THE EFFECTS OF LEARNING ON BODILY STRESS REACTIONS

by

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APPROVAL SHEET

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CHAPTER I

INTRODUCTION

During the twentieth century in education, the concept of "training of the intellect" has been replaced by the relatively new concept of "educating the whole individual." It was with this underlying philosophy that Metheny (36:27) defined the educated person as "one who has fully developed his ability to utilize constructively all of his potential capacities as a person in relation to the world in which he lives." She more specifically defined the "whole individual" as a psychosomatic unity of mind-body-emotions. (36)

The concept of the psychosomatic unity of man had it origin some thirty-six years ago, not in education but in endocrinology, when Hans Selye submitted to the realm of science and education the theory of stress and adaptation. This has proved to be one of the most unifying theories in the history of scientific research, for all sciences were integrated into one theory to better understand the behavior of biological man in his environment. In the 1950's, Ulrich (42) related Selye's stress theory to physical education, in a competitive situation for college women.

Selye (13:54) has defined the state of stress as "the state manifested by a specific syndrome, which consists of all non specific induced changes within a biologic system." Under normal conditions the body maintains a homeostatic level. When external and internal forces, called stressors, impinge upon it, the physiological equilibrium is no longer maintained and change in physiological response occurs; this he

called adaptation of the body. Examples of such stressors are: cold and heat, x-ray, physical exercise, inflammation, and emotional stimuli such as fear, depression, and joy.

Emotional stress is elicited when the individual interprets the situation as being stressful. This is dependent upon one's environment and personality and also upon his physical structure.

Educators should familiarize themselves with the nature and the implications of the stress theory in the field of education. Our basic aim of educating the "total being" can then be supported intelligently utilizing scientific basis.

It was with this basic attitude in mind that the writer decided to study "the effects of the learning of motor skills on physiological stress reactions".

Nine subjects were selected on the basis of previous physical fitness scores. They were submitted to four testing conditions in which clinical tests of blood sugar, oxygen analysis and blood pressure were administered:

1. Before the instructional program, to determine the basic homeostatic conditions of each individual.
2. After a demonstration of selected apparatus skills. Since this situation had the potential of inducing psychic fear, it was established as an assumed stressor situation.
3. After the completion of three-fourths of the unit.
4. At the conclusion of the apparatus unit.

CHAPTER II

STATEMENT OF PROBLEM

The primary purpose of this study was to determine the effects of the learning of apparatus skills upon bodily stress reactions.

Physiological tests were administered to a selected group of physical education majors at four different times during the experimental program. The first test was given to establish the homeostatic level of the subjects. The second test was administered following a demonstration of five apparatus skills selected from those to be taught in the unit. This situation was assumed to have the potential of being emotionally stressful as the result of fear. The third and fourth tests were given after completion of three-quarters of the teaching unit and at the conclusion of the unit.

The following clinical tests were used: systolic and diastolic blood pressure; oxygen consumption, measured by both the Haldane-Guthrie apparatus and the Benedict-Roth spirometer; and blood sugar.

The secondary purpose of the study was to determine if participation in apparatus activities affected physical fitness level, as determined by the WAC Physical Fitness Test. The test was given before and after the apparatus program.

CHAPTER III

REVIEW OF LITERATURE

HOMEOSTATIS AND ADAPTATION

It has taken many centuries to develop even a limited scientific understanding of the human body. It was twenty-four centuries ago when the homeostatic state of man was first recognized by Hippocrates. He defined homeostatis in terms of disease. "Disease is not only suffering, but also the struggle of the body to restore itself to normal." (13:11) Twenty-three centuries later, French physiologist, Claude Bernard stated that the body maintains an "internal constancy" regardless of the external influences. Fifty years later, Walter B. Cannon, a Harvard physiologist, called this internal equilibrium, "homeostatis". (13)

More recently, Hans Selye, eminent physiologist, developed the theory of adaptation which he explained through the General Adaptation Syndrome, (G.A.S.). External influences, physical and psychic in nature, produce a deviation from the homeostatic condition. Selye called this adjustment or imbalance, adaptation; and the influencing stimuli, stressors. Stressors include such stimuli as: inflammation, cold, x-ray, heat, emotional stimuli, and muscular exercise. Adaptation is physiologically expressed in the same manner, regardless of the eliciting agent or the stressor. Selye (13:54) defined the state of stress as being "that state manifested by a specific syndrome, which consists of all the non specific induced changes within a biological system."

Selye's G.A.S. evolves in three distinct stages: alarm reaction (A.R.), stage of resistance (S.R.), and the stage of exhaustion (S.E.). The first stage, (A.R.), alarms the body to prepare for emergency. During the second stage, (S.R.), adaptation occurs and there is resistance against the stressor; resistance to other stimuli is also lowered. In the final stage, (S.E.), adaptation can no longer be maintained and the organism eventually dies. (13)

Rees (39:274) has defined stress in general medicine and psychiatry:

> To denote various psychosocial situations which tend to produce disorganization of behavior, including physical and mental illness. The response of individuals to stressful psychosocial situation may be apt and adaptive or it may be inept or maladjustive, the latter sometimes taking the form of physical and mental illness.

Rees (39:275) quoted Victors who interpreted stress as a broader concept including:

1. The forces, changes, stimuli, conditions, or situations which are stressful.
2. The process whereby they produce their effects on the organism.
3. The changes in the organism-behavorial, emotional, physiological, biochemical, and structural change.

MacCalman (35:56,57) described the personality of the individual who is vulnerable to emotional stress.

> It is a weakness in the personality, rather than an inborn trait or previous neurotic, which produces the sensitization to stress. Strong emotional dependence, or over compensatory trends against it, are the factors which most commonly make the individual particularly vulnerable; but again a certain degree of intensity is necessary to produce symptoms for dependent trends are to be found in everyone.

Fear, rage, joy, depression are examples of emotions which can act as stressors. Their presence is dependent on man's personal interpretation of the surroundings and also his biological structure. As a stressor, emotions induce physiological changes within the organism. This relationship between "mind and body" is called psychosomatic. Luongo (34:295) expressed well the significance of this interrelationship when he said, "emotional problems can become health problems".

Extensive research has been conducted in psychology, physiology, and medicine to determine the influence of the mind upon the body. Rees (39) found when studying psychosocial stress of psychosomatic patients, that stressful life situations preceded the initial attack of:

1. 12 per cent of asthmatic children
2. 36 per cent of asthmatics between sixteen and forty-five years and 46 per cent of those having onset after forty-five
3. 30 per cent vasomotor rhinitis
4. 10 per cent hayfever
5. 47 per cent peptic ulcer
6. 45 per cent thyrotoxieases
7. 51 per cent urticare angioneurotic oedema

He concluded that the occurrence of stress preceding the onset of disease was significantly lower in the control group than in the corresponding psychosomatic group.

In contrast, research to determine the influence of biological maladjustments such as, disease or endocrine imbalance, upon emotional health is rare. However, in a recent study, Selye (41) has shown that excessive amounts of endocrine secretion can cause mental reactions of excitement, depression, and even produce anesthesia and sexual derange-

ments. He called the influence of "body upon mind", a somatopsychic relationship. Hence, the link between the soma and psychic is no longer seen as a one-way path but instead, a circular one, with mind and body affecting each other.

Selye's G.A.S. is gradually being accepted by other scientists, but many psychologists have proposed theories which conflict with his. Adolph (16) stated that the response syndrome is not the same for every stressor. According to Lacey (31), Alexander claimed that in psychosomatic disorders there are specific physiological changes for specific emotions. Rees (39), in his psychosocial study of stress, enumerated the following emotional changes which are capable of causing any of the psychosomatic disorders; he investigated: anxiety, anger, resentment, hostility, humiliation, depression, and sometimes joy and elation. According to Rees (39:276), Grace and Graham experimented with a sample and found that "there were Specific Conscious Attitudes to the precititating situation for each psychosomatic disorder and that there were specific physiological changes associated with each attitude." Rees noted that their claims were based on small samples which were not representative of the disorders. He also indicated that their findings have not been accepted by other investigators. Loftus, Gold, and Deethelm (33) reported that research on schizophrenics showed that specific emotions do not cause specific changes in the functioning of the heart. Valk (43) summarized publications of J. Hambling, L. Schachter, and S. Wolf and H. G. Wolf as claiming there is a difference in the kinds of emotions which initiate changes in systolic blood pressure and diastolic blood pressure.

Until there is conformity in the experimental method and procedure

of the physiologist and the psychologist, emotions cannot be accurately defined or measured physiologically. (38)

Henry Maudsley (1867), as quoted by Rees (39:278), best summarized the concept of adaptation of the organism:

> Life in all its forms, physical and mental, morbid or healthy is a relationship. Its phenomena result from the reciprocal action of an individual organism and external forces. Health as the consequence and evidence of a successful adaptation to the conditions of existence implies the perservation, well being and development of the organism, while disease marks a failure in organic adaptation to external conditions and leads, therefore, to disorder, decay and death.

Physiology of Stress

Since the discovery of Selye's adaptation theory, scientists have experimented to determine the role or function of the endocrine glands in controlling stress. Although there are many gaps in the knowledge of this physiological process, the following reactions are believed to occur:

1. Perception of stress is transmitted as a stimulus, by way of the autonomic nervous system, the thoracolumbar division, to the adrenal medulla, (the inner portion of the adrenal glands).
2. The adrenal medulla secretes epinephrine which activates the pituitary gland to produce ACTH, (adrenocorticotrophic hormone), and by the way of the circulatory system, acts directly on the body tissues causing the following adaptation:
    a. Constriction of arterioles
    b. Increase in the rate and force of the heart

c. Rise in systolic pressure

d. Rise in pulse rate

e. Increase in minute volume and in volume of respiration

f. Increase in blood sugar

g. Increase in metabolic rate and oxygen consumption

h. Increase in rate of coagulation of blood (8:736,737)

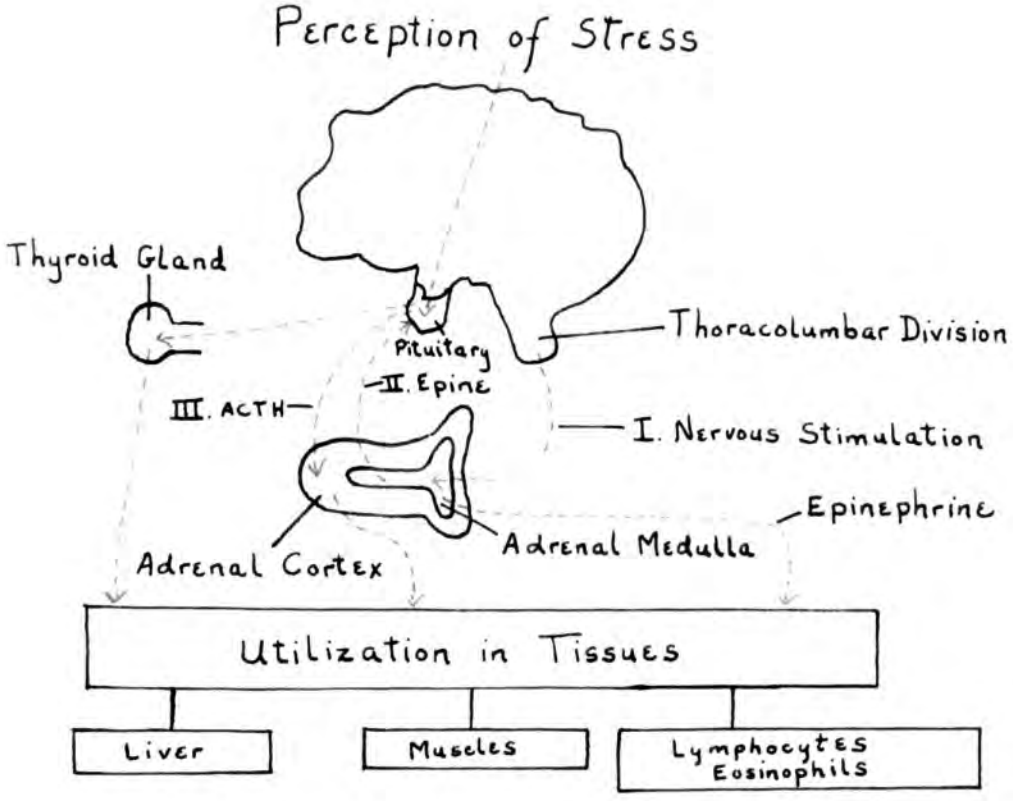
The pituitary gland is also stimulated by nervous impulse from the floor of the brain. Hence, the nervous system plays a temporary role in adapting the body to stress, while epinephrine acts as the link between the endocrine and nervous systems, reinforcing and prolonging adjustments of bodily reactions.

3. ACTH of the pituitary causes the adrenal cortex, (the outer portion of the adrenal glands), to produce several hormones which increase carbohydrate metabolism.

4. The pituitary also produces TTH, (thyrothrophic hormone). TTH stimulates thyroxin secretion of the thyroid whose primary purpose is that of regulating the metabolism of the body.

FIGURE 1

Physiology of Stress



Adapted from Selye (13:113) and Cohen (21:276)

ANXIETY

Cameron defined anxiety as an inborn capacity which is moulded in the process of interaction of personality and external environment. "It is the total reaction, physiological, biochemical, and structural." (19:1) Padolsky (37:110) defined this state as "the reaction to a threat

to the existence of one's self as a human being; or to the values that one identifies with that existence." He denoted the three main causes of anxiety today to be: the awareness of mortality, the uncertainty of the future and intellectual activity. Basowitz (1) and co-workers indicated the characteristics of anxiety to be: alertness, when "self" is threatened, activation of physiological preparedness, increased speed and efficiency of psychological performance, and loss of judgment of the "real and unreal". Rees (39:276) listed situations which can be stressful or a threat to the security of the personality:

1. Bereavement of a loved person
2. Threat to a loved person by illness or accident or other cause
3. Marital and family problems
4. Work and financial problems
5. Conflicts: sex drives, ambitions, prestige, and individual needs.

Cohen (21) supplemented Selye's triad syndrome with a description of the anxiety level during each stage. During the alarm stage, the psychological stimulus is perceived as stressful. Anxiety is expressed in the resistance stage as the desire to flee from the nearing disaster. At this point the biological mechanisms have prepared the body for the escape. "If the adaptive response is thwarted, the individual remains in an acute state of resistance. Under this constant threat, which is reality for the individual, his resistance to other stimuli is greatly lowered." (21:279) In the final stage, the individual can no longer respond to patterns of anxiety and is left with primitive forms of response. Rees (39) called this withdrawal from reality as being a pattern common to psychotic disorder.

Anxiety and emotions in general, appear to be an intangible, and hence, a non-measurable aspect of man, but many tests have been used to determine the psychological reflection and physiological interpretations of individual anxiety patterns. Some of the physiological measurements include: changes in the circulatory system, blood pressure, pulse rate; changes in the blood chemistry such as glucose content, eosinophil count, coagulation time; in addition, metabolic rate, chemical composition of the urine, and others. Measures of psychological interpretation are: The Manifest Anxiety Scale (20), Kahs-Black Intelligence Test, the Rorschach Ink Blot, interview or observation, Electroencephalography (32), Katography, Interpretative Projection Technique, level of aspiration (28). Many investigators are using both types of measurement and correlating the results to formulate the relationship.

EMOTIONAL STRESS AND PHYSIOLOGICAL CHANGES

Fluctuation in the cardiorespiratory mechanisms are measured by: oxygen consumption in gas analysis, blood sugar level, blood pressure, and the metabolic rate. Extensive experimentation has been done, using these tests as indices of homeostatic imbalance. The findings of this research has indicated definite changes in cardiorespiratory function as the result of emotional stress.

Circulatory System

Cannon (3), in experimentation with cats, found the following body changes after fear had been induced: rapid beating of the heart, rapid blood coagulation, increase in blood sugar, and increased arterial pressure. Valk (43) made blood pressure readings before, during, and after interviews and test situations with normal and hypertensive

subjects. From the results, he concluded that there was a temporary rise in normals and a higher rise in hypertensive subjects during periods of emotional conflict. Hickam (27), having used an emotional state of anxiety as the stressor, found a ten per cent increase in the mean arterial pressure of healthy medical students. He also said that doses of epinephrine can produce the same effects as anxiety:

1. Increased heart rate and output.
2. Moderate increase in oxygen consumption.
3. Moderate elevation of the mean blood pressure (27:296).

Schneider (40:302) claimed that "with anxiety, tension, fear, anger and hostility, the blood clotting time is shortened, blood viscosity is increased, and the blood pressure is increased."

According to Gavey (24), J. D. P. Graham studied the blood pressure of 605 men who had experienced a long period of desert warfare. In 187 cases he found the pressure exceeding 100 milligrams, and upon re-examination of thirty-three two months later the pressure had returned to normal. Grollman (25) observed an increase in pulse rate and pressure, and a slight increase in oxygen consumption; he induced a psychic stressor to normal subjects.

Metabolic Rate and Blood Sugar Concentration

During anxiety, Altschule (17), observed patients with and without heart disease, and concluded that during the stress there was: no increase in cardiac output, an increase in pulse rate, and an increase in metabolic rate. Hetzel (26) reported the effects of inflicting emotional stress on euthyroid, hypothyroid, adrenalectomized subjects. His findings were:

1. Rise in oxygen consumption
2. Rise in respiratory quotient

3. Increase in carbon dioxide elimination

4. Increase in ventilation.

Hetzel (26) quoted the results obtained by Ziegler and Levine in a similar experimental design. They found that an increase in metabolic rate occurred in association with excitement, but that when depression or resentment were present, no increase occurred. Daniels (22) claimed that in diabetic cases emotions are a definite causative factor in the fluctuation of the blood sugar level. Walker (44) quoted Samson who noted hyperglycema during periods of emotional stress. Dunbar (5) stated that Dobreff and Tomoff observed a rise in blood sugar in eleven out of thirteen patients before an operation and nine out of eleven students before taking exams.

Experimentation on cardiorespiratory changes initiated by emotional stimuli has shown the following results:

1. A definite increase in heart beat
2. Shortened coagulation time
3. Increased amounts of blood sugar in the blood
4. A moderate increase in oxygen consumption with a corresponding increase in metabolic rate.

LEARNING

The answer to the question of whether the learning of motor skills initiates emotional stress will depend upon many variables, such as: the degree of success experienced by the learner, the danger element involved in the activity, the previous motor experience, and the method and manner that is used by the instructor. Obviously, the response will be different for each individual, dependent upon her interpretation of the situation.

Psychology of Learning

Ragsdale (12:25) has defined motor learning as "the discovery of correct responses, which may or may not be entirely different from the actions that preceded them." Ragsdale (12) also disagreed with the theory that learning occurs when the correct responses are selected from many, most of which are incorrect. A response is learned when it has been reinforced or strengthened by an unconditioned stimulus. Otherwise, the conditioned reflex is weakened and it becomes extinct.

The learning curve is a graphic representation of the rate of learning and an estimate of the physiological limit of the learner. The learning curve forms no standard or set pattern. It is characterized by sloping and horizontal lines, and curves. The initial phase of learning is represented by an upward sloping line. This indicates a period in which fundamental skills and thus, simple neural pathways are developed. As more complicated skills are introduced the learning rate slows down and the sloping line ascends more slowly and may even level off as in a plateau or descend. The physiological limit is seldom attained, but it is approached as the curve starts to level off and remain constant.

The plateau is the period during which no further progress is made. This can be attributed to: a decline in motivation, fatigue, reaching the physiological limit, or a standstill following the acquisition of fundamental skills. Some psychologists believe that the plateau is an unnecessary part of the learning curve. They claim that types of motivation and new methods of teaching can be utilized to eliminate this period of "no progress".

Physiology of Motor Learning

Wells (14) stated that the preliminary phase of motor learning involves the attempt to correlate visual and auditory stimuli with previous motor experiences and the kinesthetic "feel" of the desired movement. At first, the learner concentrates on the correct sequence and execution of movement, which at the beginning is uncoordinated. Following the learning process, performance is more coordinated due to the transition from stimulus to response. The learner no longer analyzes or "thinks" about the skill to be performed, it has become an automatic unconscious response.

Movement is classified as either reflex or volitional. A reflex is defined as "an invariable response to a definite stimulus affecting a sensory receptor." (11:40) The reflex is further characterized as being involuntary and inborn in origin. An example of a simple reflex is the knee jerk. Tapping the ligament below the knee causes the quadriceps muscles of the thigh to be stretched; the muscle spindles are also stimulated. In this case, they are the receptors, that is, they receive the stimulus. The impulse travels by way of afferent nerve paths to the spinal cord where the motor neurons relay the impulse along efferent paths to the muscle or the effector. The effector is another name for the organ of response. The muscles then contract causing extension of the knee. The arc imposed by the impulse is called the reflex arc.

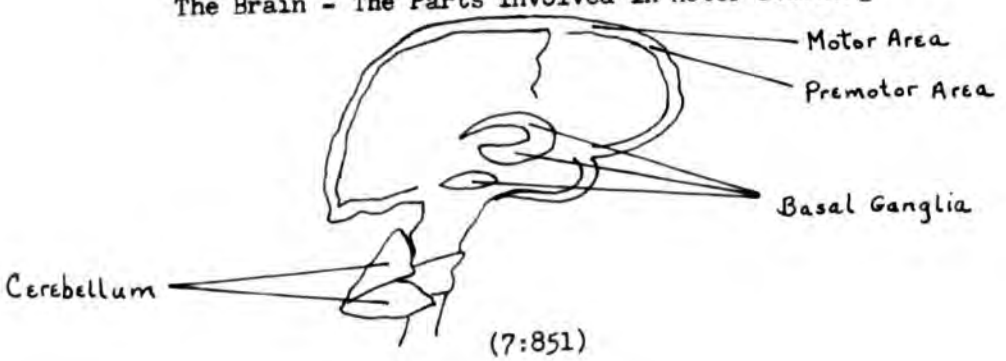
Petrovitch Pavlov, the noted scientist, has contributed extensively to the present knowledge of the learned or conditioned reflex. His major experimentation was in connection with the salivary reflex. Food, of course, was the stimulus which produced salivation. Other stimuli:

auditory, visual, and thermal, were presented to dogs simultaneously with food. After a period of time the animals would salivate when subjected to just the accessory stimulus. (6) This reflex, called a learned or conditioned reflex, is said "to occur when an indifferent stimulus, which by itself would cause no reflex, is associated repeatedly with another stimulus and elicits a response." (10:26) In contrast to unconditioned reflex action, it produces voluntary, acquired, and unpredictable response or movement.

Most physiologists agree that the initial movements in motor learning are controlled by the motor area of the cerebral cortex in the brain. This area controls specific muscles and hence, the finer movements of the body. After practice periods, learned performance is no longer controlled by the motor area but instead the responsibility is that of the premotor area of the cerebral cortex. When this portion is destroyed or damaged, "the ability to execute complex, learned types of skilled activities is lost." (11:43) Bowen and Stone (2) stated that after a skill has been learned the cerebral control lessens and the cerebellum and the basal ganglia take over. Skill then becomes a type of reflex activity with an integration within the cortex of sensory and proprioceptive stimulation and memory, learning and reasoning.

FIGURE 2

The Brain - The Parts Involved in Motor Learning



(7:851)

The neurological basis of learning is a controversial issue. According to Lipovitz (10), Thorndike believed that a learned response is a neurological bond between the stimulus and the response. This bond is the result of the growth of new nerve cells. On the other hand, Zoethout (15) stated that some investigators claim motor learning is due to connections of neurons which were previously established, but high synaptic resistance blocked the impulse. As learning occurs this resistance is lowered. Research in this area has been limited.

Anxiety and Performance

In reviewing the studies of the effects of emotions upon performance, Deese (4) stated that in learning, emotion is not the only factor to be considered, but also heightened motivation. These two intangible variables cannot be separated; one, as a state of stress, deterioriates performance, while heightened motivation tends to improve performance. According to Howell (29), Bills also recognized what he called two types of tension: The first, he attributed to emotional upset where performance is inhibited, the other, to effort which facilitates it.

Basowitz (18) found in a study of anxiety and performance that among the performance tests administered, motor tasks were significantly affected with a decrease in motor control. Jackson (30) related similar results as the result of experimentation on the effects of fear on muscle coordination. He taught aerial gymnastics to a beginning and an expert group. He found a correlation between mental and physical states. Fear induced individuals performed with jerky and uncoordinated movement. After successful performance, he noted that fear tended to be eliminated. Zoethout (15:608) said, "that fear may exercise a more powerful inhibition

than any other single factor does; it restrains the individual from doing well."

Some psychologists, in anxiety and motor performance experimentation, say that anxiety, whether it be motivation or emotion, acts as a drive. In other words, high anxious subjects are predicted to perform better than low anxious subjects. In these studies the form of movement is not observed, only the reaction time. Price (45) studied the effects of verbally indiced failure on a group, preceding a pursuit performance test. She found no recognizable effect on the motor performance. Montague, as quoted by Deese, Lazarus, and Keenan (23), showed that anxiety results in inferior learning when there are interfering responses, but it leads to superior performance when such responses are limited. Howell (29) found that when a tense group was motivated while doing pursuit motor skills, they showed a significant improvement over the non tense group.

Emotions, anxiety, motivation and their effect upon learning or performance is very controversial. The big gap seems to be in a lack of conformity in defining the elements which affect learning.

CHAPTER IV

PROCEDURE

The subjects for this study were nine freshmen and sophomore physical education majors enrolled at The Woman's College of The University of North Carolina for the academic year of 1959-1960. One of the subjects dropped from the program after the second week for academic reasons. Subjects were selected on the basis of scores made on the strength components of a fitness test battery which was administered annually. Ten available students with the highest T-scores were chosen, their scores falling in the top three standard deviations of the distribution of T-scores for freshmen and sophomore majors in physical education.

The clinical tests used in the testing program were: systolic and diastolic blood pressure; oxygen analysis, measured by the Haldane-Guthrie apparatus; oxygen consumption, measured by the Benedict-Roth spirometer; and blood sugar analysis. These tests were administered four times during the entire program. The first test was given to determine the basic homeostatic condition of each subject. The second, followed the introduction of five selected apparatus skills that were to be taught in the unit. The third and fourth tests were given after completion of three-quarters of the unit and at the conclusion.

The WAC Fitness Test was also administered preceding and following the apparatus unit to determine any change in the level of fitness.

EXPERIMENTAL DESIGN

The subjects were not informed of the implications of the study other than an interest in the physiological changes as the result of participation in apparatus activities. They did not know when testing periods were scheduled, nor did they perform in any apparatus activities prior to any of the physiological testing.

A descriptive analysis of the apparatus techniques, included in the teaching unit, may be found in the appendix.

Test I Physiological tests were given to determine the homeostatic level of each individual. These tests included: systolic and diastolic blood pressure, oxygen analysis, blood sugar determination, and oxygen consumption. For each testing period, the tests were given in the above order and at approximately the same time during the evening. In addition, the WAC Fitness Test was given to determine the basic experimental state of fitness.

Test II The aforementioned clinical tests were administered a second time immediately following a demonstration of five selected apparatus skills. These skills were selected from various levels in the progression used in teaching. The demonstration included:

1. The swing on the stationary rings
2. The swing on the stationary rings progressing into an inverted hang.
3. Traveling on the parallel bars
4. Front dismount on the parallel bars
5. Side vault on the horse.

It was assumed that the demonstration had the potential to elicit emotional stress resulting from fear. Obviously, the acquisition of fear was dependent upon the individual's past experience of participation in apparatus activities and also her personal interpretation of the situation. Of the nine taking part in the program, one had had an excellent background in apparatus and had previously assisted in teaching apparatus; four had had limited experience, and the remaining had had no training at all.

Intervening Variable

The teaching program was conducted two evenings a week for eight weeks starting February 15 and ending April 6, 1960.

Two graduate students, Pauline Loeffler and Peggy Kingston, were selected to teach and supervise activities on the parallel bars and stationary rings. They were chosen on the basis of previous teaching experience and interest in the teaching of apparatus skills.

The three instructors, including the writer, met weekly to discuss individual progress and the plans for the coming lessons.

After the first two weeks of the unit, a skill check list was introduced to the group. This list included all the skills that would be taught and checked by the instructor. In this manner, they were encouraged to perform with good form and body control.

In order to challenge and motivate the student of exceptional ability and background, advanced skills were taught to her.

The last week and a half of the program was devoted to the preparation of a demonstration. The performers were placed into three groups according to personal interest and individual ability. Each group, on its respective piece of apparatus, worked toward perfecting individual

skill and also created routines.

The first lesson of instruction was an orientation period in which the participants learned how to handle the apparatus equipment, and learned the necessity for spotting and the underlying principles involved. Weight supporting exercises were also introduced to the group. After the subjects had become adjusted to supporting the body with ease and control, and at the same time moving the lower limbs, fundamental skills were taught. More advanced techniques were taught as the group progressed.

A detailed outline of the unit and the testing program may be found in the appendix.

Test III The physiological tests were administered after completion of three-quarters of the unit to determine individual response at this point in the learning process. All participants were then familiar with: the hazards involved and the necessity for safety, their own progress and capabilities on the apparatus. Three skills, one on each piece of apparatus, were reviewed verbally: straddle vault on the horse, front dismount on the parallel bars, and the swing into stunts, stationary rings. These skills had been previously demonstrated by a few of the subjects. The group was tested immediately after the discussion.

Test IV The subjects had been divided into three groups and at this time were perfecting skills for the demonstration. Believing this, the group met for the last time for practice. Instead of the expected situation, the final testing was given immediately upon arrival.

The WAC Fitness Test was given after the program was concluded.

CLINICAL TESTS

Systolic and Diastolic Pressure

Blood pressure was measured by the pressure cuff Baumanometer manufactured by the W. A. Baum Company, New York. Three readings were taken of sitting blood pressure and an average of the three was recorded.

Oxygen Analysis

The Haldane-Guthrie Analysis apparatus was used to determine oxygen consumption. The apparatus is comprised of a graduated gas burette which is filled with a colored displacing liquid of distilled water, concentrated sulfuric acid, and methyl orange indicator. To the right of the burette are two gas absorbing chambers, one containing sodium hydroxide, which absorbs carbon dioxide present in the air sample, and the other, alkaline pyrogallate, which absorbs oxygen present in the sample. A leveling bulb is connected to the gas burette by means of a rubber tube. As the bulb is lowered, the displacing liquid falls in the burette; as the bulb is raised, the liquid rises and forces the gas sample upward and into either the atmosphere or into the manifold of the gas absorbing chamber. A stopcock at the top of the burette is used to control the direction of the sample. Each gas chamber also has a stopcock, which when opened permits passage of the gas into the chamber.

The subject inhales atmospheric air through the nostrils and exhales into a rubber tube, connected to the top of the gas burette. When at least thirty-eight or thirty-nine milliliters of gas have been collected, the supply of air to the apparatus is cut off by turning the stopcock. The leveling bulb is then lowered to the same level as that of the displacing liquid, and the total volume of the sample is recorded as V.

The stopcock is opened again, this time connecting the air sample to the manifold. The carbon dioxide absorbing chamber, the one nearest to the burette, is also opened and the air is passed up and down the capillary structure several times. This is done by raising and lowering the leveling bulb. Care must be taken not to pass any air down and out of the capillary openings into the absorbing liquid and finally into the atmosphere. After the air is forced through the chamber four or five times, it is returned to the gas burette where the volume is recorded. This process is repeated until the volume reading is constant. This volume, V 1, is the volume of the sample after the carbon dioxide has been removed.

The remaining gas is passed through the oxygen absorber. The mechanical process is the same as that for carbon dioxide absorption. The volume, recorded as V 2, is the sample air after the oxygen has been absorbed.

With the necessary volumes recorded, the percentage of oxygen and carbon dioxide expired can be calculated. The following formulas are used when V equals the original volume of the gas sample, V 1 equals the volume of the sample after C02 absorption, and V 2 equals the volume of the sample after 02 absorption:

$$\text{percentage of C02} \quad \frac{V - V1}{V} \quad \text{X 100}$$

$$\text{percentage of 02} \quad \frac{V\,1 - V\,2}{V} \quad \text{X 100}$$

The Haldane-Guthrie Gas Analysis apparatus is manufactured by the Fisher Scientific Company, Silver Spring, Maryland.

Blood Sugar Analysis

The underlying principle of the Lamotte blood sugar test is that of simple reduction of potassium ferricyanide by sugar in the blood, and the colormetric determination of the ferricyanide formed as Prussian Blue. The reading, in milligrams of sugar per one-hundred milliliters of blood, is obtained by comparing the sample with colored standards.

Procedure

1. 10 ml. of reagent A, tungstic acid, is added to a test tube.
2. 0.1 ml. of blood is taken from a small finger puncture and is added to reagent A.
3. The test tube is stoppered with a cork and is shaken for five minutes. The sample can be put aside at this point, but the analysis must be completed within five hours after the sample is taken.
4. The contents of the tube are filtered. The filter paper is first rinsed with distilled water to free any foreign matter present.
5. The filtrate is poured into a large test tube to the 4 ml. mark. The rest of the filtrate is saved in case the test for sugar content is negative.
6. 0.5 ml. or reagent B, potassium ferricyanide, and 0.5 ml. of reagent B, alkaline cyanide, are added to the filtrate.
7. The tube is placed in boiling water for eight minutes.
8. The tube is removed and reagent D, ferric solution, is added to the warm solution with a special 3 ml. pipette.

When D is added, the solution turns a shade of blue.

9. The tube is twirled to hasten the diffusion of the color throughout the solution.
10. The sample is dilluted to the 25 ml. mark with distilled water and inverted several times.
11. The sample is compared with colored standards to determine the quantity of sugar in the blood.

The Lamotte Blood Sugar Outfit is manufactured by the Lamotte Chemical Products Company, Towson 4, Maryland.

Oxygen Consumption

The Benedict-Roth spirometer was the second apparatus used to determine 02 consumption. This method involves breathing into a closed circuit. The nose of the subject is clamped to prevent inspiration of atmospheric air. A mouth piece fits between the lips and the gums and between the teeth, and is directly attached to two tubes which lead into the apparatus. One tube supplies oxygen for inspiration; the other serves as an outlet for the expiratory gases. The latter leads into a cylinder that contains soda lime for the absorption of C02 and water. Expired oxygen is freed in this manner and is reused by the subject.

The respiratory rate, depth, and 02 consumption are recorded on a synchronized kymograph. A pen, filled with ink, is connected to the floating cylinder of oxygen, and records its sensitivity to respiratory movements on a metabolic chart.

After the completion of all the other clinical tests, the subjects were requested to walk to the Science Building for the Benedict-Roth testing. This test was given approximately three to four hours after the evening dormitory meal.

Preceding the first test for the "normal", the subjects were briefly informed of the mechanics of the test. After the clamp and mouthpiece were adjusted, the valve, which permits the subject to breath atmospheric air or oxygen from the spirometer, was opened to the atmosphere. This procedure permits the subject to adjust to breathing into the closed circuit. All subjects took the test in a reclining position.

FITNESS TEST

WAC Fitness Test

The WAC Fitness Test (9) was administered before and after the apparatus unit. The battery consisted of: sit-ups, modified push-ups, wing-lifts, and squat thrusts. The latter two were timed tests, and were given first. A point was credited to the performer if she executed the movement pattern according to the standards established by the WAC test. The results of the tests are indices of abdominal, shoulder girdle, and back strength, in addition to endurance and speed of movement.

1. Wing-lift - The subject lies in a prone position and clasps the fingers behind the neck. The upper part of the body is lifted until the lower portion of the rib cage is touching the floor. The performer then returns to the original position. One point is given for each completed performance and points are lost when:
   a. The elbows touch the floor at any time.
   b. The desired height is not achieved.
   c. The hands are released from behind the neck.

   The time limit for this test was one minute.

2. Squat thrust - The starting position is a squat position with the hands placed on the floor between the knees. The legs are extended backward with the body in a straight line. The subject returns to the starting position. Points are deducted when the body does not maintain a straight line. The time limit was thirty seconds.

3. Sit-up - The sit-ups are done with the knees bent and in close to the body. The hands remain along the side of the participant, but do not assist her in getting into the erect, sitting position. Points are lost when:

    a. The hands or arms are used to aid in sitting.

    b. The foot and knee position are changed.

    c. The subject rests in the sitting or reclining position.

4. Push-up - The fourth test in the battery was the modified push-up with the knees and the lower leg supporting some of the body weight. The hands are at least shoulder width apart; the body is in a straight line. This position is maintained while the body is lowered to the floor and the chin touches. Points are lost if the body sags or the chin does not touch the floor.

The data compiled from these tests, both clinical and fitness, was treated statistically.

CHAPTER V

PRESENTATION OF DATA

The purpose of this study was to determine the effect of the learning of apparatus activities upon physiological stress reactions. Seven variables were utilized: blood sugar determination; oxygen analysis, measured by the Haldand-Guthrie apparatus; oxygen consumption, measured by the Benedict-Roth spirometer; systolic and diastolic pressure; and certain aspects of physical fitness, measured by the WAC Fitness Test. The physiological tests were administered to each of the nine subjects: (Test I), preceding the instructional unit to determine the homeostatic level; (Test II), following a demonstration of five skills selected from the apparatus progression which was to be taught; (Test III), after completion of three-fourths of the unit; and (Test IV), at the conclusion of the program. The fitness test was given at the beginning and at the end of the instructional program. The raw data for these tests may be found in Tables XII - XV, pages 86-89.

STATISTICAL ANALYSIS

Differences between Means

The data were treated statistically by using Fisher's "t" to compute the significance of difference that might exist among the four experimental conditions. Both the significance of difference between means and the means of difference scores were computed, accepting the five per cent level of confidence and below as statistically significant.

The ranges, means, and the standard deviations of the raw data may be found in Tables I, II, and III, pages 31-33.

TABLE I

RANGES, MEANS, AND STANDARD DEVIATIONS
OF BLOOD SUGAR, O2 ANALYSIS, O2 CONSUMPTION,
DIASTOLIC AND SYSTOLIC PRESSURE, AND FITNESS TESTS
FOR THE FIRST TESTING CONDITION

Variables	TESTING CONDITION I (NORMAL) Range	Mean	Standard Deviation
Blood Sugar	75-175	113.888	26.6435
Diastolic Blood Pressure	63-85	74.888	5.3840
Systolic Blood Pressure	101-112	108.222	3.4569
O2 Analysis	1.7610-5.1570	3.076	1.1561
O2 Consumption	18.5684-102.1935	41.753	22.9605
WAC Fitness Test:			
Push-up	5-27	16.111	7.2639
Sit-up	0-26	11	10.3172
Squat thrust	12-15	13.750	0.9938
Wing lift	23-58	47.222	10.6539

TABLE II

RANGES, MEANS, AND STANDARD DEVIATIONS OF BLOOD SUGAR, 02 ANALYSIS, 02 CONSUMPTION, DIASTOLIC AND SYSTOLIC PRESSURE FOR THE SECOND AND THIRD TESTING CONDITIONS

Variables	Range	Mean	Standard Deviation
TESTING CONDITION II (STRESSOR)			
Blood Sugar	87-125	102.666	9.8544
Diastolic Blood Pressure	63-92	74.555	8.2342
Systolic Blood Pressure	91-113	104.222	6.2321
02 Analysis	0.2010-3.4600	2.084	0.8696
02 Consumption	38.9169-108.2873	52.0953	20.2708
TESTING CONDITION III (COMPLETION OF THREE-FOURTHS OF UNIT)			
Blood Sugar	70-100	75	16.6666
Diastolic Blood Pressure	62-87	74.111	7.0149
Systolic Blood Pressure	96-107	102.222	3.4300
02 Analysis	-0.3010-3.9240	2.194	1.3047
02 Consumption	34.8750-129.8051	53.4673	27.4409

TABLE III

RANGES, MEANS, AND STANDARD DEVIATIONS OF BLOOD SUGAR, 02 ANALYSIS, 02 CONSUMPTION, DIASTOLIC AND SYSTOLIC PRESSURE, AND FITNESS TESTS FOR THE FOURTH TESTING CONDITION

Variables	TESTING CONDITION IV (CONCLUSION OF UNIT) Range	Mean	Standard Deviation
Blood Sugar	50-125	66.555	20.4692
Diastolic Blood Pressure	64-79	71.444	4.2193
Systolic Blood Pressure	95-108	101.111	3.8135
02 Analysis	0.3750-3.6250	2.160	1.0526
02 Consumption	28.5516-45.7806	36.6405	6.0945
WAC Fitness Test:			
Push-up	2-26	15.111	8.2791
Sit-up	0-25	7.777	9.3426
Squat thrust	12-16	13.375	1.3405
Wing lift	28-63	48.555	8.7065

Tests I and II

Fisher's "t's" were computed to find the significance of difference between uncorrelated means of Tests I and II for all clinical measures. No acceptable statistical significance was noted.

The "t" values for all testing conditions may be found in Table IV, page 36.

Tests I and III

Fisher's "t's" were computed to find the significance of difference between uncorrelated means of Tests I and III for all clinical tests. In this respect, a difference in blood sugar was found to be statistically significant at the one per cent level of confidence. Likewise, in this respect, a difference in systolic blood pressure was found to be statistically significant at the one per cent level of confidence.

Tests I and IV

Fisher's "t's" were computed to determine the significant relationship between the uncorrelated means of Tests I and IV for both fitness and clinical tests. In this respect, a difference in blood sugar was found to be statistically significant at the one per cent level of confidence. Similarly, in this respect, a difference in systolic blood pressure was found to be statistically significant at the one per cent level of confidence. There was also, a difference in diastolic blood pressure, statistically significant at the five per cent level of confidence.

Tests II and III

Fisher's "t's" were computed to find the significance of

difference between uncorrelated means of Tests II and III for all clinical tests. A difference in blood sugar was found to be statistically significant at the one per cent level of confidence.

Tests II and IV

Fisher's "t's", for determination of significance of difference between uncorrelated means, were computed for all clinical tests of Tests II and IV. A difference in blood sugar was found to be statistically significant at the one per cent level of confidence.

Tests III and IV

Fisher's "t's" were computed to find the significance of difference between uncorrelated means of Tests III and IV for all clinical measures. No acceptable statistical significance was noted.

Since this experiment was concerned with the relationship between the individual differences of the subjects, a difference score was computed by subtracting an individual's score from Test II from the score recorded for Test I, Test III from Test I, Test IV from Test I, Test III from Test II, and so on, for all tests. The resulting, secondary measurements are called difference scores. The difference data were used to further clarify statistical relationships that might exist among the experimental conditions.

The ranges, means, and standard deviations of all mean difference scores may be found in Tables V - VIII, pages 37-40.

Tests I and II

The test for the significance of difference between correlated pairs of means was computed, without regard to the direction of change, for the means of difference scores between Tests I and II for all clinical tests.

difference between uncorrelated means of Tests II and III for all clinical tests. A difference in blood sugar was found to be statistically significant at the one per cent level of confidence.

Tests II and IV

Fisher's "t's", for determination of significance of difference between uncorrelated means, were computed for all clinical tests of Tests II and IV. A difference in blood sugar was found to be statistically significant at the one per cent level of confidence.

Tests III and IV

Fisher's "t's" were computed to find the significance of difference between uncorrelated means of Tests III and IV for all clinical measures. No acceptable statistical significance was noted.

Since this experiment was concerned with the relationship between the individual differences of the subjects, a difference score was computed by subtracting an individual's score from Test II from the score recorded for Test I, Test III from Test I, Test IV from Test I, Test III from Test II, and so on, for all tests. The resulting, secondary measurements are called difference scores. The difference data were used to further clarify statistical relationships that might exist among the experimental conditions.

The ranges, means, and standard deviations of all mean difference scores may be found in Tables V - VIII, pages 37-40.

Tests I and II

The test for the significance of difference between correlated pairs of means was computed, without regard to the direction of change, for the means of difference scores between Tests I and II for all clinical tests.

TABLE IV

SIGNIFICANCE OF DIFFERENCE AMONG THE MEANS OF ALL TESTING CONDITIONS

	I and II	I and III	I and IV	II and III	II and IV	III and IV
Blood Sugar	1.2212	3.7286*	3.7413*	4.4979*	9.5805*	1.0456
02 Analysis	1.8549	1.4189	1.5895	-0.1547	-0.1686	0.0726
02 Consumption	-0.9858	-2.6448	0.5817	-0.1188	2.1857	1.7003
Diastolic Blood Pressure	0.1148	0.3152	2.4003***	0.1047	0.9747	0.9738
Systolic Blood Pressure	1.4856	4.3029*	3.7794*	0.7929	1.7842	0.7169
WAC Fitness Test:						
Push-up			0.8018			
Sit-up			1.4811			
Squat thrust			1.1577			
Wing lift			-0.2367			

* Indicates statistical significance at the 1 per cent level of confidence.
*** Indicates statistical significance at the 5 per cent level of confidence.
Key: I - Normal conditions
II - Stressor conditions
III - Completion of three-fourth of unit
IV - Conclusion of the unit

TABLE V

RANGES, MEANS, AND STANDARD DEVIATIONS OF THE DIFFERENCE SCORES BETWEEN TESTING CONDITIONS I AND II, AND I AND III

Variables	Range	Mean	Standard Deviation
TESTING CONDITIONS I AND II			
Blood Sugar	0-75	16.777	22.8025
Diastolic Blood Pressure	0-17	6.111	5.4862
Systolic Blood Pressure	0-18	5.777	5.6328
02 Analysis	0.2130-3.1950	1.445	1.0868
02 Consumption	0.0550-69.5181	30.9662	24.2066
TESTING CONDITIONS I AND III			
Blood Sugar	11.112-61.112	24.073	16.4079
Diastolic Blood Pressure	1-16	5.222	4.6852
Systolic Blood Pressure	1-12	5.111	3.3812
02 Analysis	0.1360-4.471	1.366	1.4148
02 Consumption	3.3855-27.6116	14.6467	8.9240

Key: Testing Conditions I - Normal
II - Stressor
III - Completion of Three-fourths of unit

TABLE VI

RANGES, MEANS, AND STANDARD DEVIATIONS OF THE DIFFERENCE SCORES BETWEEN TESTING CONDITIONS I AND IV

	TESTING CONDITIONS I AND IV		
Variables	Range	Mean	Standard Deviation
Blood Sugar	0-125	47.333	35.7835
Diastolic Blood Pressure	0-11	4.333	3.0912
Systolic Blood Pressure	1-14	7.777	4.2891
02 Analysis	0.2750-2.9230	1.675	0.8285
02 Consumption	1.2794-66.7935	16.3449	19.4148
WAC Fitness Test:			
Push-up	1-6	3.222	
Sit-up	0-19	4.111	
Squat thrust	0-2	0.625	
Wing lift	0-40	10.444	

Key: Testing Condition I - Normal
IV - Conclusion of the unit

TABLE VII

RANGES, MEANS, AND STANDARD DEVIATIONS OF THE DIFFERENCE SCORES BETWEEN TESTING CONDITIONS II AND III, AND II AND IV

Variables	Range	Mean	Standard Deviation
TESTING CONDITIONS II AND III			
Blood Sugar	0-62	27.666	17.3974
Diastolic Blood Pressure	2-21	9.555	7.2589
Systolic Blood Pressure	0-12	6.444	3.6549
02 Analysis	0.0770-3.7650	1.566	1.2630
02 Consumption	0.1768-79.9194	18.4139	27.0115
TESTING CONDITIONS II AND IV			
Blood Sugar	0-50	36.111	16.0793
Diastolic Blood Pressure	0-21	7.111	5.9004
Systolic Blood Pressure	2-7	5.555	1.8352
02 Analysis	0.0620-3.0850	0.835	0.9603
02 Consumption	1.0160-68.2387	16.633	19.0303

Key: Testing Condition II - Stressor
III - Completion of three-fourths of unit
IV - Conclusion of the unit

TABLE VIII

RANGES, MEANS, AND STANDARD DEVIATIONS OF THE DIFFERENCE SCORES BETWEEN TESTING CONDITIONS III AND IV

	TESTING CONDITIONS III AND IV		
Variables	Range	Mean	Standard Deviation
Blood Sugar	0-38	22.222	9.9641
Diastolic Blood Pressure	0-13	7.111	4.0674
Systolic Blood Pressure	1-8	3.777	2.4845
02 Analysis	0.0360-2.6960	1.026	0.8325
02 Consumption	0.2975-94.4051	16.8929	27.9504

Key: Testing Conditions III - Completion of three-fourths of unit
IV - Conclusion of unit

In this respect, a mean difference in oxygen analysis and oxygen consumption was found to be statistically significant at the one per cent level of confidence. A mean difference in systolic and diastolic blood pressure was found to be statistically significant at the two per cent level of confidence.

Fisher's "t's" for all testing conditions may be found in Table IX, page 43.

Tests I and III

The "t" for significance of difference between correlated pairs of means was computed, without regard to direction of change, for the means of difference scores between Tests I and III for all clinical tests. In this respect, a mean difference in blood sugar, oxygen consumption, systolic blood pressure was found to be statistically significant at the one per cent level of confidence. Also a mean difference in diastolic pressure was found to be statistically significant at the two per cent level of confidence. A mean difference in oxygen analysis was found to be statistically significant at the five per cent level of confidence.

Tests I and IV

The test for significance of difference between correlated pairs of means was computed, without regard to the direction of change, for the means of difference scores between Tests I and IV for clinical and fitness tests. In this respect, a mean difference in blood sugar, oxygen analysis, and systolic and diastolic blood pressure was found to be statistically significant at the one per cent level of confidence. A mean difference in oxygen consumption was found to be statistically

significant at the five per cent level of confidence.

A mean difference in push-ups was found to be statistically significant at the one per cent level of confidence. Also, a mean difference in squat thrusts, and wing lifts was found to be statistically significant at the five per cent level of confidence.

Tests II and III

The "t" for significance of difference between correlated pairs of means was computed, without regard to the direction of change, for the means of difference scores between Tests II and IV for all clinical measures. In this respect, a mean difference in blood sugar, systolic and diastolic blood pressure was found to be statistically significant at the one per cent level of confidence.

Tests II and IV

The "t" test for significance of difference between correlated pairs of means was computed, without regard to the direction of change, for the means of difference scores between Tests II and IV for all clinical measures. In this respect, a mean difference in blood sugar was found to be statistically significant at the one per cent level of confidence. Similarly, in this respect, a mean difference in both diastolic and systolic pressure was found to be statistically significant at the one per cent level of confidence. A mean difference in oxygen analysis and oxygen consumption was found to be statistically significant at the five per cent level of confidence.

Tests III and IV

The test for significance of difference between correlated pairs of means was computed, without regard to the direction of change, for

TABLE IX

SIGNIFICANCE OF DIFFERENCE AMONG MEANS OF DIFFERENCE SCORES OF ALL TESTING CONDITIONS

	I and II	I and III	I and IV	II and III	II and IV	III and IV
Blood Sugar	2.0810	4.1498*	3.7414*	4.4978*	6.3519*	6.3077*
02 Analysis	3.7611*	2.7320***	5.7167*	0.3507	2.4631***	3.4897*
02 Consumption	3.6184*	4.6422*	2.3812***	1.9282	2.4722***	1.7095
Diastolic Blood Pressure	3.1516**	3.1534**	3.9643*	3.7077*	3.4089*	4.9451*
Systolic Blood Pressure	2.9016**	4.2769*	5.1299*	4.9876*	8.5725*	4.3018*
WAC Fitness Test:						
Push-up			5.2051*			
Sit-up			2.0596			
Squat thrust			2.3764***			
Wing lift			2.4170***			

* Indicates statistical significance at the 1 per cent level of confidence.
** Indicates statistical significance at the 2 per cent level of confidence.
*** Indicates statistical significance at the 5 per cent level of confidence.
Key: I - Normal conditions
II - Stressor conditions
III - Completion of three-fourths of unit
IV - Conclusion of the unit

the means of difference scores between Tests III and IV for all clinical tests. In this respect, a mean difference in blood sugar, oxygen analysis, systolic and diastolic blood pressure was found to be statistically significant at the one per cent level of confidence.

Correlations

The data of the experiment were also treated statistically by using the Pearson Product-Moment Coefficient of Correlation to determine relationships that might exist between physiological measures and between the fitness tests within Tests I-IV.

Of the correlations computed for Tests I-IV, none were statistically significant. All coefficients of correlations of Tests I-IV may be found in Tables X and XI, pages 45-46.

SUMMARY OF STATISTICAL RESULTS

Difference Between Means

1. In the clinical measure of blood sugar, the means of Tests I and III, I and IV, II and III, and II and IV were found to be statistically significant at the one per cent level of confidence.
2. In systolic blood pressure, the means of Tests I and III, and I and IV were found statistically significant at the one per cent level of confidence. Also, in diastolic blood pressure, the means of Tests I and IV were found to be statistically significant at the five per cent level of confidence.

Difference Between Means of Difference Scores

1. In blood sugar, the means of Tests I and III, I and IV, II and III, II and IV, and III and IV were found to be statistically

TABLE X

COEFFICIENTS OF CORRELATIONS FOR
MEASUREMENTS UNDER TESTING CONDITIONS I AND II

	NORMAL CONDITIONS						
	02 Anal.	02 Cons.	D. B. P.	S. B. P.	Sit-up	Squat thrust	Wing lift
Blood Sugar	-0.0553	0.0012	0.0091	0.0322			
02 Analysis		-0.1023	0.5038	-0.1884			
02 Consumption			0.0083	0.0185			
Push-up					0.0375	-0.0359	-0.0387
Sit-up						-0.0854	-0.0374
Squat thrust							0.0000
	STRESSOR CONDITIONS						
Blood Sugar	0.3241	-0.0051	-0.0200	-0.0591			
02 Analysis		0.0525	0.4137	-0.9089			
02 Consumption				0.0149			

TABLE XI

COEFFICIENTS OF CORRELATIONS FOR
MEASUREMENTS UNDER TESTING CONDITIONS III AND IV

	COMPLETION OF THREE-FOURTHS OF UNIT						
	02 Anal.	02 Cons.	D. B. P.	S. B. P.	Sit-up	Squat thrust	Wing lift
Blood Sugar	**-0.1021**	0.0097	**0.0142**	-0.0291			
02 Analysis		-0.0068	0.0485	0.3531			
02 Consumption			0.0023	-0.0191			
	CONCLUSION OF UNIT						
Blood Sugar	-0.1569	-0.0330	0.0085	-0.0328			
02 Analysis		0.1539	0.0667	-0.0030			
02 Consumption			0.1627	0.0297			
Push-up					0.0051	-0.0116	-0.0135
Sit-up						-0.0665	-0.0138
Squat thrust							0.0000

significant at the one per cent level of confidence.

2. In oxygen analysis, the means of Tests I and II, I and IV, and III and IV were found to be statistically significant at the one per cent level of confidence; the means of Tests I and III, and II and IV were found statistically significant at the five per cent level of confidence.
3. In oxygen consumption, the means of Tests I and II, and I and III were found statistically significant at the one per cent level of confidence. In addition, the means of Tests I and IV, and II and IV were found to be statistically significant at the five per cent level of confidence.
4. In the clinical measure of systolic pressure, the means of all testing conditions were statistically significant, Tests I and II, at the two per cent level of confidence; Tests I and III, I and IV, II and III, II and IV, III and IV, at the one per cent level of confidence.
5. In diastolic pressure, the means of all tests were statistically significant: Tests I and II, and I and III, at the two per cent level of confidence; Tests I and IV, II and III, II and IV, and III and IV, at the one per cent level of confidence.
6. In the WAC Fitness Test, the push-ups, were found to be statistically significant at the one per cent level of confidence for the means of Tests I and IV. Squat thrusts and wing lifts were found statistically significant at the five per cent level of confidence for the means of Tests I and IV.

Correlations

1. None of the correlations for Tests I-IV were found statistically significant.

CHAPTER VI

ANALYSIS OF DATA

The effects of the learning of specific apparatus skills on bodily stress reactions was determine by a statistical analysis of the measurements taken under the four experimental conditions.

The variables measured were: blood sugar and oxygen analysis, oxygen consumption, and diastolic and systolic blood pressure. The first test was for the determination of the basic homeostatic level of each individual; the second, for determining the nature of a physiological response to a stressor situation, which was a demonstration of five selected skills from the instructional program; and the third and fourth tests, for the determination of the effects of learning on physiological response; after the completion of three-fourths of the unit, and at the conclusion of the unit. Certain aspects of physical fitness were measured before and after the program, by the WAC Fitness Test.

These variables were treated statistically to determine the significance of difference: among the means for all testing conditions, and also, among the mean difference scores for all testing conditions, without regard for the direction of the change.

A statistical analysis was also used to determine existing relationships among the measurements for each of the four testing conditions.

ANALYSIS OF TEST RESULTS

Differences Between Means

Tests I and II - (Normal and Stressor Conditions)

There was a fall in the readings of the measurements: blood sugar, oxygen consumption, as measured by the Haldane-Guthrie method, and diastolic and systolic blood pressure. The change was not statistically significant for any of these measurements. This may indicate that the test for the homeostatic level had the potential of being a stressful situation, and thus, producing higher readings than those for the actual stressor situation. The subjects were not familiar with the testing devices or procedure. The element of surprise or excitement may have affected these readings for the normal.

Dobreff and Tomoff, as stated by Dunbar (5), reported a rise in blood sugar in patients before an operation and in students previous to taking an exam. Altschule (17) observed patients with and without heart disease during periods of anxiety, and concluded that during emotional stress there is a definite rise in metabolic rate. Hickam (27) claimed that anxiety caused a ten per cent increase in the mean arterial pressure of healthy medical students taking oral exams.

A rise in oxygen consumption, as measured by the Benedict-Roth apparatus, was found not to be statistically significant. In testing for the basic homeostatic condition, sufficient time was permitted for each individual to adjust to the discomfort of the apparatus. Preceding the other testing sessions, the period of adjustment was shortened. This may account for the rise in oxygen consumption during the second test.

Tests I and III - (Normal, Completion of Three-fourths of Unit)

There was a significant fall in systolic blood pressure and blood sugar between Tests I and III. This result suggests that at this progression in learning, the situation was significantly less stressful than the preliminary test for the "normal". In addition, the subjects by this time had become adjusted to the testing apparatus and the procedure.

A drop in oxygen consumption, measured by the Haldane-Guthrie apparatus and diastolic blood pressure was found not to be statistically significant. This seems to indicate that at this time the individuals adapted themselves quickly to the situation.

Again, there was a rise in oxygen consumption, as measured by the Benedict-Roth method, which was not statistically significant. This may suggest that the shortened period of adjustment was not sufficient time for individuals to adjust to the testing apparatus.

Tests I and IV - (Normal, Conclusion of the Unit)

For Tests I and IV there was a significant fall in the scores of blood sugar, and systolic and diastolic blood pressure. It would seem to indicate that at the termination of the unit, the situation had been sufficiently learned so as not to be stressful to the subjects.

There was a fall in oxygen consumption, utilizing both methods of testing for oxygen consumption. The drop, which was not statistically significant, may be attributed to a more rapid adaptation to the concluding situation; and, in the case of measurement by the Benedict-Roth method, an adjustment to the testing apparatus.

The differences between the means of the fitness tests were not

statistically significant. In the scores for the push-ups and the squat thrusts, there was slight fall; for wing lifts, there was a slight increase in number. There was even a greater fall in the scores for sit-ups. These results, which seem to indicate that the physical fitness level was lowered, rather than raised as the result of apparatus activities, could have been affected by: an invalid count of movements by the subjects, in other words, movements which were not consistent with the standards of the WAC Fitness Test; for the sit-ups, if an incorrect leg position was assumed, the number executed would be affected.

Tests II and III - (Stressor, Completion of Three-fourths of the Unit)

For Tests II and III a significant fall in scores was noted for blood sugar. This seems to indicate that learning at this point in the unit was less stressful than the assumed stressor itself.

In the measurements of systolic and diastolic blood pressure a fall in the scores was found not to be statistically significant. This fall might be an indication of the stressor being of insufficient intensity.

There was also a rise in oxygen consumption, utilizing both testing methods, which was not statistically significant. The rise in the oxygen consumption, as measured by the Haldane-Guthrie apparatus, may be explained by the surprise of a test being given, as the subjects did not know the number of tests or when they were scheduled. Such emotional excitement could have easily affected these scores, since this was one of the first tests administered.

The rise in the consumption of oxygen, as measured by the Benedict-Roth spirometer, might have been initiated by the lack of time to adjust to the mechanical awkwardness of the spirometer.

Tests II and IV - (Stressor, Conclusion of the Unit)

A significant difference was found between the means of Tests II and IV for blood sugar. This significant fall in score seems to indicate that the concluding situation was less stressful than the demonstration, the assumed stressor situation.

For the measurement of oxygen consumption, as measured by the Haldane-Guthrie testing device, there was a rise in the scores, which was not significant. This may be attributed to the initial excitement of an unexpected test. Since this was one of the first tests administered, it could have been a causative factor.

As reported by Hetzel (26), Ziegler and Levine found an increase in metabolic rate as the result of emotional excitement of interviews, concerning stressful events in the subjects past.

Differences in the means of oxygen consumption, measured by the Benedict-Roth spirometer, and diastolic and systolic blood pressure were not statistically significant. There was a decrease in the values of the scores for each of these variables. This difference may be explained by a more rapid adaptation to the concluding learning situation, or by a stressor situation which was inadequate in producing anxiety in the individuals.

Tests III and IV - (Completion of Three-fourths of the Unit, Conclusion of the Unit)

There was a drop in the scores for all clinical tests, but these changes were not statistically significant. This may indicate two possibilities: a rapid adaptation to the situation, or the fact that the third and fourth tests were given at approximately the same point in the learning curve for the group.

Differences Between Mean Difference Scores

The significance of difference between the mean difference scores was computed for all testing conditions without regard to the direction of the change. The change was significant for all measurements with the exception of: blood sugar, between Tests I and II; oxygen consumption, utilizing the Haldane-Guthrie method, between Tests II and III; oxygen consumption, utilizing the Benedict-Roth method, Between Tests II and III and Tests III and IV; and in the fitness tests, the sit-ups, between Tests I and IV.

The significant results seem to indicate further that a stressor has produced definite changes in the physiological response throughout the experimentation.

The change for blood sugar for Tests I and II was found not to be statistically significant. This appears to indicate that the testing procedure for the "normal" was capable of inducing emotional stress of an intensity almost as great as that induced by the demonstration. This was evident in the proximity of the scores for both sets of raw data.

The changes between Tests II and III for oxygen consumption, utilizing both methods, were not statistically significant. This result suggests that the assumed stressor was not intensified enough.

The change between Tests III and IV for oxygen consumption, as measured by the Benedict-Roth spirometer, was not statistically significant; and indicates the possibility of another emotional factor influencing the scores. The scores for Test III were considerably higher than those for Test IV. Perhaps, this is a further indication of an inadequate adjustment to the metabolic apparatus during Test III.

The change for sit-ups was not statistically significant for

Tests I and IV. This result may be due to an inadequate leg position while executing the sit-ups, which would definitely affect the number performed.

Correlations

The inter-correlations for Tests I, II, III, and IV were not statistically significant. There is the possibility that the scores for Test I were high for a reading for the homeostatic level of the subjects; for, when compared with the scores for the stressor condition, all but one measurement, oxygen consumption, using the Benedict-Roth apparatus, were higher than the stressor condition recordings.

In Test II other inconsistent results were found. As blood sugar decreased, oxygen consumption, measured by the Benedict-Roth method, increased. And as oxygen consumption, measured by the Haldane-Guthrie method, decreased in score, oxygen consumption, measured by the spirometer, increased.

For Test III, results were also inconsistent. In diastolic blood pressure and blood sugar, and systolic blood pressure and blood sugar, scores decreased, while for other measurements, when one decreased the other increased in value.

The scores for measurements for Test IV were lower than any of the other test scores, but the relationships were low and not significant.

The final fitness scores dropped from those scored on the initial test. This may suggest that incorrect procedure was used by the subjects in counting movements executed, or that movements were performed incorrectly, as in the sit-ups.

Although the statistical analysis has indicated that there were

no significant relationships within the experiment, this may be a valid reason for believing that the presentation of apparatus skills and the actual learning is not sufficiently stressful to elicit the stress syndrome.

CHAPTER VII

SUMMARY AND CONCLUSIONS

This experiment was conducted to determine the effects of the learning of apparatus skills upon bodily stress reactions.

The subjects were nine physical education majors enrolled at The Woman's College of the University of North Carolina. They were selected on the basis of individual scores made on a physical fitness test, which was an indication of shoulder girdle strength.

The experimental design consisted of the administration of the clinical tests of blood sugar, oxygen analysis and systolic and diastolic blood pressure under four testing conditions: preceding the instructional program, to determine the homeostatic level of each individual; immediately following a planned demonstration, which was assumed to produce psychic fear; after three-fourths of the unit had been taught; and at the conclusion of the program.

The secondary purpose of the study was that of determining the effects of apparatus on the physical fitness level of the subjects. The WAC Fitness Test was administered before and after the unit.

All measurements were treated statistically to determine the significance of difference among the means and the mean difference scores of the testing conditions.

The measurements were also inter-correlated to determine significant relationships within each testing condition.

SUMMARY OF THE STATISTICAL FINDINGS

Tests I and II - (Normal and Stressor Conditions)

1. A fall was found in the scores of: blood sugar; oxygen consumption, utilizing the Haldane-Guthrie method; and diastolic and systolic blood pressure. This decrease in scores was not statistically significant for any of the tests mentioned.
2. There was a rise in oxygen consumption, as measured by the Benedict-Roth spirometer, which was not statistically significant.

Tests I and III - (Normal, Completion of Three-fourths of the Unit)

1. There was a significant fall in the scores of: blood sugar and systolic blood pressure.
2. A fall in the scores of oxygen consumption, measured by the Haldane-Guthrie method, and of diastolic blood pressure was found not to be statistically significant.
3. There was no statistically significant rise in oxygen consumption, measured by the Benedict-Roth apparatus.

Tests I and IV - (Normal, Conclusion of the Unit)

1. There was a significant fall in the scores of: blood sugar, systolic and diastolic blood pressure.
2. There was fall in the scores of oxygen consumption, utilizing both methods of measuring, which was not statistically significant.
3. Scores of the physical fitness test were found not to be statistically significant.

Tests II and III - (Stressor, Completion of Three-fourths of the Unit)

1. A significant decrease in score was found for blood sugar.
2. There was a fall in scores of both diastolic and systolic blood pressure, which was not statistically significant.
3. There was a rise in oxygen consumption, utilizing both methods of measuring the consumption, which was not statistically significant.

Tests II and IV - (Stressor, Conclusion of the Unit)

1. There was a significant fall in the score for blood sugar.
2. A rise was found for oxygen consumption, measured by the Haldane-Guthrie method, which was not statistically significant.
3. There was a decrease in the scores of oxygen consumption, using the Benedict-Roth method, diastolic and systolic blood pressure, which was not statistically significant.

Tests III and IV - (Completion of Three-fourths of the Unit, Conclusion of the Unit)

1. There was a decrease in the scores of all clinical tests, which was not statistically significant.

The significance of difference between the mean difference scores was used to further clarify statistical relationships that might exist among the experimental conditions. These were computed without regard to directional changes.

The changes for all measurements were statistically significant except in the following:

1. Blood sugar - Tests I and III
2. Oxygen consumption, as measured by the Haldane-Guthrie testing

device - Tests II and III

3. Oxygen consumption, measured by the Benedict-Roth spirometer - Tests II and III and Tests III and IV
4. In the fitness test: sit-ups - Test I and IV.

The correlations for all measurements within Tests I, II, III, and IV were not statistically significant.

CONCLUSIONS

The results of the statistical analysis of the data indicate that the testing conditions for the "normal" seemed to induce physiological syndrome which may have been the result of psychic fear. The anticipation of taking unfamiliar physiological tests might have affected the individual interpretation of the testing situation, and thus, intensified the physiological response.

From the results, there was also an indication that the stressor situation itself was not intense enough to elicit the stress syndrome, or that the presentation of apparatus skills to this selected group of physical education majors was not stressful to them because of previous experience in varied types of physical activities.

The statistical results for Testing Conditions III and IV were found to be very similar, apparently indicating that these tests were administered at approximately the same point in the learning curve for the group. The scores for these two testing conditions were considerably lower than those for Conditions I and II; this may be due to the fact that the learning of specific apparatus skills was also not stressful enough to elicit the stress syndrome.

In concluding, the writer would like to submit a recommendation for further study. It would be of value to measure not only the physiological response during the learning of an activity, but also, the psychological response. In addition, it would be of interest to experiment with a sample of lower motor ability.

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APPENDIX

APPARATUS UNIT AND TESTING PROGRAM

Week I

I. Test I for the basic homeostatic condition

II. WAC Fitness Test

Week II

I. Test II, after the demonstration of five selected skills (the assumed stressor)

II. Orientation:

A. Safety

1. Student knowledge of the manipulation of apparatus equipment

2. Spotting

B. Teaching preliminary exercises on each piece of apparatus

Teach the basic skills:

A. Horse

1. Front lean rest position

2. Approach

3. Approach with front lean rest

4. Knee mount

5. Squat vault

B. Parallel bars

1. Swing, low

C. Stationary rings

1. Tip-up position

2. Knee hang

Week III

I. Review

Introduction of new skills

A. Horse

1. Knee mount, stand, dismount
2. Squat vault with layout
3. Front vault

B. Parallel bars

1. Swing
2. Straddle seat

C. Stationary rings

1. Angel
2. Horizontal lying position
3. Skin the cat

II. Review

New skills

A. Horse

1. Side vault

B. Parallel bars

1. Swing
2. Side saddle
3. Turnover

C. Stationary rings

1. Bird's nest
2. Flying hang
3. Inverted hang

Week IV

I. Review

New skills

A. Parallel bars

1. Front lean rest position

2. Routine-swing, side saddle, turnover, side saddle, dismount

B. Stationary rings

1. Trunk twist

C. Flying rings

1. Swing

II. Review

New skills

A. Horse

1. Forward roll off the horse

2. Chest stand

3. Chest stand and forward roll

B. Parallel bars

1. Angel

2. Increase the height of swing

Week V

I. Review

New skills

A. Horse

1. Cross seat

2. Cross seat into riding seat position

B. Parallel bars

1. Rear dismount

C. Flying rings

1. Swing into:

a. Tip-up

b. Knee hang

c. Angel

II. Review

New skills

A. Horse

1. Face dismount from riding seat

2. Riding seat

B. Parallel bars

1. Create routine

C. Flying rings

1. Swing into:

a. Horizontal lying position

b. Bird's nest

Week VI

I. Review

New skills

A. Buck

1. Straddle vault

2. Wolf vault

B. Parallel bars

1. Traveling

C. Flying rings

1. Swing into inverted hang

II. Review

New skills

A. Horse

1. Straddle vault

2. Wolf vault

B. Parallel bars

1. Front dismount

C. Flying rings

1. Swing with a half turn

Week VII

I. Test III, after the discussion of the three previously demonstrated skills: straddle vault on the horse, front dismount on the parallel bars, and swing into stunts on the flying rings.

II. Final checking of individual skills (check list)

Week VIII

I. Practice for demonstration

II. Practice for demonstration

Week IX

I. Practice for demonstration

II. Test IV

Week X

I. Demonstration

DESCRIPTIVE ANALYSIS OF APPARATUS TECHNIQUE

The Horse

Terminology:

A. Directions on the horse

1. The near side of the horse - The side the performer approaches.
2. The far side of the horse - The side on which the performer dismounts.

B. Parts of the horse

1. Pommels - The handles mounted on the horse.
2. Saddle - The area between the two pommels.
3. The right end of the horse - The right side of the horse as it is approached.
4. The left end - The left side of the horse as it is approached.

C. Exercises on the horse

1. A mount - An arm supporting exercise in which the body weight is supported while the legs are moved.
2. A vault - An exercise on the horse in which the arms and hands only momentarily support the body weight.

D. Grasps

1. Ordinary - The palms face each other.
2. Reverse - The palms face the performer.
3. Combined - One hand is in an ordinary grasp, the other in a reversed grasp.

Techniques on the Horse

1. Approach - Running steps followed by a two foot take-off. The approach precedes the stunt to be performed on the horse.
2. Front lean rest position - With an ordinary grasp, a jump is taken upward, going into a straight arm position. The shoulders are slightly forward of the arms; the back is arched; the legs are together with the thighs resting on the near side of the horse.
3. Mounts from the front lean rest position:
   a. Raise alternately one leg then the other to the respective ends of the horse.
   b. Raise both legs first to one end then to the other.
   c. Flex at the hips and knees and rest the knees on the saddle of the horse.
   d. Draw the knees to the chest, resting the feet on the saddle of the horse.
4. Knee mount, stand, and dismount - The performer goes into the knee mount position, releases the hand grasp, stands, and dismounts on the far side of the horse.
5. Squat vault - The spring is upward straightening the arms, and at the same time tucking the knees to the chest. As the horse is cleared, the legs are extended and the arms aid by pushing the body away from the horse to dismount on the far side of the horse.
6. Front vault - A reversed grip is used on the side over which the front of the body passes, thus using a combined grasp. The legs spring upward and over the right end of the horse and maintain a

straight line from the shoulders. The reversed grip on the right pommel causes the body to be turned toward the top of the horse as it clears. The grasp is released shortly before the dismount, which is a standing position facing the far side of the horse.

7. Side vault - In the side vault, the ordinary grasp is used. As the legs spring upward and over the right end of the horse, the right hand grip is released, and the left side of the performer clears the horse. The performer dismounts with her back to the far side.

8. Forward roll from the front lean rest position - From the front lean rest position, the hips are flexed and the body is rolled toward the far side of the horse with the arms extended toward the mat in preparation to going into a forward roll. The stunt is concluded by going into a standing position.

9. Chest stand - First, a front lean rest position is assumed, then relaxing the arms, the mid-section of the body is balanced on the saddle. The hands move to the near side of the horse to grip the pommels. The palms and the thumbs of the hands face each other. After this grip is maintained, the body is rolled toward the far side, and the legs are raised upward and in the same direction. In the dismount, the legs are lowered to return to the preliminary position.

10. Chest stand into the forward roll - From the chest stand position, the legs are lowered; the body is balanced on the saddle, and the performer dismounts into a forward roll.

11. Cross seat - Only one leg is swung upward and to the side, and before the leg is cleared, the grip on that side is released. The recovery is a forward stride position with the thighs supporting the body. The back is arched and the legs are extended.

12. Riding seat position - The performer sits on the end of the horse facing the saddle. Again, the legs bear the body weight and are extended from the sides; both hands grip the pommel on that end.

13. Cross seat into riding seat - From the cross seat position, with the left leg forward, the right hand grip is released and the right leg is swung upward and across the right end of the horse. The momentum of the swing carries the leg on the far side and over the left end of the horse to the riding seat position.

14. Face dismount from the riding seat - From the riding seat position, both legs are swung backward and upward. As the legs swing upward, the arms are straightened to aid in lifting the legs. At the height of the backswing, the performer clears the horse and dismounts on the far side, facing the same direction.

15. Riding seat - Both legs spring upward and to the right side as in going into a side vault. At the height of the jump, the trunk is twisted to the left, the legs are spread, and the performer lands in the riding seat position.

16. Straddle vault - On the upward spring, the arms are extended to give additional height. The ordinary grasp is released immediately to maintain erect posture, and the legs, extended sideward, clear the pommels and the ends of the horse. After the horse is cleared,

the legs are brought together for the dismount on the far side.

17. Wolf vault - From the spring, the left knee is tucked to the chest, while the right leg is extended sideward. The right hand grip is released shortly before both legs clear the horse. The legs are brought together for the dismount on the far side.

Techniques on the Stationary Rings

1. Preliminary exercises:

   a. The following exercises are performed from a straight arm hanging position.

      (1). Alternate knee raising

      (2). Double knee raising

      (3). Alternate leg raising

      (4). Double leg raising

      (5). Alternate knee raising and extending of the leg

      (6). Double knee raising and extending of both legs

   b. The rings are adjusted to shoulder height for each individual participant. The above exercises are executed from a chinning position with the arms flexed in close to the side of the body.

2. Stunts on the stationary rings:

   For all skills on the stationary rings, the rings are adjusted to shoulder level.

   a. Tip-up position - The legs spring upward and backward, following in close to the chest with the knees tucked. An inverted position is maintained. To recover, the legs roll forward and are dropped gently to the mat.

      This is the fundamental skill on the stationary rings. It precedes and follows each stunt performed.

b. Knee hang - From the tip-up position, one leg and then the other is placed through the rings. When the knee hanging position is maintained, the legs are crossed at the ankles. The grip on the rings is released and the upper part of the body hangs below the rings with the arms crossed in front of the chest. To recover, to the tip-up, the procedure is reversed.

c. Flying angel - From the knee hang, the body is raised to a sitting position in the rings. The ropes are grasped in front of the body about chest level, and are pulled sideward as the performer leans forward. The head is up, the back is arched, the legs are extended backwards. To recover, the procedure is reversed.

d. Horizontal lying position - From the tip-up position, the legs are extended toward the wall so that they are parallel with the mat. The procedure is reversed for the recovery.

e. Skin the cat - This skill is a continuation of the tip-up. The body continues rolling after the inverted position is maintained. As both feet touch the mat, they push off immediately, causing the performer to roll back to the original standing position.

f. Bird's nest - While in the tip-up position, each foot is placed into a ring. The legs are extended and the head is thrown back so that the performer faces the mat. The head is erect and the back arched. In the recovery, the procedure is reversed.

g. Flying hang - While in the bird's nest, opposite hand and foot

are released from the rings, for example, the right hand and the left foot. Both the arms and the legs are straightened, causing the body to turn to a supine position in the rings.

To recover, the free hand and foot are replaced to their original positions; both feet are then dropped gently to the mat.

h. Inverted hang - From the tip-up, the hips, knees, and ankles are extended toward the ceiling. The legs are guided upward by the ropes, until full extension is attained, then the legs are drawn together. The back is arched and the head is back.

i. Trunk twist - From an extended arm hanging position, the legs, which are extended, are rotated from the hips in a circular pattern. The eyes are focused on a spot straight ahead. To recover, the legs are dropped to the mat.

3. Techniques on the flying rings:

All skills on the flying rings are executed from a straight arm hanging position.

a. Swing - The performer takes steps backward, and with short running steps, propells her body into a forward swing. This push-off is followed by the swinging of extended legs forward and upward. As the performer descends a two step push-off is taken where the ropes fall perpendicular to the floor. At the backswing the legs are extended at the hips and the back is slightly arched.

To stop, the legs must be spread and dragged each time the performer descends from the forward swing.

b. The swing into simple stunts - Such stunts as the bird's nest, inverted hang, flying angel, etc., are executed at the top of the forward swing. As the legs swing upward, they are drawn in close to the chest, and thus, the tip-up position.

To recover from the tip-up, the legs are extended and swung backward at the height of the backswing.

c. The swing into the half turn - At the height of the forward swing, the head, shoulders, and hips initiate a turn in the opposite direction. To return to the original position, another turn is executed, again, in the opposite direction.

Parallel Bars

1. Preliminary exercises:

a. Front mount and support - The spring is from both feet, the arms sweeping up between the bars. At the height of the jump, the bars are gripped; the arms are straight. The head is erect, the back arched, and the legs extended and together.

In the dismount, a push away from the bars is used so that the dismount is beyond the end of the bars.

b. Front mount and walk - From the front mount and support position, the body is shifted to one arm as the other slides a short distance forward on the bar. The weight is then transferred to the forward arm, while the trailing arm is moved in the line of direction.

In the dismount, the body is pushed forward and beyond the end of the bars.

2. Other techniques on the parallel bars:

a. Swing - From the front mount and support position, the legs

are swung forward and upward; the swing is initiated by movement from the trunk and flexion from the hips. The arms are straight and the head held erect at all times. As the legs swing backwards, the back arches slightly. The legs remain extended and together throughout the entire swing.

To dismount, at the height of the backswing, the body is pushed away from the bars to land beyond the end.

b. Straddle seat - As the legs descend from the forward swing, the legs are spread wide apart and land on the outside of the bars in an extended position. The weight is supported on the thighs, the hands grasp the bars close behind the body to aid in maintaining balance.

In the dismount, the legs are flipped up and drawn together to clear the bars, and descend from the forward swing position.

c. Side saddle - On the descent from the forward swing, both legs are swung to the right, clearing the right bar. The left leg lands on the bar so that the thigh and knee rest on it; the hip and knee joints are flexed and the foot points toward the mat. The right leg is in complete extension, also pointing toward the mat. The arms are extended from the shoulders for balance.

In the dismount, the body is pushed away from the side of the bars and land facing in the same direction.

d. Turnover - From the side saddle position with the left hand gripping the bar in close behind the left hip, both legs are straightened and the right leg leads over and across the

opposite bar. As the turn is completed the right hand grips the bar and a straddle position is assumed, facing in the opposite direction.

e. Front lean rest - After mounting to a side saddle, the hands are moved across to the farther bar to grip it at shoulder's distance apart. The body weight is then rolled onto the left thigh, as the performer faces the bars. The arms are extended and bear most of the weight. The lower legs rest on the other bar in an extended position.

To dismount, return to the side saddle.

f. Angel - While in the front lean rest position, a leg is extended toward the ceiling; the back is arched, and the head is erect.

In the dismount, the front lean rest and the side saddle positions are resumed.

g. Rear dismount - At the height of the forward swing, the weight is shifted to the right arm and the legs descend across the right bar. As they descend on the outside of the bar, the right hand is released and the left replaces it on the bar. The performer lands facing the same direction with the left side to the parallel bars.

h. Front dismount - The front dismount is mechanically the same as the rear dismount; with the exception that the former is executed at the height of the backswing instead of the forward swing, thus, causing the front part of the body to face the bar on the descent.

i. Traveling - From the straddle, the hands are placed on the

bars in front of the body so that as the performer leans forward, the shoulders are squarely over the arms. As the weight is taken on the arms, the legs are swung upward and backward, and are drawn together when the bars have been cleared. The legs swing forward and are spread at the height of the forward swing to recover to the straddle seat again.

j. Forward roll - The bars are grasped in front of the body; the performer then leans forward so that the upper arms, with elbows out to the side, rest against the top of the bars. The head is lowered, the hips raised, and the participant goes into a forward roll onto the bars in the line of direction. The weight is carried over the upper arms, and the legs remain straight throughout the roll. On the descent, the legs are still spread for a recovery into a straddle seat.

k. Backward roll - This skill is similar to the forward roll on the bars. It is executed from the straddle seat position by a rocking motion backwards. After the rock is started, the hands, with the palms out, are put on the small of the back; the elbows are out to the side. The performer recovers into the straddle.

l. Shoulder stand into the forward roll - In the straddle position the hands are brought in front of the thighs and placed on the bars. The body weight is brought over the upper arms as in the forward roll. The legs are drawn in close to the body and then extended toward the ceiling; the back is slightly arched. As the performer goes into the forward roll, the back is

rounded and the hips flexed.

m. Chest stand - Starting from the front lean rest, the body slides back until the upper arms are resting on the bar closer to the head. The performer then reaches back and grasps the bar behind with both palms down on top of the bar. The hips are raised into the air, then the legs. The back is arched and the body is in a vertical position.

In the dismount, the back is rounded, the head tucked as in the forward roll. The grip on the bars is released as the body descends, and the hands are shifted from the rear to the forward bar. The performer lands on the mat in a squat position.

n. Skin the cat - The performer stands facing the side of the bars. The arms go under the closer bar and grasp the farther one with palms down. A leg is swung forward and upward, the head is thrown back so that the body circles first, the farther bar on the underneath side and then on the outside; and then, the nearer one as the body lands in a front lean rest position. The performer is still facing in the same direction as in the starting position on the mat.

o. Flying mount - The performer stands several feet from the end of the bars, facing them. A running approach is taken between and to the center of the bars. At this point, the body is thrust forward, and the arms are swung upward to grasp the bars. The under side of the upper arm rests on the top of the bars. The legs swing forward and upward toward the ceiling. The hips follow immediately and the legs are straightened

and spread to the side at the height of the forward swing. The arms aid in giving an added push so that the performer lands in an upright, straddle seat position.

p. Forward fall - The starting position is a straddle seat position with the arms extended overhead. The arms initiate a pendulum movement toward the mat. The weight of the upper part of the body causes it to swing under and back up to the original straddle seat position. In order for the performer to maintain balance while doing the forward fall, the legs must be extended to the side.

TABLE XII

RAW DATA FOR
BLOOD SUGAR (TESTING CONDITIONS I-IV)
AND FITNESS TESTS (TESTING CONDITIONS I AND IV)

	BLOOD SUGAR (mg./100 cc. bld.)				WAC FITNESS TEST							
					Push-up		Sit-up		Squat t.		Wing t.	
Subj.	I	II	III	IV	I	IV	I	IV	I	IV	I	IV
1.	125	125	100	125	10	7	0	0	14	13	57	53
2.	100	100	75	50	12	14	0	0	13	13	56	53
3.	175	100	75	50	27	23	16	13	14	14	49	28
4.	75	100	75	75	8	2	1	0	15	13	58	47
5.	100	100	50	75	5	6	21	25	14	13	46	49
6.	100	100	75	50	22	19	26	22	12	12	50	48
7.	125	112	50	62	17	14	0	0	15	16	50	50
8.	125	100	100	62	20	26	12	6	13	13	23	65
9.	100	87	75	50	24	25	23	4	-	-	36	46

Testing Condition
I - Normal
II - Stressor
III - Three-fourths of unit completed
IV - Completion of unit

TABLE XIII

RAW DATA
DIASTOLIC AND SYSTOLIC BLOOD PRESSURE
(TESTING CONDITIONS I-IV)

	DIASTOLIC AND SYSTOLIC BLOOD PRESSURE							
	I		II		III		IV	
Subject	D.	S.	D.	S.	D.	S.	D.	S.
1.	73	109	63	91	79	103	71	95
2.	63	106	67	115	62	102	67	108
3.	77	110	66	97	87	105	74	104
4.	75	101	92	104	71	99	71	102
5.	85	112	77	108	69	103	79	104
6.	77	108	77	107	79	107	75	100
7.	76	112	80	109	75	106	69	102
8.	75	111	75	104	77	99	64	97
9.	73	105	74	105	68	96	73	98

Testing Condition
I - Normal
II - Stressor
III - Three-fourths of unit completed
IV - Conclusion of unit

TABLE XV

RAW DATA FOR OXYGEN ANALYSIS
(TESTING CONDITIONS I-IV)

Subject	OXYGEN ANALYSIS (per centage of oxygen consumption) I	II	III	IV
1.	2.228	3.460	-0.301	0.375
2.	3.396	0.201	3.648	0.952
3.	3.609	1.701	3.924	1.965
4.	4.744	2.330	2.183	2.219
5.	5.157	2.397	0.686	2.234
6.	2.013	2.308	3.145	3.625
7.	2.375	1.899	2.857	3.541
8.	2.398	2.915	1.980	3.038
9.	1.761	1.548	1.625	1.486

Testing condition
I - Normal
II - Stressor
III - Three-fourths of unit completed
IV - Conclusion of unit

Typed by

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