions of preliminary warm-up of differing duration. The task consisted of a bicycle pedal arrangement with a prescribed work load turned as rapidly as possible after bouts of exercises of either two or four minutes. In this experiment warm-up exercises were without effect but there was some improvement in performance in the second task attributed to the practice on the first task. It was reported that this was particularly true in the initial phase of the second task.

Psychological advantages of warm-up prior to performance was investigated by Smith and Bozymowski³⁴ as a function of the attitude towards warm-up. Eighty-six college women were divided into four groups on attitude toward warm-up and an assignment of a warm-up or no warm-up

³³Willard S. Lotter, "Effects of Fatigue and Warm-up on Speed of Arm Movement," The Research Quarterly, XXX (March, 1959), 57-65.

³⁴Judith L. Smith and Margret F. Bozymowski, "Effect of Attitude Toward Warm-ups on Motor Performance," The Research Quarterly, XXXVI (March, 1965), 78-85.

condition. The results were such that the subjects with a favorable attitude toward warm-up performed significantly better on an obstacle race under a warm-up condition than those subjects with a favorable attitude toward warm-up that did not perform preliminary exercises prior to performance. Those subjects with less favorable attitude toward warm-up had performances that were not facilitated by preliminary exercise.

A study of the research concerning stress adaptation and exercise was made by Michael.³⁵ He reports that evidence indicates that adaptation to exercise produces a measure of protection against emotional stress. He further reports that the advantage of exercise lies in the fact that the defense mechanism is stimulated and that exercise is not similar to other stresses. However, he points out that the use of exercise as a means of adapting to stress raises many questions that cannot be answered at the present time.

³⁵Ernest D. Michael, Jr., "Stress Adaptation Through Exercise," The Research Quarterly, XXVIII (March, 1957), 50-53.

CHAPTER III

PROCEDURES OF THE STUDY

Description of the Subjects

The subjects for this study were seventy-two students enrolled in regular physical activity classes at North Texas State University during the 1969 spring semester. These subjects were obtained from students meeting class on Tuesday and Thursday of each week at one of the three morning periods. The subjects' ages ranged from eighteen through twenty-three years with the exception of two subjects who were twenty-five and thirty years old. All procedures of the experiment concerned with subject participation were carried out during the regular class periods on three class meeting days. The activities of the three days were conducted so that all subjects completed the same items on the same day.

Students who otherwise qualified to continue from one day's activities to the next but were absent on the next day that activities pertaining to the study were held, were arbitrarily dropped from the study. Twenty-eight students out of the 119 students who qualified the first day were dropped because of this reason. Another eighteen subjects were randomly dropped from the study at the conclusion of the experiment in order to have an equal number of subjects in each group to facilitate the computational procedures.

The activities of the first day consisted of administering a manifest anxiety scale. On the second day, a three item general motor ability test was administered to students that qualified as subjects according to their manifest anxiety scores. The third day consisted of thirty simple and thirty complex task attempts for all subjects after they performed an assigned warm-up condition.

Subject Selection and Group Assignment

The Taylor Manifest Anxiety Scale under the camouflaged title of Biographical Inventory was administered to 306 students enrolled in regular physical activity classes for the purpose of selecting subjects on the basis of manifest anxiety traits. (See Appendix A.) The manifest anxiety scale was administered to these students during their regular class period with the aid of their regular class instructors serving as proctors.

Students scoring twenty-one or more were selected as members of the high manifest anxiety group. Students scoring seven or less were selected as members of the low manifest anxiety group.

A score sheet for the subsequent tests was devised for each qualified student. (See Appendix B.) Each high and low manifest anxiety subject had a code number digit entered on his score sheet to indicate his group assignment. The scores of twenty-one and seven reflect the 80th and 20th

percentiles respectively in reference to the norms for a sample of 1971 college students.¹ The number of students with high anxious qualifying scores was sixty-two, or about 20 per cent of the number of students initially sampled. Fifty-seven, or about 18 per cent of the total, qualified as low anxious students.

Each of the two groups, the high manifest anxiety group and the low manifest anxiety group, was further divided into two groups so that the members in each half were matched as closely as possible on their manifest anxiety scores. This resulted in two high manifest anxiety groups matched on manifest anxiety scores and two low manifest anxiety groups matched on manifest anxiety scores so as to make the assignment of the two warm-up conditions as unbiased as possible.

One warm-up condition was assigned to each of the high manifest anxiety groups by the flip of a coin. The same procedure was used to assign the two warm-up conditions to the two low manifest anxiety groups. The warm-up condition assigned to each group was entered in code on each group member's score sheet.

The details of the two warm-up conditions are as follows:

Warm-up condition--The warm-up condition consisted of eight general calisthenics type exercises that were considered to be unrelated to the two phase serial type motor task used

¹Janet A. Taylor, "A Personality Scale of Manifest Anxiety," Journal of Abnormal and Social Psychology, XLVIII (April, 1953), 285-290.

in this study. These exercises in the order administered were arms extended body twist-upright position, arms extended-body twist-bent at the waist, hands and arms extended between legs twelve inches behind heels in bouncing motion, side straddle hops, push ups, sit ups, squat thrusts, and running in place. These exercises required eight minutes. The warm-up condition also included a rest period of approximately five minutes after the exercises for recovery from any fatiguing effects from the exercises.

No warm-up condition--The no warm-up condition consisted of sitting passively on benches for a length of time equal to that required for the warm-up condition including the recovery time.

As a control for the effects which the order of simple and complex task performance might have on the outcome of the experiment dealing with task complexity, one-half of each of the four groups performed the complex coin-tossing task before the simple coin-tossing task; the other half of each group performed the simple task before the complex.

General Motor Ability Testing Procedures

Equating all four manifest anxiety groups on general motor ability was believed to be an important control. Due to the infeasibility of doing this by direct means, summed T-scores, as reflected by the subjects' transformed raw

scores on the Barrow Motor Ability Test Indoor Battery² were considered as a potential covariate control. This general motor ability battery consisted of three items--the standing broad jump, medicine ball put, and zigzag run. The battery was administered on the second day with the aid of students and physical education instructors.

Two courses for the standing broad jump were used. Tape, marked off in inches from a starting line, was used to measure the distance of the jump on both courses. Both jumping areas were laid out on a single 12 x 12 foot tumbling mat. Three students were used at each of the two courses to monitor, measure, and record the subjects' jumps. Each subject was allowed three jumps, however, his best jump was recorded as his score.

Two zigzag run courses were set up using folding chairs as course markers. Each course was proctored by a physical education instructor with two students as aids. Stop watches were used to time the three required trips through the course to the nearest tenth of a second. One attempt was allowed for each student with the exception of a few subjects that became misrouted for some reason on their first try or hit one of the chairs used as course markers. These subjects were permitted to try the zigzag run until they had an error free attempt.

²Harold M. Barrow, "Test of Motor Ability for College Men," The Research Quarterly, XXV (October, 1954), 253-260.

One medicine ball put area was used and it was marked in one foot intervals to facilitate measuring the tosses. Each subject was allowed three tries and his best toss was recorded on his score sheet.

All subjects were free to take the three items of the battery in any order they desired. A limiting factor of this freedom was the medicine ball put because of the single court provision.

A simple analysis of variance of the high manifest anxiety and low manifest anxiety groups' general motor ability scores produced an $F(3, 68) < 1$. The summary of this analysis is reported in Table I. Thus, general motor ability, as measured by the Barrow Motor Ability Test Indoor Battery, is unrelated to anxiety as measured by the Taylor Manifest Anxiety Scale.

TABLE I

SUMMARY OF THE SIMPLE ANALYSIS OF VARIANCE OF
THE HIGH ANXIETY AND LOW ANXIETY GROUPS'
GENERAL MOTOR ABILITY SCORES

Source	Sum of Squares	df	Variance Estimate	F Ratio
Between	1758.33	3	586.11	< 1
Within	42741.67	68	628.56	
Total	44500.00	71		

Task Data Gathering Procedures

The third and final day of subject participation in the study was used to gather simple and complex task attempts data under specified conditions. It was at the beginning of the class periods on this day that the two phases of the serial type motor task to be performed were revealed to the subjects for the first time.

The subjects were instructed that the simple task involved two five-cent coins and that the complex task involved three five-cent coins. Demonstrations of successful and unsuccessful task attempts for each task were given. In addition to the demonstrations, instructions pertaining to how the tasks were to be performed were read aloud by the investigator. (See Appendix C.)

All subjects were told the sequence and order of activities as designated by the code numbers on their individual score sheets. The subjects with code numbers for the warm-up condition performed the calisthenic exercises while those subjects with code numbers for the no warm-up condition sat passively on benches. During the rest period of the two warm-up conditions, instructions concerning the order in which the tasks attempts would be tried were given.

Each subject had a student scorer that marked his score sheet either good or not good after each attempt. Each student tried thirty attempts for each task level. Scores reflected successful attempts on each of the two levels of

task complexity. All score sheets were collected and scored by hand.

Instruments

The Taylor Manifest Anxiety Scale³ is a paper and pencil test consisting of fifty true-false items. Each item has polarity properties of high and low manifestations of anxiety depending on the true or false answer appropriate to the item. The test is scored according to the number of high anxious answers. According to Taylor,⁴ in a sample of 1971 college students the scores of twenty-one and seven represent the 80th and 20th percentiles, respectively, in a distribution that was slightly skewed positively. This skewness is reflected by the score of about thirteen representing the 50th percentile while the mean score was 14.5.

Test-retest procedures yielded a Pearson produce-moment coefficient of correlation of .89 after a lapse of three weeks, .82 after five months, and .81 after nine to seventeen months. While these figures indicate a relatively high degree of test reliability, it should be noted that the mean scores were lower by about two points on the retest.

There is considerable evidence that the test does measure manifest anxiety. A comparison of scores between a

³Janet A. Taylor, "A Personality Scale of Manifest Anxiety," Journal of Abnormal and Social Psychology, XLVIII (April, 1953), 285-290.

⁴.....

college student sample and a neurotic and psychotic patient sample assumed to be highly anxious is such evidence. This comparison revealed a mean score of approximately thirty-four for the patients which is equivalent to the 98.8 percentile score in the student distribution.⁵

The Barrow Motor Ability Test Indoor Battery⁶ is a three item battery consisting of the standing broad jump, medicine ball put, and zigzag run. Construction of the test was based on expert opinion in relation to eight selected factors believed to be highly relevant to motor ability. These factors were agility, hand-eye-foot-eye coordination, speed, power, arm and shoulder coordination, strength, and flexibility. Twenty-nine tests were selected as potential measuring devices for these factors and were administered to 222 male college students. The scores were transformed to T-scores, summed, and a correlation matrix was formed that included intercorrelations of all items to criterion items. Final selection of the three items for the battery was on the basis of high correlation with the criterion and low correlation with each other. Reliability coefficients of the three items on test-retest are .89 for the standing broad jump, .79 for the zigzag run, and .89 for the medicine ball put. Validity of the battery is reported to be .92. Scoring

⁵Ibid., p. 290.

⁶Harold M. Barrow, "Test of Motor Ability for College Men," The Research Quarterly, XXV (October, 1954), 253-260.

tables are available for transforming raw scores into T-scores. A general motor ability score is obtained by summing the T-scores of the three items.

Procedures for Treating Data

The hypothesis of this study was tested by means of a 2 x 2 x 2 analysis of variance technique with repeated measures on the last factor.⁷ The independent variables were the two levels each of anxiety, warm-up conditions, and task complexity. The task complexity variable was the repeated measure. The dependent variable was the scores on the coins tossing and grasp tasks.

⁷B. J. Winer, Statistical Principles in Experimental Design, (New York, 1962), pp. 337-344.

CHAPTER IV

ANALYSIS OF THE DATA

The data obtained for this study were analyzed through the use of three statistical techniques. The first technique was a simple analysis of variance utilizing the data obtained from the administration of the Barrow Motor Ability Test Indoor Battery. This was done to determine the homogeneity among the four manifest anxiety groups on general motor ability in consideration of a possible analysis of covariance approach to the simple and complex task scores. The results of this test were not significant, $F(3, 68) < 1, p > .05$. Therefore, inasmuch as the four manifest anxiety groups did not differ significantly in motor ability, scores on the Barrow Motor Ability Test Indoor Battery were not used as a covariate control, and a $2 \times 2 \times 2$ analysis of variance was performed on the coin tossing task data. This analysis involved two levels of anxiety (high and low), two levels of warm-up (warm-up and no warm-up), and two levels of task complexity (simple and complex). The task complexity factor involved repeated measurements. The summary of the results of this analysis is presented in Table II, and the corresponding means and standard deviations are reported in Table III.

TABLE II
 SUMMARY OF ANALYSIS OF VARIANCE OF COINS
 TOSSING AND GRASPING SCORES

Source of Variation	df	MS	F
Between Subjects	71		
A (Anxiety)	1	73.677	1.740
B (Warm-up)	1	31.177	< 1
AB	1	396.670	9.368**
Subjects within groups (error between)	68	42.343	
Within Subjects	72		
C (Task)	1	8,387.511	351.427**
AC	1	21.003	< 1
BC	1	31.169	1.306
ABC	1	91.845	3.848*
C X Subjects within groups (error within)	68	23.867	

*Significant at the .10 level.

**Significant at the .01 level.

TABLE III

MEANS AND STANDARD DEVIATIONS OF GROUPS' SCORES
 UNDER TWO LEVELS OF ANXIETY, WARM-UP,
 AND TASK COMPLEXITY

Anxiety Levels	Warm-up Conditions	N	Task Complexity	
			Simple Task	Complex Task
High Anxiety	Warm-up	18	Mean = 15.667 S.D. = 7.008	Mean = 1.833 S.D. = 2.587
	No warm-up	18	Mean = 18.722 S.D. = 7.067	Mean = 3.556 S.D. = 5.241
Low Anxiety	Warm-up	18	Mean = 22.778 S.D. = 6.478	Mean = 4.222 S.D. = 4.479
	No warm-up	18	Mean = 16.000 S.D. = 6.155	Mean = 2.500 S.D. = 4.597

Findings Related to the Hypothesis

It was hypothesized there would be a triple interaction among manifest anxiety levels, task complexity, and warm-up conditions such that (a) under the no warm-up condition, the high manifest anxiety group would score significantly higher than the low manifest anxiety group on the simple task, but would score significantly lower than the low manifest anxiety group on the complex task; and (b) under the warm-up condition, the high manifest anxiety group would score significantly higher than the low manifest anxiety group on the simple task, but would not score significantly different than the low manifest anxiety group on the complex task.

The interaction of manifest anxiety, warm-up, and task complexity was not significant, $F(1, 68) = 3.848, p > .05$. On the basis of this finding, the research hypothesis of interaction among anxiety levels, warm-up conditions, and task complexity was not accepted.

The interaction of anxiety levels and task complexity was also non-significant, $F(1, 68) < 1, p > .05$, as was the interaction between warm-up and task complexity, $F(1, 68) = 1.306, p > .05$. The interaction of anxiety levels and warm-up conditions was, however, highly significant, $F(1, 68) = 9.368, p < .01$.

The main effect due to the level of anxiety was not significant, $F(1, 68) = 1.740, p > .05$, nor was the main

effect of warm-up conditions, $F(1, 68) < 1, p > .05$. The main effect for the two levels of task complexity, simple and complex, was highly significant, $F(1, 68) = 351.477, p < .01$. Therefore, the complex task was significantly more difficult than the simple task.

Because the interaction between anxiety levels and warm-up conditions was highly significant, a simple effects analysis of the corresponding main effects was performed. A summary of the means and standard deviations of the groups' scores under the two levels of anxiety and the two levels of warm-up are reported in Table IV.

TABLE IV
MEANS AND STANDARD DEVIATIONS OF GROUPS' SCORES
UNDER TWO LEVELS OF ANXIETY AND TWO
LEVELS OF WARM-UP

Anxiety Levels	Warm-up Conditions	
	Warm-up	No Warm-up
High Anxiety	Mean = 17.500 S.D. = 8.554 n = 18	Mean = 22.278 S.D. = 10.984 n = 18
Low Anxiety	Mean = 27.000 S.D. = 6.966 n = 18	Mean = 18.500 S.D. = 8.815 n = 18

The performance of the high anxiety group without warm-up was significantly better than that of the high anxiety group with warm-up, $F(1, 68) = 4.851, p < .05$. Of the two high anxiety groups then, the mean score of 22.278 for the group with no warm-up was significantly better than the mean score of 17.500 for the group with warm-up.

The performance of the low anxiety group with warm-up was significantly better than that of the low anxiety group without warm-up, $F(1, 68) = 15.350, p < .01$. The mean scores for this significant difference in performance were 27.000 for the low anxiety group with warm-up and 18.500 for the low anxiety group without warm-up.

The performance of the low anxiety group with warm-up was significantly better than that of the high anxiety group with warm-up, $F(1, 68) = 19.182, p < .01$. The mean score for the low anxiety group with warm-up was 27.000 and the mean score for the high anxiety group with warm-up was 17.500.

Under the no warm-up condition, the performance of the high anxiety group and the low anxiety group was not significantly different, $F(1, 68) = 3.020, p > .05$. While the mean score for the high anxiety group with no warm-up of 22.278 was better than the mean score for the low anxiety group with no warm-up of 18.500, it was not significantly better.

Discussion

The findings of this study were interpreted as generally supporting the position of anxiety interpreted as a drive or motive state. An exact application of the theory of Taylor and Spence¹ to the results of this study could not, however, be made without some adjustments of interpretation due to the complexity of the tasks used in this study. In the sense of a typical simple task being a single response, as in classical conditioning experiments, the two coins task (assumed to be the simple task in this study) was apparently too complex to be termed a simple task. Also, the complex task, the three coins task, was much too difficult. The limited range of scores on the complex task, as indicated by the fact that of the seventy-two subjects, thirty-two had no successful attempts at all, was evidence of the extreme complexity of this task. The two coins task was also extremely difficult for the subjects of this study as evidenced by the fact that 39 per cent of the subjects' scores fell below the 50 per cent of successful attempts. On the basis of this interpretation it was somewhat surprising that the performance of the high anxiety group was better than the low anxiety group under the no warm-up condition, although the difference was not statistically significant. It does, however, tend to emphasize

¹Janet A. Taylor and Kenneth W. Spence, "The Relationship of Anxiety Level to Performance in Serial Learning," Journal of Experimental Psychology, XLIV (August, 1952), 61-64.

the change in direction of the high anxiety and low anxiety groups' performance scores under the prior calisthenic type warm-up condition.

If we assume simply that both tasks used in the present study are complex, the Taylor and Spence drive theory can account quite well for these results. Warm-up apparently increased the drive or motivation level of both the high and low anxiety groups. This increase in drive facilitated the performance of the low anxiety group by motivating them. The increase in drive produced by warm-up disorganized the performance of the high anxiety group by increasing their already high state of motivation beyond the optimum. In the case of improved performance scores for the low anxiety group, the increase in motivation resulted in strengthening the correct initial response. For the decline in performance scores for the high anxiety group, the increase in motivation probably resulted in strengthening the competing responses as has been found in other studies.

The results of the various performances found in this study can also be explained by the perceptual-field theory. The non significant difference in performance of the high and low anxiety groups under the no warm-up condition would constitute the stress of the tasks consistent within the range of normal striving for the maintenance of well being. However, with the added stress provided by the warm-up condition, the task was perceived as a challenge for self

enhancement by the low anxiety group, and, therefore, an increased desire for this enhancement resulted in a better performance. The high anxiety group, on the other hand, reacted to the normal stress of the task interacting with the stress afforded by the warm-up as a perceived threat to the maintenance of their well being. Under this perceived threat, performance scores deteriorated as defensive mechanisms such as distortions in the perceptual field and over-reaction took place.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The problem under consideration was a study of the interacting effects of anxiety levels, warm-up conditions, and task complexity on learning a serial type motor task for male college students. In order to further clarify the problem the primary purpose was to determine the interacting effects of high anxious and low anxious male students' learning performance on a two phase serial type motor task under prior warm-up and no warm-up conditions.

The subjects for this study were seventy-two male students enrolled in regular physical activity classes at North Texas State University during the 1969 spring semester. The subjects were obtained from students meeting class on Tuesday and Thursday of each week at one of the three morning periods. All procedures of the experiment concerned with subject participation were carried out during the regular class periods on three class meeting days. The activities of the three days were conducted so that all subjects completed the same items on the same day.

The activities of the first day concerned the administration of the Taylor Manifest Anxiety Scale to 306

students under the camouflaged title of Biographical Inventory. Students scoring twenty-one or more were selected as members of the high manifest anxiety group while students scoring seven or less were selected as members of the low manifest anxiety group. Each of the two groups were further divided into two groups so that members in each half were matched as closely as possible on their manifest anxiety scores.

The second day's activities were concerned with the administration of the Barrow Motor Ability Test Indoor Battery to all students who qualified on manifest anxiety test scores. The results of the students' performance on the three items of this test were utilized statistically to test the homogeneity of the four manifest anxiety groups on general motor ability. The results of this analysis was that the four manifest anxiety groups did not differ significantly on general motor ability.

One of two warm-up conditions was assigned by chance to that one high manifest anxiety group and one low manifest anxiety group had the warm-up condition while the other high manifest anxiety group and low manifest anxiety group had the no warm-up condition. The warm-up condition was a series of general calisthenic type exercises for a period of eight minutes while the no warm-up condition was a resting period of the same duration.

One further division of each of the four manifest anxiety groups was made prior to the third day's activities. One-half of each of the four manifest anxiety groups were assigned by chance to try all of the simple task attempts first and then to try all of the complex task attempts while the other half of each of the four groups were designated to try all of the complex task attempts first and then try all of the simple task attempts. This division was made for the purpose of negating any ordering effect the two levels of the task of the experiment might have.

The third and final day of subject participation in the study was used to gather simple and complex task attempts data under specified conditions. It was at this time that the two phases of the serial type motor task to be attempted was revealed to the subjects. Both phases of the serial type motor task began with five-cent coins placed on the back of the preferred hand between the wrist joint and outstretched finger tips. Within these limits, the spacing of coins was at the discretion of each subject. The coins were to be tossed simultaneously into the air with an arm and hand movement. While the coins were air-borne, the subjects were to grasp the coins from above, one at a time, with distinct grasping motions equal in number to the number of coins involved in that particular phase of the task. Any deviation from this criterion was judged an unsuccessful attempt. The two phases of this serial type motor task were

referred to individually as the simple task and the complex task. Two coins were used for the simple task while three coins were used for the complex task.

All subjects followed a sequence of activities determined by their assigned warm-up condition and the complexity of the first task attempts to be tried. Each subject tried thirty attempts for each task level after he had performed his assigned warm-up condition. Scores were recorded for successful attempts on each of the two levels of task complexity.

After all of the activities of the experiment were completed it was necessary to drop eighteen students by drawing lots so as to have an equal and even number of subjects in each of the four manifest anxiety groups. The loss of these students as subjects was due to absenteeism of some students who had been assigned to groups. Students were arbitrarily dropped from the study when they missed any of the scheduled activities. The final number of subjects for the study was seventy-two--eighteen in each of the four manifest anxiety groups.

Computations were made to determine the homogeneity of the four manifest anxiety groups on general motor ability. This analysis was performed in consideration of a possible need of a subsequent analysis of covariance technique. A simple analysis of variance utilizing subjects' performance scores on the Barrow Motor Ability Test Indoor Battery

indicated no significant differences in motor ability among the four groups utilized in the study. On the basis of this finding it was assumed that the four manifest anxiety groups did not differ significantly on general motor ability and that a subsequent analysis of covariance was not warranted.

An analysis of variance technique corresponding to a 2 x 2 x 2 factorial design with repeated measures on one factor was utilized to analyze the data collected for this experiment. The findings from this analysis were related to the hypothesis and the primary purpose of the study.

It was hypothesized that there would be a triple interaction among manifest anxiety levels, task complexity, and warm-up conditions such that (a) under the no warm-up condition, the high manifest anxiety group would score significantly higher than the low manifest anxiety group on the simple task, but would score significantly lower than the low manifest anxiety group on the complex task; and (b) under the warm-up condition, the high manifest anxiety group would score significantly higher than the low manifest anxiety group on the simple task, but would not score significantly different than the low manifest anxiety group on the complex task.

The interaction of anxiety, warm-up and task complexity was not significant at the .05 level. On the basis of this finding, the research hypothesis of interaction among anxiety levels, warm-up, and task complexity was not accepted.

The interaction of anxiety levels and task complexity was not significant at the .05 level, nor was the interaction of warm-up and task complexity significant at the .05 level. The interaction of the anxiety levels and the warm-up conditions used on this study was significant beyond the .01 level. The main effect of manifest anxiety levels was not significant at the .05 level. Similarly, the main effect due to warm-up conditions was not significant. The main effect for the two levels of task complexity was highly significant; that is, the complex task was significantly more difficult to perform than was the simple task.

In order to interpret the significant interaction effect found for anxiety levels and warm-up condition, a series of simple effects analysis were performed. The high anxiety group with the prior no warm-up condition performed significantly better than the high anxiety group that had the prior calisthenic type warm-up. For the low anxiety groups, the low anxiety group with the calisthenic type warm-up scored significantly better than the low anxiety group with no warm-up. Under the warm-up condition, the low anxiety group performed significantly better than the high anxiety group. Under the no warm-up condition, the high anxiety group performed better than the low anxiety group, but not significantly.

Conclusions

Based on the findings of the study, two conclusions were formulated. The first was that the use of calisthenic type warm-up prior to engaging in a motor learning situation would be beneficial for improving motor learning in low anxiety-prone individuals. The second was that the use of calisthenic type warm-up prior to engaging in a motor learning situation would have an interfering effect on motor learning for high anxiety-prone individuals.

Recommendations

The findings of this study suggest some recommendations for physical educators and coaches. One recommendation is that universal endorsement of either calisthenic type warm-up or no warm-up at all should be avoided for optimum learning to take place in motor learning situations. Another recommendation is that it should be recognized that rest prior to a motor learning performance is as important for optimum learning in some people as prior warming-up is for others.

Recommendations evolving out of this study for further research are primarily concerned with modifications for replication studies. It is recommended that a similar study be conducted using a less complex simple task than was used for this study. It seems that a similar study conducted at the junior high and senior high school levels would be

beneficial. Also, it is recommended that a single motor task learning situation with anxiety levels and warm-up conditions be studied. And aside from the motor learning recommendations, it is recommended that a similar study be conducted using already learned motor skills as the task.

APPENDIX A

BIOGRAPHICAL INVENTORY

Name _____ P.E. 116, Sec. _____
School Address _____ Phone _____
Age _____, Height _____, Weight _____, Classification _____

DIRECTIONS: This biographical inventory contains fifty questions which will provide reference for a grouping procedure and for selecting people to take part in an experiment. This will in no way influence your grade in P.E. and your answers will be kept confidential. Please cooperate and answer each item either with a block type T for true or with a block F for false in the space provided by each number.

Do not pass over an item but give an answer to every single one. Do not spend time pondering--answer each immediately the way you want to at this moment (not last week, or usually). You may have answered questions similar to these before, but answer them as you feel now.

- _____1. I do not tire quickly.
- _____2. I am often sick to my stomach.
- _____3. I am about as nervous as other people.
- _____4. I have very few headaches.
- _____5. I work under a great deal of strain.
- _____6. I cannot keep my mind on one thing.
- _____7. I worry over money and business.
- _____8. I frequently notice my hand shakes when I try to do something.
- _____9. I blush as often as others.
- _____10. I have diarrhea ("the runs") once a month or more.
- _____11. I worry quite a bit over possible trouble.
- _____12. I practically never blush.
- _____13. I am often afraid that I am going to blush.
- _____14. I have nightmares every few nights.
- _____15. My hands and feet are usually warm enough.
- _____16. I sweat very easily even on cold days.
- _____17. When embarrassed I often break out in a sweat which is very annoying.
- _____18. I do not often notice my heart pounding, and I am seldom short of breath.
- _____19. I feel hungry almost all of the time.
- _____20. Often my bowels don't move for several days at a time.
- _____21. I have a great deal of stomach trouble.
- _____22. At times I lose sleep over worry.
- _____23. My sleep is restless and disturbed.
- _____24. I often dream about things I don't like to tell other people.
- _____25. I am easily embarrassed.

- _____26. My feelings are hurt easier than most people.
- _____27. I often find myself worrying about something.
- _____28. I wish I could be as happy as others.
- _____29. I am usually calm and not easily upset.
- _____30. I cry easily.
- _____31. I feel anxious about something or someone almost all of the time.
- _____32. I am happy most of the time.
- _____33. It makes me nervous to have to wait.
- _____34. At times I am so restless that I cannot sit in a chair for very long.
- _____35. Sometimes I become so excited that I find it hard to get to sleep.
- _____36. I have often felt that I faced so many difficulties I could not overcome them.
- _____37. At times I have been worried beyond reason about something that really did not matter.
- _____38. I do not have as many fears as my friends.
- _____39. I have been afraid of things or people that I know could not hurt me.
- _____40. I certainly feel useless at times.
- _____41. I find it hard to keep my mind on a task or job.
- _____42. I am more self-conscious than most people.
- _____43. I am the kind of person who takes things hard.
- _____44. I am a very nervous person.
- _____45. Life is often a strain for me.
- _____46. At times I think I am no good at all.
- _____47. I am not at all confident of myself.
- _____48. At times I feel that I am going to crack up.
- _____49. I don't like to face a difficulty or make an important decision.
- _____50. I am very confident of myself.

APPENDIX B

NAME _____ Age _____ Circle One: Fr So Jr Sr

P.E. 116, Sec. _____, Meeting on Tues. and Thur. at _____ o'clock

	RAW SCORE	T-SCORE	CODE NUMBERS*		
			A	B	C
MOTOR ABILITY SCORE:					
STANDING BROAD JUMP	_____	_____			
ZIGZAG RUN	_____	_____			
MEDICINE BALL PUT	_____	_____			
SUM OF T-SCORES		_____			

TASK SCORING DIRECTIONS: IF AN ATTEMPT IS GOOD, CIRCLE GOOD--IF AN ATTEMPT IS NOT GOOD, CIRCLE NOT GOOD

1. GOOD NOT GOOD	16. GOOD NOT GOOD	1. GOOD NOT GOOD	16. GOOD NOT GOOD
2. GOOD NOT GOOD	17. GOOD NOT GOOD	2. GOOD NOT GOOD	17. GOOD NOT GOOD
3. GOOD NOT GOOD	18. GOOD NOT GOOD	3. GOOD NOT GOOD	18. GOOD NOT GOOD
4. GOOD NOT GOOD	19. GOOD NOT GOOD	4. GOOD NOT GOOD	19. GOOD NOT GOOD
5. GOOD NOT GOOD	20. GOOD NOT GOOD	5. GOOD NOT GOOD	20. GOOD NOT GOOD
6. GOOD NOT GOOD	21. GOOD NOT GOOD	6. GOOD NOT GOOD	21. GOOD NOT GOOD
7. GOOD NOT GOOD	22. GOOD NOT GOOD	7. GOOD NOT GOOD	22. GOOD NOT GOOD
8. GOOD NOT GOOD	23. GOOD NOT GOOD	8. GOOD NOT GOOD	23. GOOD NOT GOOD
9. GOOD NOT GOOD	24. GOOD NOT GOOD	9. GOOD NOT GOOD	24. GOOD NOT GOOD
10. GOOD NOT GOOD	25. GOOD NOT GOOD	10. GOOD NOT GOOD	25. GOOD NOT GOOD
11. GOOD NOT GOOD	26. GOOD NOT GOOD	11. GOOD NOT GOOD	26. GOOD NOT GOOD
12. GOOD NOT GOOD	27. GOOD NOT GOOD	12. GOOD NOT GOOD	27. GOOD NOT GOOD
13. GOOD NOT GOOD	28. GOOD NOT GOOD	13. GOOD NOT GOOD	28. GOOD NOT GOOD
14. GOOD NOT GOOD	29. GOOD NOT GOOD	14. GOOD NOT GOOD	29. GOOD NOT GOOD
15. GOOD NOT GOOD	30. GOOD NOT GOOD	15. GOOD NOT GOOD	30. GOOD NOT GOOD

SIMPLE TASK: TOTAL "GOOD"
SCORE ONLY - - - - - _____COMPLEX TASK: TOTAL "GOOD"
SCORE ONLY - - - - - _____

*CODE NUMBERS: Schedule of digit entries

Under A: 1--High anxiety group member.
2--Low anxiety group member.Under B: 4--Warm-up condition assignment.
5--No warm-up condition assignment.Under C: 7--Scheduled to try all simple task attempts first,
then try all complex task attempts.
8--Scheduled to try all complex task attempts first,
then try all simple task attempts.

APPENDIX C

Two Phase Serial Type Motor Task

Both phases of the serial type motor task begin with five-cent coins placed on the back of the preferred hand between the wrist joint and outstretched finger tips. Within these limits, the spacing of coins may suit you. The coins are to be tossed simultaneously into the air with an arm and hand movement. While the coins are air-borne, you are to grasp the coins from above, one at a time, with distinct grasping motions equal in number to the number of coins involved in that phase of the task. Any deviation from this will be judged an unsuccessful attempt. Examples of such deviations are failing to grasp one or more coins while they are air-borne, dropping a coin or coins after being caught, grasping one or more coins from below with the palm of the hand up, trapping a coin or coins to the body or other objects, grasping more than one coin in one distinct grasp, grasping with the hand other than the one used to toss the coins, or grasping a coin or coins when they are other than air-borne.

The two phases of this serial type motor task will be referred to individually as the simple task and the complex task. The two coin task is the simple task. The three coin task is the complex task. Each of you will have thirty attempts at the simple task and thirty attempts at the complex task. The best possible score will be thirty for either task.

Some of you will try all of the simple task first, and then will try all the complex task attempts. The reverse order will be true for others of you. Look on your score sheets where it shows some code numbers in red pencil. Those of you with a seven under the "C" section will try all simple task attempts first. Those of you with an eight under the "C" section will try all the complex task attempts first. After you have tried thirty attempts of this task, you continue on to the other task and try it thirty times.

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