THE PSYCHOPHYSIOLOGICAL EFFECTS OF A RUNNING PROGRAM
ON DEPRESSION, SELF-ESTEEM, AND ANXIETY

DISSERTATION

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Charles P. Hannaford
Denton, Texas
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The purpose of the present study was to investigate the psychophysiological effects of exercise on measures of cardiovascular fitness, depression, self-esteem, and anxiety. The 1.5 mile run (Cooper, 1972) was used to determine changes in cardiovascular fitness. The Zung Self-Rating Depression Scale was used to measure varying levels of depression. The Rosenberg Self-Esteem Scale was used to measure self-esteem. The Spielberger State-Trait Anxiety Inventory was used to measure state anxiety. An Electromyographic Assay and Digital Skin Temperature were performed on the Experimental and Corrective Therapy Groups in order to measure physiological concomitants of anxiety. A Body Composition Assay was performed in order to measure changes in body composition.

Twenty-five males were recruited from a Veterans Administration Medical Center, Day Treatment Center to serve as subjects and were randomly assigned to either the Experimental Group or Corrective Therapy Group. Ten subjects were recruited from the Veterans Administration Mental Hygiene Clinic to serve as Waiting List Controls. Subjects in the
Experimental Group ran three days per week for 30 minutes at 60% maximum heart rate. Subjects in Corrective Therapy were involved in noncardiovascularly-oriented exercise for one hour, three times per week. A total of 27 subjects from all three groups completed the study.

It was hypothesized that the Experimental Group would increase their levels of cardiovascular fitness, demonstrate the greatest decrease in depression and anxiety, and show the greatest increase in self-esteem when compared to the Corrective Therapy or Waiting List Control Groups.

Statistical results demonstrated significant improvements in cardiovascular conditioning for the Experimental Group. Statistical results indicated significant decrements in depression for the Experimental Group compared to the Waiting List Controls. There were no significant differences found in anxiety or self-esteem among groups. Statistical results for electromyographic activity demonstrated that the Experimental Group was significantly less tense. No significant findings were observed on Digital Skin Temperature or Body Composition Assay. Therefore, running was effective in reducing depression, and producing decrements in somatic anxiety, but was not effective in reducing cognitive anxiety or improving self-esteem. Future research was suggested.
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THE PSYCHOPHYSIOLOGICAL EFFECTS OF A RUNNING PROGRAM
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Historical

After years of research and scientific contemplation, humankind has yet to fully comprehend the mind-body relationship. The notion of "mens sana in corpore"—a sound mind is a sound body—offers many implications for the rehabilitation and development of more integrated and healthy behavior. Through this focus, sound body could be represented by an achieved level of physical fitness, and sound mind as a healthy psychological state. The importance of a positive interaction between physiological and psychological functioning is delineated in the Human Resource Development Model (Carkhuff, 1971). This model places emphasis on the integration of an individual's physiological state with the intellectual and emotional spheres of functioning. Further, it suggests that the development of any of these spheres will affect functioning in the other areas. In fact, during the past decade a growing body of research has attempted to substantiate the assumption that an achieved level of physical fitness (derived mostly through aerobic training) has a direct positive influence on emotional functioning.

In fact, for centuries, man has had strong opinions regarding the importance of exercise in the maintenance of
physical and mental health. Unfortunately, a modicum of systematic research has been conducted to determine whether there is a connection between chronic exercise and mental health and, if a positive connection exists, what specific factors or variables under the rubric of chronic exercise are responsible for its effectiveness in the maintenance and restoration of physical and mental health.

While acknowledging that the distinction between physical and mental health is conceptually naive, it is heuristically useful to make the dichotomy because there is a substantial body of evidence concerning the positive physiological consequences of chronic exercise in contrast to a paucity of data concerning psychological changes associated with exercise. The interest in the effect of exercise on physical health continues to produce evidence that chronic exercise reduces risk factors associated with coronary artery disease, obesity, hypertension, and associated risk factors of cigarette smoking, elevated blood lipids, and "type A" personality characteristics. All of these factors influence the span and quality of life to some degree and though prospective statistical proof is difficult to obtain, it appears even more certain that being physically fit reduces the risk of life-threatening physical disease and enhances the quality of emotional functioning. Furthermore, the value of chronic exercise in the maintenance of mental health, as well as its therapeutic efficacy, is emphasized throughout
the rehabilitation and physical fitness literature. For the most part, these views are holistic in nature and recognize the totality of mind and body. This position is consonant with Health Psychology, and teleologically at least, such explanations have been quite popular.

Finally, chronic physical exercise (especially running) has become widespread in recent years, and research describing the psychological benefits of improvements in fitness has emerged from a variety of settings. Physical educators, exercise physiologists, psychologists, rehabilitation counselors, psychiatrists, and physicians have addressed this issue with some degree of optimism (Folkins & Sime, 1981). The psychological benefits of varying levels of fitness training, especially running (heretofore referred to as running or jogging), have been propagandized by the popular press. Since this is an emerging field of inquiry, especially for Health Psychologists (Southern & Hannaford, 1981), it becomes important to review current theory.

Current Theory

Since the time of the Industrial Revolution, society has supplied itself with sophisticated machines which afford freedom of travel, advanced farming techniques, and mass mechanized production resulting in greatly reduced human energy expenditure, and consequently, decreases in levels of fitness. Physical fitness can be defined as the ability to carry out daily tasks with vigor and alertness, without
undue fatigue, and with ample energy to meet unforeseen emergencies (Hockey, 1974). Medical research suggests that decrements in bodily functions are primarily due to atrophy associated with a sedentary lifestyle as opposed to the normal aging process (Henderson, 1976). According to the previously mentioned Human Resource Development Model (Carkhuff, 1974), it seems reasonable to assume that one's affective and psychological capabilities may deteriorate in concordance with decreases in physical functioning. According to Sheehan (1975), those who remain the "perpetual athlete" are physically two or three decades younger than the sedentary individuals who share the same chronological age. Therefore, physically fit people could develop an awareness, a physical intelligence, and a sensual connection with their body that enhances one's ability to better cope with the challenges of everyday existence. However theoretical, this point deserves more consideration.

Currently, research on the psychological effects of physical fitness training has been inhibited by the lack of conceptual ties between body and mind. Until the recent advent of Health Psychology, psychologists have typically viewed the mind as separate from the body. Eacher (1972) suggests that "the mind-body problem is relevant to contemporary psychology only to the extent that the dualistic nature of man remains unchallenged" (p. 563). The term psychosomatic exemplifies this dualistic focus. Since the
introduction of this concept, a link between mind and body has existed which has formed a foundation for a new field of inquiry. Even though this notion has been challenged as overly simplistic and outmoded (Selby & Calhoun, 1978), a new framework for causation, provided by the psychosomatic perspective, has greatly expanded treatment strategies in medicine. Harris (1978) has proposed that a "somatopsychic" perspective can, similarly, serve as a framework for causation which can generate hypotheses regarding the effects of exercise. "The somatopsychic rationale for man's involvement in physical activity and sport, in brief, is the theory that bodily activity and function influence his behavior" (Harris, 1978, p. 240).

Somatopsychic theory does not, however, fully address the complex question of how changes in physical fitness affect psychological variables. This theory provides for the creation of new boundaries for areas of psychophysiological investigation. Previously, most attempts to explain the psychological effects of physical fitness training have been performed piecemeal, and research has been largely atheoretical (Folkins & Sime, 1981). Speculations regarding the proposed benefits have tended to emphasize either physiological or psychological aspects giving little evidence to the interplay between the two. Therefore, the somatopsychic phenomena deserves more attention.
The most common experience reported by persons involved in regular physical activity is difficult to describe or measure objectively. The sensation brought about by chronic exercise has been most often described as "a feeling of well-being." Individuals engaged in running programs report this feeling more often than persons participating in other types of physical activity, therefore, it would appear that running or jogging would be the most efficient means of exercise by which to obtain this sensation.

Running/jogging is a form of aerobic exercise, which Cooper (1972) defines as the type of exercise that demands great amounts of oxygen and forces the body to process and deliver it to the tissue cells, where it combines with nutrients to produce energy. He states that it strengthens the cardiovascular system so an individual can sustain a pace over a long period of time without building oxygen debt.

Moreover, Cooper (1972) claims jogging/running is the quickest and most beneficial aerobic exercise. He has formulated a "point system" for measuring the differing values of various aerobic exercises, based on the amount of oxygen (and hence energy) required to perform each exercise. The amount of oxygen is translated into points, the more vigorous the exercise, the more points awarded. In effect, points are earned according to the type of exercise, the
duration, and the effort expended. Cooper (1972) concludes that running earns more points in a shorter period of time than other forms of aerobic exercise.

Cooper's (1972) studies demonstrate that if a runner/jogger sustains the activity long enough and hard enough, the individual is getting adequate endurance exercise to produce certain beneficial physiological changes which he calls "training effect." Specifically, he claims training effect: (a) increases the efficiency of the lungs, to process more air with less effort; (b) conditions the heart to pump more blood at a lower rate; (c) increases the size and number of blood vessels, and enhances collateral circulation; (d) increases total blood volume; (e) improves muscle tone, and changes fat weight to lean weight; (f) causes the rhythmic contraction and relaxation of muscles; (b) induces sweating and raises body temperature; and (h) enhances cerebral oxygenation. Therefore, Harris' (1978) somatopsychic theory which states that physical activity causes enhancement of physiological functioning, is supported by Cooper (1972). Thus it seems reasonable that the previously mentioned physiological changes brought about by chronic aerobic exercise could provide the individual with the sense of well-being. It is further suggested that a sense of well-being increases one's self-concept and augments an individual's ability to cope with depression and anxiety.
Specific Physiological Alterations

The physiological changes during and after exercise which are the most easily detectable, are peripheral in nature. These physiological alterations have been attributed, at least, in part, to changes in plasma norepinephrine (N.E.) and epinephrine (E.). Exercise clearly affects plasma N.E., and E. (Christensen, Galbo, Hansen et al, 1979). Short-term, high intensity exercise such as vigorous stair climbing (anaerobic) has been shown to result in a rise in both plasma N.E., and E. (Dimsdale & Moss, 1980). The effect on N.E. was more significant than on E., indicating a relatively greater contribution of the Sympathetic Nervous System (S.N.S.).

Prolonged aerobic exercise results in a rise in both plasma N.E. and E. (Christensen et al, 1979; Galbo, Richter, Hilsted et al, 1977). The rise in plasma E. is typically associated with more intense work in the latter stages of exercise. A relationship also exists between the decrease in plasma insulin in prolonged exercise and the increase in plasma E.

In relation to the observed reductions in plasma N.E. sometimes observed with training (Christensen et al, 1979), Brown and Van Huss (1973) observed an increase in brain N.E. with exercise training. In a subsequent investigation, Brown, Payne, Kim et al (1979) attempted to determine the location of increased N.E. levels. Following an endurance
training program, N.E. and serotonin (5-HT) levels in trained animals on a normal diet were higher than for the normal sedentary animals in the cerebellum and midbrain. In the cerebral cortex, the serotonin levels of exercise-trained animals on a high fat diet were elevated. The authors suggest that the higher levels of N.E. in the midbrain may have been associated with cardiovascular adaptations. The higher 5-HT concentrations were hypothesized to be related to obesity. The adaptation may also have been related to changes in substrate regulation. Because plasma 5-HT has been shown to be involved in pancreatic secretions (Bryce & Jacoby, 1978), changes in the brain may be associated with a central regulatory process.

This central regulatory process theory is further supported by Ransford (1982), who states that the antidepressant effect of exercise is related to alterations in central amine activity. Amines, chemicals secreted by neurons into the synapses, transmit information to neighboring neurons. Consequently, changes in the intensity of aminergic synaptic transmission can markedly influence the function of the nervous system. The major amines found in the brain are N.E., dopamine (D.A.), and 5-HT. Norepinepherine and D.A., are called catecholamines, while 5-HT is an indoleamine; all three are monoamines. Neurons that manufacture and secrete monoamines originate primarily in the brain stem, as well as in and around the reticular formation. Neurons that secrete N.E. and 5-HT
project to the hypothalamus, limbic system, and several other structures involved in affect. The dopaminergic neurons project primarily to the basal ganglia. The basal ganglia, limbic system, and hypothalamus are involved in motor behaviors, emotional, and motivational states, respectively (Fuxe, Hohfelt, & Ungerstedt, 1970).

The possibility that amines may be linked to affective disorders like depression has been suggested by several researchers (Coppen, Prange, Whybrow et al., 1972; Goodwin & Bunney, 1973). In general, these investigators summarize that affective disorders are associated with impaired transmission at central aminergic synapses. Evidence for this amine hypothesis stems from studies which reveal that the major urinary metabolites of 5-HT, D.A., and N.E. are reduced in depressed patients. Serum cortisol levels are increased (Sachar, Hellman, Roffwarg et al., 1973). Lowered urinary and serum levels of amine metabolites presumably indicate a reduction of amine release at central synapses and thus a hypofunctioning of these synapses.

In such cases, the metabolites are 5-hydroxyindoleacetic acid (5-HIAA), homovanillic acid (HVA), and 3-methoxy-4-hydroxphenylglycol (MHPG), respectively (Ransford, 1982). In other words, it has been observed that depressed patients have lowered urinary levels of 5-HIAA (Coppen et al., 1972), HVA (Papeschi & McClure, 1971), MHPG (Fawcett, Mass &
Dekirmenjian, 1972) and increased serum cortisol (Sachar et al, 1973).

The central regulatory hypothesis is further supported by evidence that intracerebral neurochemical changes accompany exercise. Brown, et al (1979) measured N.E. and 5-HT concentration in rats following eight weeks exposure to 30 minutes of treadmill running, five days per week. In most brain areas, N.E. and 5-HT concentrations were significantly greater than in sedentary control rats. The increased concentrations of N.E. are consistent with known modulating action of the brain of sympathetic activity following exercise training (Sacks & Sachs, 1981). Brown et al (1979) speculates that the increased amounts of 5-HT in the midbrain might be the mechanism responsible for decreased appetite and weight loss following chronic aerobic exercise.

In humans, Noel, Sak, Stone, and Frantz (1972) found that running stimulates increases in both prolactin and growth hormone. Colt, Wardlaw, and Frantz (1981) demonstrated that running causes increased plasma B-endorphin in about one-half the subjects tested; during repeat runs at higher intensity, the increase in plasma B-endorphins are considerably augmented. The secretion of these pituitary hormones is known to be influenced by the hypothalamic neurotransmitters, 5-HT, dopamine (D.A.), and N.E. Thus, in humans, there is indirect evidence of exercise-induced alterations in these intracerebral monoamines.
It is of extreme importance to note that alterations in these monoamines are implicated in the pathogenesis of affective disorders such as depression (Schildkraut, 1967). Sleep, food intake, thirst, pain threshold, and other autonomic functions are influenced by these monoamines (Reichlin, 1974) which are suspected to mediate the effects of antidepressant drugs (Palmer, Robinson, Manian, & Salser, 1972). Interestingly, there is evidence that running causes alterations in these monoamines, thus, once again, it is tempting to postulate a unifying intracerebral monoamine hypothesis to explain the known psychological consequences of running.

Clearly, many questions remain concerning the specific role of the neurotransmitters and neuromodulators in mediating the responses to aerobic exercise (jogging/running). The existing data are provocative, and future research may implicate the catecholamines as important components of the exercise response. Therefore, it becomes necessary to further establish a rationale for jogging/running as either an adjunct to existing forms of therapy, or as a treatment in and of itself for disorders such as decrements in self-concept, debilitating anxiety, and depression.

Running—A Rationale for Use as a Treatment Strategy

Despite the variety of approaches, problems of experimental or clinical verification of the efficacy of running therapy are immense. Some disorders being treated--
depression, decrements in self-concept, and anxiety for example, are often difficult to diagnose reliably. For example, depression can be a disorder in itself, a symptom secondary to another malady, or a normal response to misfortune. Similarly, anxiety is found in a variety of psychiatric conditions, and all three (self-concept, anxiety, and depression) are more often than not interrelated. Another difficulty is the necessity of controlling for the naturally remitting course of these disorders for which running possibly cures. Finally, a problem exists in establishing a causal connection between running and the proposed therapeutic benefits. A major question in research literature asks whether the findings of the therapeutic effects of running are the results of chance, experimenter bias, a nonspecific aspect of intervention, or do they represent the actual effects of this type of exercise. Currently, none of the research avoids all of these pitfalls; these studies are preliminary efforts to delineate whether running is an effective therapy, and, if so, the mechanisms of its action (Sacks & Sachs, 1981).

In Western society, general practitioners manage such problems as depression, anxiety, and decrements in self-concept (Shepard, Coppen, Brown, 1977). While benzodiazepines have become a mainstay in the management of anxiety (Blackwell, 1973), there is no comparable medication for the treatment of poor self-concept and/or mild to moderate
depression. The latter two disorders are typically managed with supportive psychotherapy until spontaneous remission occurs. Although there exists some evidence supporting the use of tricyclic antidepressants in moderate (neurotic or reactive) depression (Klerman, Dimascio, & Weisman, 1974; Lipman & Covi, 1976), most clinicians do not prescribe these drugs for moderate depression because of the dangerous side effects. According to recent research (Folkins & Sime, 1981), aerobic jogging/running could provide an alternative somato-psychic treatment for minor to moderate depression which can be made available at low cost to large numbers of patients.

While there exists something of a backlash of criticism against jogging/running by some who do not run or have run in such a way that it is unpleasant, running is actually a natural phenomena. Jogging and running are eminently natural activities for human beings, and most people can find satisfaction and even pleasure in having their bodies function in this regular rhythmical activity (Griest, Klein, Bischens, & Faris, 1979). Since this activity is learned as a part of our normal growth and development, and mankind can continue jogging/running as long as the existence of physical disabilities are absent, it can legitimately fulfill many purposes. Running/jogging can be done at any time of the year, in almost any weather, indoors and out. It can occur in groups or individually and at a pace that is comfortable for almost anyone.
When compared to psychotherapy as a possible treatment for such things as depression, anxiety, and poor self-concept, running/jogging is much more cost effective. If one assumes 10 sessions, a reasonable average for outpatient psychotherapeutic treatment, and that psychotherapists charge a minimum of $50.00 per session, the relative cost for treatment of one patient is $115.00 for running versus $500.00 for psychotherapy (Sacks & Sachs, 1981). If the treatments are equally effective in terms of outcome (Folkins & Sime, 1981) running/jogging is approximately four times more cost effective as a treatment.

To further substantiate running/jogging as a viable treatment strategy, Folkins, Lynch, and Gardner (1972) demonstrated that subjects in the poorest physical and psychological condition show the greatest improvements. Gutin (1966) also concluded that the beneficial psychological gains of physical fitness via running, are most pronounced in those individuals with the lowest initial physical fitness scores. Ismail and Tractman (1973) studied a group of 60 middle-aged men who jogged three times per week for 12 weeks. High and low fitness groups showed significant increases in emotional stability, creativity, and self-sufficiency after completion of the program. The low fitness subjects approached the pretest scores of the high fitness group on all measures following fitness training. This suggests that unfit individuals begin to approach fit individuals in
certain psychological characteristics and functioning as a result of progressive exercise training via running. In general, the more deconditioned people are, the less "normal" their psychological profiles, and the more change they demonstrate as they achieve an improved level of physical fitness by running. Thus, there exists further evidence for the rationale that running is an effective treatment strategy.

Running also has beneficial side effects in contrast to some chemotherapeutic alternatives where adverse side effects can be deleterious. Running as a treatment also emphasizes the role each patient can play in treating psychological disorders and maintaining health—thereby utilizing the greatest untapped resource available—the patient.

In summary, running/jogging has been advanced as a treatment for a variety of psychological maladies. For the most part, however, the information from these studies is merely suggestive. "Improvement" can often be attributed to the Hawthorne effect, or to "regression toward the mean." Furthermore, very few studies have used rigorous cardiovascularly-oriented fitness training. It is the purpose of the proposed study to examine the relationship of changes in cardiovascular fitness as related to dependent measures of self-esteem, depression, and anxiety.

Self-Esteem

The research with the greatest payoff focuses on fitness training and dependent measures of self-concept (Folkins &
Sime, 1981). Researchers in this area generally assume a "self-as-object" meaning for self, that is, a person's attitudes and evaluations of their self-body traits, abilities, and the like (Folkins & Sime, 1981). Changes in the body (e.g., from fat to lean mass) as a result of fitness training could reasonably be expected to alter one's body image, which is highly correlated with and expected to radiate to self-concept (Zion, 1965) and affect (Goldberg & Folkins, 1974).

The importance of self-concept cannot be overemphasized in relation to the individual's intrapersonal and interpersonal spheres of functioning. A poor self-concept is usually equated with undesirable psychological entities which result from an individual's negative view of himself in relation to the world.

Collingwood and Willett (1971) report that an increase in physical fitness facilitates a more positive self-concept and body attitude. These authors suggest that physical training is a vehicle to increase physical fitness and may function as a key therapeutic mode for rehabilitating psychological problems. Anderson (1979) further contends that through physical activity man develops a greater sense of confidence in his body. In addition, many decisions in the civilized world are determined by assessments based on the law of survival of the fittest (Anderson, 1979). Hence,
the determination of many decisions occur after cognitive assessments of power; contests for which the physically fit individual may feel more prepared.

In a review of the literature on fitness training and self-concept, Layman (1974) reports that "of seven studies involving tests of self-concept before and after a physical development program, four reported improvement in self-concept or body image" (p. 43). Research since this review generally confirms the assumption that fitness training improves self-concept (McGowan, Jarman, & Pedersen, 1974; Leonardson, 1977; Goldberg & Polkins, 1974; Bruya, 1977; Leonardson & Garguilo, 1978; Hilyer & Mitchell, 1979). Therefore, self-concept can greatly affect the way a person dresses and presents himself, the degree of comfort in social situations, the level of confidence and performance sexually, and ultimately the entire scope of his interpersonal relationships.

For example, poor self-esteem or self-concept can adversely affect or exacerbate existing negative psychological states—such as anxiety. Berg and Smallwood (1974) maintain that a person's self-esteem is intimately tied to the way in which the body is perceived, and that low body cathexis is associated with anxiety in the form of disease. According to Secord and Jourard (1953), an individual's attitudes toward the body (a body cathexis) is of crucial importance because negative feelings about the body are associated with
anxiety and insecurity involving the self. Therefore, there appears to be an inverse relationship between self-concept and anxiety.

**Anxiety**

Much of the research relating fitness training to various affective states focuses on stress emotions, especially anxiety. Selye (1974) maintains that stress is often channeled destructively into distress of anxiety. Selye (1974) suggests that as modern man frequently responds to real or perceived personal threats with the "fight or flight" syndrome, anxiety remains in the individual's interior milieu cathecting energy and producing somatic fatigue, headaches, ulcers, asthma, low back pain, and heart disease. He believes that a regular program of exercise creates a cross-resistance to various forms of pathogenic anxiety. This concept contends that benefits accrue as a result of alternative types of activity, in order to prevent any one organ system from experiencing an undue amount of reactivity caused by anxiety.

It is logical to assume that fitness training produces positive effects in relation to an individual's capacity to effectively deal with anxiety. The rationale for using physical exertion to lower anxiety is threefold: first, exertion is an active, assertive, and competing response to anxiety; second, physical exertion is the natural consumption of physiological arousal and tension; and third, sufficient
exertion can partially exhaust and inhibit the capacity for further anxiety arousal. According to deVries (1968), men involved in a 24-week running program decreased by 25% their muscular electrical activity (measured by an electromyographic-EMG) defined as tension. Reduced tension may serve as a significant feedback cue for an individual to rate himself as less anxious. Therefore, anxiety appears to be inversely related to the relaxation response. Chapman and Mitchell (1965) reported that the physically fit individual responds to anxiety with greater cardiac stroke volume rather than with increased heart rate. They further stated that the stroke volume method of accommodating anxiety is more efficient because it is associated with fewer anxiety associated cues, for example, a racing heart.

Driscoll (1976) agrees that fitness training significantly reduces anxiety. He found that subjects suffer from anxiety onsets before significant events. In this study, the greatest decrements in anxiety occurred in a group that combined pleasant thoughts with exercise. According to Anderson (1979), the average person's anxieties about health and aging are usually not acute, but are chronic because the anxieties are present on some level of consciousness at all times. Again, it is suggested that physical activity serves to allay anxiety—especially anxiety associated with health and aging, since fitness training is a positive action that
reverses problems associated with aging and poor health. Therefore, anxiety may operate on many dimensions simultaneously.

Schwartz, Davidson, and Coleman (1978) state that anxiety is not a diffuse undifferentiated internal state, but rather reflects a pattern of specific psychophysiological processes having significant implications for the assessment and treatment of affective disorders. Thus, they state that anxiety is multidimensional and consists of cognitive/psychic and somatic components. These authors suggest that while physical exercise has been found to reduce global anxiety, such activity would primarily lead to reductions primarily in somatic anxiety with less of an effect on the cognitive dimension.

In a series of studies, Morgan & Horstman (1976) assessed anxiety by means of the Spielberger State-Trait Anxiety Inventory (STAI) before and after vigorous exercise. They found state anxiety actually fell below the preexercise baseline with moderate to heavy exercise, whereas no drop was found after light exercise. When 15 adult males ran aerobically for 15 minutes, anxiety decreased below the baseline immediately after running and remained diminished for some time. Six male anxiety neurotics and six normal males were tested before and after maximal treadmill running to complete exhaustion, and a similar finding resulted. Neither anxiety nor symptoms were present in either group. Thus, vigorous
aerobic exercise reduces state anxiety as measured by the STAI in both normals and anxiety neurotics (Morgan et al., 1976).

Research demonstrates that brief or high doses of exercise relieves state anxiety. DeVries and Adams (1972) state that exercise "has a significantly greater effect upon resting musculature, without any undesirable side effects, than does meprobamate" (p. 140). These authors recommend exercise as a reasonable treatment modality when a tranquilizer effect is desired.

Selye (1972) states that, at times, anxiety is transformed into frustration or futility and the result is an emotional energy drain manifested in the form of depression. Such information supports psychosomatic research which indicates that physical changes occur from continued psychological states; it seems logical to assume the reverse: Psychological changes result from physical states, such as fitness. Again, Harris' (1978) somatopsychic theory is supported, this time for the treatment of anxiety disorders. In addition, Selye (1974) proposes that anxiety can be transformed into depression, which also seems to be positively affected by exercise, especially running.

Depression

The depressed patient is characterized primarily by physiological and psychomotor retardation, and complains of the inability to perform physical activities requiring
minimal physical exertion (Morgan, Roberts, Brand, & Feinerman, 1970). Indeed, it seems that the depressed state is the antithesis of the sense of well-being sensation reported earlier (Brunner, 1969; Mann, Garrett, Farlic, Murray, & Billings, 1969; Morgan, 1969). For this reason, it seems that the relationship between depression and physical exercise should be investigated further.

Current research suggests that sustained aerobic exercise (running) is a viable treatment for depression. Early research by Cureton (1953, 1963) on the psychological effects of regular physical exercise has subsequently been supported by several researchers (Folkins, 1976; Ismail & Young, 1973; Lion, 1978; Sharp & Reilly, 1975). In these studies, psychological gains—including, decrements in depression and anxiety, and increases in self-concept—were associated with structured physical activity. Morgan (1970) states that surveys have indicated that approximately 50% of all medical and surgical patients suffer from emotional disorders. Furthermore, about 60% of these disturbances manifest as depressive reactions.

With the recent interest in running, it is not surprising to find many researchers using this type of exercise in their investigations (Nowlis & Greenberg, 1979). Jogging was used in conjunction with, and compared to psychotherapy in treating depression (Greist, et al., 1979). Greist et al. (1979) found jogging prescription as effective as psychotherapy in overcoming depressive symptoms. In a similar study, Folkins
(1976) found that subjects who participate in three exercise sessions per week for 12 weeks, experience significant decrements in both depression and anxiety. Blue (1979) found depressed patients experience decreases in depression on the Zung Self-Rating Depression Scale (Zung, 1965) following a 60-week aerobic running program established by Cooper (1972). Blue (1979) hypothesizes that running may produce anti-depressant properties for many people with varying degrees of depression.

Finally, a study conducted in Poland (Rajewski, Strayzewski, Kapelski, et al., 1978) indicates that exercise has psychological benefits for clinically depressed patients. The patients in this study were 30 subjects diagnosed as endogenously depressed; 15 of these depressions developed during the course of manic-depressive psychoses; and 15 were periodic depressives. The activity consisted of various gymnastic and agility exercises lasting 30 minutes every morning for three weeks. Both before and after the exercises, patients were administered various psychological tests of depression and tests of CNS reactivity. A comparison of pre- and postexercise scores indicate a significant improvement in mood and CNS reactivity. The authors summarize the "psychomotor exercises conducted among patients with endogenous depression causes an improvement in their psychological condition and increases the reactivity of the CNS and regulatory vegetative capacity" (Rajewski et al., 1978, p. 381).
Again, exercise is reported to significantly decrease depression and its symptoms and is further substantiated as a viable treatment modality. According to Greist et al. (1979), running as a treatment for depression shares many features with other medical treatments. That is, it is effective for some, but not all cases of mild and moderate depression. Its usefulness in the treatment of major depression has not been researched adequately but fortunately, other effective treatments for the severe disorders are available.

**Purpose**

The purpose of the present study was to investigate the relationship between an experimental Running Group (RG), a Corrective Therapy (CT) group, and a Waiting List Control (WLC) group on dependent physiological and psychological measures of cardiovascular fitness, depression, self-esteem, and anxiety. The physiological measure for cardiovascular fitness was the time required to complete the 1.5 mile run (Cooper, 1972). The psychological dependent measure for depression was the summed values of items on the Zung Self-Rating Depression Scale (SES) (Zung, 1965). The psychological dependent measure for self-esteem was the score on the Rosenberg Self-Esteem Scale (RSES) (Rosenberg, 1965). The psychological dependent measure for anxiety was the summed value on the state portion of the State-Trait Anxiety Inventory (STAI) (Spielberger, 1969).

Hence, there was one physiological dependent measure and there were three psychological dependent measures.
In addition, the present study used a physiological measure to investigate morphological changes as a result of the experimental and CT treatments. This measure for body composition was determined by millimeters of subcutaneous body fat as indicated by Lange Skin Fold Calipers (Wilmore, 1977).

Finally, psychophysiological measures for anxiety were investigated by changes in muscular electromyographic activity and digital skin temperature readings. Neither the psychophysiological nor body composition measures were included in the formal hypotheses. Both psychological and physiological measures were performed to investigate the multidimensionality of anxiety suggested earlier by Schwartz et al. (1978).

It was hypothesized that for the RG there would be a significant decrease in times to complete the 1.5 mile run. It was also hypothesized that Zung Self-Rating Depression Scale scores would decrease significantly more in the RG than in the CT or WLC groups. In addition, it was hypothesized that the scores on the Rosenberg Self-Esteem Scale would increase significantly more in the RG than in the CT or WLC groups. Finally, it was hypothesized that the scores on the State-Trait Anxiety Inventory, state portion, would decrease significantly more in the RG than in the CT or WLC groups.
Method

Subjects

Twenty-five males participating in the Memphis, Tennessee, Veterans Administration Medical Center, Day Treatment Center served as subjects for the present study. The diagnoses for these subjects was heterogeneous (primarily schizophrenic, manic-depressive, and major affective disorders), and the ages ranged from 25 to 60 years. These 25 subjects from the Day Treatment Center (DTC) were randomly assigned to either the Running Group (RG) or Corrective Therapy (CT) group. In addition, 10 subjects were recruited from the Memphis, Tennessee, Veterans Administration Medical Center, Mental Hygiene Clinic to serve as the Waiting List Control (WLC) group. The subjects in the WLC group were heterogenous with respect to diagnosis, cardiac risk factors, age, and sex. Twenty-seven subjects completed the study. There were nine subjects remaining in each of the three groups at the end of the study.

Subjects from the DTC were informed that the length of time required of them for participation would be one hour, three times per week, for eight weeks. All subjects signed two informed consent forms (Appendix A and Appendix B) which indicated that they agreed to release the experimenters and the Veterans Administration from liability. In addition, this form explicitly informed each subject of the degree of participation required and the risks involved, and all
subjects understood that they could remove themselves from the study at any time without negatively affecting their treatment. Each subject in the Experimental Group participated in the 1.5 mile run (Cooper, 1972) three times during the study (pre-, mid-, and post). Each subject in the Experimental Group and CT Group were measured for body composition twice during the study (pre- and post), and were measured by frontalis EMG placement and Digital Skin Temperature three times during the study (pre-, mid-, and post). Subjects in all three groups completed the SDS, RSES, and STAI (state portion) before and immediately following the study. All subjects in the Experimental Group received thorough medical screening by a staff cardiologist at the Memphis, Tennessee, Veterans Administration Medical Center. The criterion for subjects in both the Experimental and CT Groups to be dropped from the study included three consecutive misses or a total of six misses during the eight-week period.

**Experimenters**

Two males and one female were used as experimenters in the present study. The female experimenter was a clinical nurse specialist. One male experimenter was a psychology intern and the other held a Ph.D. degree and was a licensed Clinical Psychologist. All experimenters received a minimum of 10 hours supervision and didactic presentation on exercise prescription by a member of the American College of Sports Medicine (ACSM). All experimenters were experienced runners.
Instruments

The 1.5 mile run (Cooper, 1972) was a measure of cardiovascular fitness. It consisted of having subjects complete a distance of one and one-half miles as quickly as possible without creating undue discomfort. Subjects were timed during the 1.5 mile run. The total time it took each subject to complete the distance was used as an indices of varying levels of fitness. The 1.5 mile run was conducted on all subjects in the experimental group pre-, mid-, and posttreatment. The 1.5 mile run has been used frequently in research settings, and is one of the most valid and reliable "field-test" methods of determining varying levels of cardiovascular fitness (Wilmore, 1977). There are more sophisticated measures for cardiovascular fitness, such as submaximal or symptom limited stress testing. However, the 1.5 mile "fieldtest" method was used because of limited resources in the form of treadmills and professionals adequately trained to administer and interpret the protocol.

The Zung Self-Rating Depression Scale (SDS). This is a liker-type scale consisting of 20 items (Zung, 1965). This was a self-administered instrument which measured the most commonly found characteristics of depression. The instrument was given pre- and posttreatment to all three groups in order to measure changes in depression. This scale was scored by
summing the ratings across questions, after reverse scoring for items that contraindicate depression. Higher scores were indicative of more depression.

Zung (1965) reported that scale indexes for depressed patients ($\bar{X} = 0.74$), other psychiatric patients ($\bar{X} = 0.53$), and a normal control group ($\bar{X} = 0.33$) were significantly different. Additionally, the mean index rating for each group fell in the expected direction. The reliability measures are based on internal consistency with alpha ranging from .65 to .75. The validity of the SDS was established with the Minnesota Multiphasic Personality Inventory depression scale ($r = .65$).

The Rosenberg Self-Esteem Scale (RSES). This is a liker-type scale consisting of 10 items (Rosenberg, 1965). This was a self-administered instrument which measured a subject's basic feelings of self-worth. The instrument was given pre- and posttreatment to all three groups in order to measure changes in self-worth. Rosenberg stated that in comparison to other self-concept-self-esteem instruments, the RSES has profited from a substantial amount of attention to scale development and psychometric evaluation. The author reported a test-retest reliability coefficient of .85. Face validity has been established through empirical validation of the predictions that people with low self-worth scores appear
depressed to others and express feelings of discouragement; manifest symptoms of anxiety; hold a low socioeconomic status; and command less respect from others.

In scoring the RSES, numerical values from one to four were assigned to each statement. These numerical values were summed to yield the subject's self-esteem score. The higher the score, the greater was the subject's self-esteem. In the present study, the RSES scores were used as measures of self-worth.

The State-Trait Anxiety Inventory (STAI). The STAI has two forms, the state measure and the trait measure (Spielberger, 1969). The state portion of this instrument was used to measure the situational feelings of anxiety before treatment and immediately following treatment for all three groups. The state portion consists of 20 self-report questions regarding anxiety. The median correlation for males is .47. The reliability measures are based on internal consistency with alpha ranging from .83 to .92. The validity of the STAI was established with the Taylor Manifest Anxiety Scale \( r = .80 \), and the Affective Checklist \( r = .54 \). Scoring the STAI consisted of assigning numerical values from one to three to the ratings of each statement. These numerical values were summed to yield the subject's state anxiety score. Higher scores were indicative of greater anxiety.

The Electromyographic Assay and Digital Skin Temperature (EMG and DST). An EMG assay and DST were performed on all
experimental and CT subjects. The EMG equipment consisted of an *AutoGen Feedback Myograph* model number 1500, manufactured by Autogenic Systems, Inc. The DST equipment consisted of a *TELE THERMOMETER* model number 43TA, manufactured by Yellow Springs Instrument Company, Inc., Yellow Springs, Ohio. The EMG and DST were used as investigatory psychophysiological measures of anxiety. The EMG was measured in microvolts, and the DST was measured in degrees Fahrenheit; both measures were performed pre-, mid-, and posttreatment on the Experimental and CT Groups.

The EMG electrodes were placed over the frontalis muscle (forehead). Two electrodes were placed approximately one inch above the eyebrows directly in line with the subject's pupils. The third electrode (ground) was placed equidistant between the two aforementioned electrodes, approximately two inches above the eyebrows. Reliability measures were performed to insure valid readings of activity in the frontalis muscle, as well as to insure proper functioning of the equipment. The EMG equipment was calibrated at the factory and was checked by a technician before the study. A latency reading six minutes following the fifth two-minute reading was performed on each subject to determine if changes might be due to a relaxation effect. Readings were taken every two minutes for a ten-minute period pre-, mid-, and posttreatment. Thus, each measure pre-, mid-, and post consisted of an average of five readings taken every two minutes.
The DST thermoster was placed on the middle digit opposite the fingernail of each subject's left hand. Readings were taken every two minutes over a ten-minute period at the same time the EMG readings were taken. The DST readings were taken pre-, mid-, and posttreatment. These measures were not taken on the WLC Group. These subjects were required to come in to the Veterans Administration Medical Center periodically for medication checks and were not willing to have these measures performed on them.

The Body Composition Assessment (BCA). This method, performed with Lange Skin-Fold Calipers, determined the percent body fat of each subject in the Experimental and CT Groups. This measurement was performed by the principal investigator who was experienced in this method of determining body composition. This procedure consisted of "pinching" and separating subcutaneous fat from lean mass at three anatomical sites (midway between the tip of the shoulder and the nipple, immediately adjacent to the navel, and midthigh). All measurements were taken on the right side of the body. The percent fat was measured in millimeters and the three readings were summed and divided by three in order to yield percent body fat.

The skin fold method of determining body composition is the most accurate field assessment technique and correlates .90 with hydrostatic weighing (McArdle, Katch, and Katch, 1981). The BCA was performed on each subject in the
Experimental and CT Groups pre- and posttreatment. The greater the mean readings as measured in millimeters, the greater the percentage of body fat. Again, this measure was not performed on the WLC Group due to their unwillingness to make extra trips to the Veterans Administration Medical Center.

Procedure

Subjects from the DTC were randomly assigned to either the Experimental Group or the CT Group. Subjects participating in these two groups were stabilized on their respective types and dosages of medication (refer to Appendix C) two weeks prior to the study and maintained on type and dosage until posttesting was completed. Subjects who could not be stabilized with respect to type or dosage of medication were allowed to continue in the study, but their data was not used in the final analysis so as not to contaminate or confound the results. All subjects who participated in either the CT or Experimental Group received extensive medical screening and signed informed consent forms before beginning treatment.

Subjects recruited from the Mental Hygiene Clinic were used as the Waiting List Control (WLC) Group. These subjects were informed that in 10 weeks they could participate in either the Experimental or CT Group if they so desired.

Running Treatment

A running leader (one of the experimenters) met the subjects three times per week (Monday, Tuesday, and Thursday) in the morning at 8:30 a.m. The leader instructed
the experimental subjects through a series of flexibility exercises for 15 minutes prior to the running treatment. Following this session, subjects in the Experimental Group walked/jogged/ran for a period of 30 minutes, at a target heart rate of 60% of their respective maximum heart rates. Target heart rates were calculated by subtracting the subject's age from 220, and multiplying the remainder by 60% (Wilmore, 1977). This was a conservative estimate of a target heart rate when compared to other methods. However, all subjects were well above their respective target heart rates (10% to 15%) when checked by the experimenters. The 15-minute session of flexibility exercises was repeated at the end of the run in order to minimize the risk of musculoskeletal injury or soreness. During each running session, the leader insured that patients were moving at a comfortable pace by constantly monitoring their respiratory rates. Pace and distance were maintained on an individual basis to insure that each subject was at 60% maximum heart rate. Each subject was given his respective target heart rate and instructed on how to take his pulse during the running treatment.

The emphasis of the Experimental Group was on avoiding pain and fatigue by interspersing walking periods with runs of varying length. Any discussion during the runs focused on the running itself (footstrike, stride, arm carry, breathing, etc.). No discussion of emotional or psychological problems was encouraged or reinforced either during or after the running
session. If inappropriate affect or ruminations occurred during a running session, the leader suggested a sequential focus on breathing, the sound and feeling of footstrike, and an awareness of the spine being maintained in an erect position. This treatment lasted for an eight-week period.

Corrective Therapy

An activity leader was present (members of the Veterans Administration Rehabilitation Medical Staff) with the subjects on the same three days and during the same hour as the running sessions. The CT sessions lasted for one hour. The leader was present in the activity room which consisted of weights, ping-pong, a swimming pool, and a mat for standard calisthenics. The leader instructed the subjects in the CT Group through corrective therapy by having the subjects do 15 minutes of weight training at below submaximal effort. This was followed by 15 minutes of unstructured time in the pool, 15 minutes of ping-pong, and 15 minutes of submaximal calisthenics. The emphasis of the CT Group was enjoyment and recreation—not cardiovascular fitness. Pulse rates were monitored by the CT leader to insure that these subjects were not getting a cardiovascular training effect. No discussion of psychological or emotional problems was allowed. If any such discussion arose, the focus was placed on the activity by the leader. This treatment lasted for eight weeks. One of the experimenters was present periodically with the CT Group in order to insure compliance by subjects and activity leaders.
Waiting List Controls

These subjects were recruited from the Mental Hygiene Clinic and were homogeneous with regard to age, sex, medication, and estimated level of fitness, to subjects in the Experimental and CT Groups. All WLC subjects were told that either CT or running treatment would be available to them at the end of a 10-week period. All WLC subjects were pre- and posttested on the three psychological variables (SDS, RSES, and STAI).

Subject Inclusion Criteria

A. Patients participating in the DTC who desire to participate in the treatment group.

1. These patients must be asymptomatic with respect to coronary heart disease (CHD).

2. All subjects must be clinically stable or absent of CHD for 6 months or longer.

3. All patients who agree to participate as subjects in the treatment group will be screened by a cardiologist who will give attention to the following CHD risk factors:
   a. Hypertension
   b. Hyperlipidemia
   c. Electrocardiographic abnormalities
      - evidence of old myocardial infarction
      - Ischemic ST-T changes
- conduction defects
- left-ventricular hypertrophy

d. Predisposing problems
- family history of CHD before age 60
- Type A coronary prone behavior pattern
- Diabetes Mellitus
- obesity

Subject Exclusion Criteria

A. Patients participating in the DTC who do not wish to participate as a subject in the treatment group.

B. Acute myocardial infarction.

C. Dangerous arrhythmias (ventricular tachycardia or any rhythm significantly compromising cardiac function).

D. Congestive heart failure.

E. Severe aortic stenosis.

F. Suspected or known dissecting aneurysm.

G. Active or suspected myocarditis or cardiomyopathy (within the past year).

H. Thrombophlebitis.

I. Recent or active infectious episodes.

J. Recent embolism, systemic or pulmonary.

K. Extremely high doses of phenothiazine agents.

L. Any patient deemed unfit to participate by a cardiologist collaborating in the proposed study.
Design and Statistical Analysis

A one-way analysis of covariance was performed on all psychological dependent measures, with the pretest scores as the covariant, across the three groups. Dependent measures for this analysis were the summed scores from the SDS, the summed scores for the RSES, and the summed state scores from the STAI. A one-way analysis of covariance was also performed between the CT and Experimental Groups on summed millimeters of body fat, with the pretest readings as the covariant in both cases. In addition, a two-by-two analysis of covariance was performed on summed microvolts and degrees Fahrenheit in order to determine differences between the Experimental and CT Groups on EMG and DST, with the pretest readings used as the covariant in both cases. Finally, a one-way analysis of variance was performed on the time, as measured in minutes, necessary to complete the 1.5-mile run for the Experimental Group. A Newman-Keuls post-hoc analysis was performed with an alpha of .05 to compare all possible pairs of means following any significant F value in any of the above analyses.

Results

Physiological Measures

The effects of cardiovascular fitness as measured by the time necessary to complete the 1.5-mile run was performed only on the Experimental Running Group (RG). The method used to assess the differences in cardiovascular fitness was a one-way repeated measures analysis of variance, F(2,26) = 36.7177,
A Newman-Keuls post-hoc analysis revealed that posttest times (mean = 19.20 minutes) was significantly lower than pretest performances (mean = 24.31 minutes). While midtest performances were better than pretest times (mean = 20.40 minutes), they were not significantly improved (see Appendix D for means and standard deviations and Appendix E for adjusted means). The results in this analysis (Table 1, Appendix F) indicated that experimental subjects (RG) significantly improved their cardiovascular fitness during the course of the study.

The Body Composition Assessment was performed only on the RG and CT Groups. The effects of treatment on these two groups were analyzed using a one-way analysis of covariance with two levels and the pretest scores were used as the covariate. The results of this analysis, $F(1,15) = 1.395$, $p = .256$, revealed no significant differences between groups. Even though the RG adjusted mean was lower (mean = 20.54 millimeters) than the CT Group adjusted mean (mean = 21.13 millimeters) at the conclusion of the study (see Appendix D for means and standard deviations and Appendix E for adjusted means), the results of this analysis (see Table 2, Appendix G) demonstrated no significant effects of groups.

**Psychophysiological Measures**

The indices of psychophysiological functioning used in this study were performed only on the Experimental and Corrective Therapy Groups. These measures included frontalis EMG (a mean of five points sampled over 10 minutes), EMG
latency (a single measure taken six minutes later), and Digital Skin Temperature (a mean of five points sampled over 10 minutes). Data were gathered on these measures prior to treatment, midway through treatment, and following treatment. Accordingly, a separate two-way analyses of covariance were used to assess the effects of the two treatments (Experimental and Corrective Therapy Groups), and changes between the two times of measurement (pretest readings were used as covariants).

The two times of measurement were midtest and posttest readings.

The frontalis EMG of the RG (adjusted mean = 2.83 microvolts) was lower than that of the CT Group (adjusted mean = 3.89 microvolts). The graphic representation of these results is presented in Figure 1. The two-by-two analysis of covariance, using the pretest readings as the covariant, demonstrated that EMG readings for the RG were significantly lower than those of the CT Group, $F(1,15) = 4.56, p = .0497$.

The analysis of covariance of frontalis EMG data are summarized in Table 3, Appendix H, and means and standard deviations are shown in Appendix D, while adjusted means are listed in Appendix E. No significant changes occurred between midtest and posttest levels, nor was there a significant interaction.

The two-by-two analysis of covariance of EMG latency data is summarized in Table 4, Appendix I. The graphic representation is presented in Figure 1. Experimental subjects (RG) demonstrated lower overall readings (adjusted mean = 2.51 microvolts) than did those subjects in Corrective Therapy (adjusted mean = 3.38
Figure 1. Adjusted means in microvolts for EMG for the Corrective Therapy (CT) and Running Group (RG) and EMG latency for Corrective Therapy Group (CTL) and Running Group (RGL).
microvolts. An analysis of covariance with the pretest readings as the covariant, demonstrated significantly lower scores for subjects in the RG, $F (1,15) = 4.82, p = .0444$.

Moreover, scores dropped significantly, $F (1,15) = 7.11, p = .0169$, for both groups between midtests (adjusted Experimental Group mean = 2.90 microvolts, adjusted Corrective Therapy Group mean = 4.49 microvolts) and the posttests (adjusted Experimental Group mean = 2.51 microvolts, adjusted Corrective Therapy Group mean = 3.38 microvolts). Means and standard deviations are shown in Appendix D, while adjusted means are listed in Appendix E.

The effects of treatments on Digital Skin Temperature for the RG and CT Group were analyzed using a two-way analysis of covariance with the pretest scores as the covariant. The summary of this analysis is shown in Table 5, Appendix J. Means and standard deviations are listed in Appendix D, with adjusted means in Appendix E, and the graphic representation is presented in Figure 2. Experimental subjects (RG) demonstrated higher overall readings (adjusted mean = 92.46 degrees Fahrenheit) than did subjects in CT (adjusted mean = 88.34 degrees Fahrenheit), but the Groups were not significantly different, $F (1,15) = 2.28, p = .1517$. Skin Temperature readings increased for the RG between the midtest (adjusted mean = 92.10 degrees Fahrenheit) and posttest (adjusted mean = 92.46 degrees Fahrenheit) while skin temperature decreased for the CT Group between the midtest (adjusted mean = 89.52
Figure 3. Adjusted means in degrees Fahrenheit for Digital Skin Temperature
degrees Fahrenheit) and posttest (adjusted mean = 88.34 degrees Fahrenheit) however, the interaction was not significant, $F(1,16) = 1.21, p = .2878$.

**Psychological Measures**

Psychological measures included the Zung Self-Rating Depression Scale, Rosenberg Self-Esteem Scale, and the Spielberger State-Trait Anxiety Inventory (state portion). The psychological measures were given to the Experimental Group, the Corrective Therapy Group, and the Waiting List Control Group. These measures were given to all three groups immediately before and following the eight-week treatment period.

The effect of treatments on depression was measured by the scores on the Zung Self-Rating Depression Scale. The results were analyzed using a one-way analysis of covariance with the pretest scores as the covariant. The results of this analysis which are summarized in Table 6, Appendix K, indicated that running significantly decreased depression, $F(2,23) = 3.61, p = 0.43$. The means and standard deviations are shown in Appendix D, while adjusted means are listed in Appendix E. Therefore, the second hypothesis was partially supported. Comparison among adjusted group means with Newman-Keuls post-hoc analysis procedure using a corrected error term for analysis of covariance (Winer, 1971) indicated that the difference between the RG (adjusted mean = 45.99) and the WLC Group (adjusted mean = 51.67) was significant ($p < .05$). The CT Group
(adjusted mean = 47.12) was intermediate between, but not significantly different from either of the other two groups.

The effect of treatments on self-esteem was determined by the scores of the Rosenberg Self-Esteem Scale. The results were analyzed using a one-way analysis of covariance with the pretest scores as the covariant. The differences across groups were not in the expected direction with the Experimental Group (mean = 22.08) falling below both the Corrective Therapy Group (mean = 23.75), and the Waiting List Control Group (mean = 24.83). The results, summarized in Table 7, Appendix L, indicated that treatments had no significant effect on self-esteem scores, $F(2, 23) = .814$, $p = .455$. Therefore, the third hypothesis was not supported. Means and standard deviations are shown in Appendix D, while adjusted means are listed in Appendix E.

The effect of treatments on anxiety was determined by the scores on the Spielberger State-Trait Anxiety Inventory (state portion). The results were analyzed using a one-way analysis of covariance with the pretest scores as the covariant. The differences across groups were in the expected direction with the Experimental Group (mean = 38.92) lower than either the Corrective Therapy Group (mean = 42.76), or the Waiting List Control Group (mean = 38.98). Even though the results were in the expected direction, they were not significant, $F(2, 23) = 1.085$, $p = .354$, and research hypothesis 4 was accordingly rejected. The results are summarized in Table 8, Appendix M, and means
and standard deviations are shown in Appendix D, while adjusted means are listed in Appendix E.

**Discussion**

The results of this study demonstrated that the Experimental Running Group significantly decreased their times necessary to complete the 1.5 mile run over the eight-week treatment period. The significant difference between the pretest and posttest times on the 1.5 mile run indicated improvement in physical and cardiovascular fitness. These results confirmed hypothesis one, and without this effect interpretation of differences among groups on other dependent measures would be compromised. The 1.5 mile run was not conducted on the CT Group for comparison. The medical staff agreed to assess and approve only the RG due to limited staff and money.

Significant reduction in depression was found in the Running Group. That is, it was demonstrated that the Experimental Running Group experienced significant decrements in depression when compared to the Waiting List Control Group. These results partially confirmed the second hypothesis, but were weakened in that the Running Group did not significantly improve over the Corrective Therapy Group on depression scores. Depression scores for the Corrective Therapy Group were intermediate between those of the other groups suggesting the possibility of mild antidepressant effects of this intervention.
which were not as powerful as those found in the running treatment. Since most running treatments in the literature have lasted 12 weeks, perhaps more significant findings would have emerged had this study continued for an additional four weeks. The running treatment was clearly effective in reducing depression when compared to the no-treatment condition. Therefore, the running treatment was clinically (if not statistically) more effective in reducing depression than the corrective therapy treatment.

There were many reasons why this study was not extended from an eight to 12-week period. Perhaps the most obvious reason had to do with the nature of the setting and the patient population at the Veterans Administration Medical Center. Most of the patients were psychiatrically disabled from the Armed Forces and receiving varying amounts of cardiotoxic and hepatotoxic medications. Some of the patients were intermittently psychotic. These patients were considered at risk for strenuous exercise and had to be monitored by the medical staff closely. The physicians responsible for approving and subsequently assuming responsibility for their well-being agreed to cooperate only if the risks were minimized. Finally, all patients were receiving disability benefits because of their respective diagnosed psychiatric handicaps and were probably reluctant to demonstrate on paper and pencil tests improvements for fear of losing some of their benefits.
This component of the present study was at least to some degree, probably responsible for the lack of improvement on the other psychological dependent measures.

The results of the running treatment on self-esteem were in contrast with the aforementioned findings. The Running Group demonstrated no significant improvement in self-esteem when compared to the Corrective Therapy or Waiting List Control Group. Thus, hypothesis two was not supported. These results would have been surprising if the population had been less pathological. However in this case, the patient population consisted primarily of institutionalized veterans who, since their diagnosed disability, have not been able to function normally in society. These patients did not engage in activities (except those at the Day Treatment Center) which would build on their low sense of esteem. Additionally, some of their food benefits were cut by the Federal Government toward the end of the study which created conflict and seemed to leave many of them feeling confused and anxious. It is suspected that this cut in benefits made all patients in the present study even more reluctant to demonstrate improvements in psychological functioning.

The results of the running treatment on anxiety were also in contrast with those found on the dependent measure for depression. The Running Group demonstrated no significant decrements in anxiety when compared to the Corrective Therapy or Waiting List Control Groups. These results were not consistent
with studies mentioned previously. However, no previous study has used a similar population under the same circumstances. The rationale for hypothesizing decrements in anxiety in the Running Group was the subjects who participated in the running treatment would be more physically fit and subsequently would experience less anxiety. Morgan's (1970) study stated that state anxiety fell below preexercise baselines with moderate to heavy exercise, whereas no significant decrement was found after light exercise. Since the present study used very mild cardiovascular training, the results of the present study are consistent with the aforementioned. Further, the State-Trait Anxiety Inventory (state portion) measures anxiety from a perceptual perspective, and this could provide an explanation for the discrepancy between the significant findings of decreased anxiety as measured by the psychophysiological measures which will be discussed later. It would seem reasonable that when one experiences anxiety on a cognitive level, it might be difficult to experience high levels of self-esteem. If the experimenter in the present study had been able to control some of the confounding variables (e.g., decrease in benefits) and if frequency, intensity, and duration of exercise could have been increased, the patients involved in the running treatment may have demonstrated significant decrements in psychological anxiety.

The results of the psychophysiological measures of anxiety (EMG, EMG latency, and DST) demonstrated a significant
decrease in muscular tension between the running treatment and corrective therapy treatment on EMG readings. Therefore, the running treatment was significantly effective in reducing muscular tension while corrective therapy treatment was not. Accordingly, the assumption that aerobic conditioning (running) has a sustained relaxing effect was supported. Again, this evidence was in contrast with the findings on the psychological dependent measure for anxiety and suggests that highly anxious persons may experience less anxiety from a physiological perspective before experiencing less anxiety psychologically. Another explanation as suggested earlier, is that these patients did not want to demonstrate psychological improvement due to a fear of losing their benefits. The EMG was perceived as a medical treatment which was not threatening to these patients since they receive a myriad of medical treatments. Therefore, the results obtained from the EMG readings might be considered a more valid clinical indication of decreased anxiety associated cues than the psychological dependent measure. The running treatment definitely had a tranquilizing effect on the running subjects. This supports the statements of Morgan and Horstman (1976) who demonstrated that running has a greater tranquilizing effect on resting musculature than does meprobamate. These authors and others have suggested that running is a physical activity that serves to naturally consume the by-products of psychophysiological arousal and tension. They further asserted that physical exertion (like
running) partially exhausts the capacity for further anxiety arousal which is supported in the present study. It would have been helpful in the present study if Subjective Units of Determination (SUD) had been recorded before and after exercise in order to more effectively determine the degree of the tranquilizing effect that took place. Consequently, the running treatment appears to retain its status as one method of reducing some aspects of anxiety. These results supported the findings of Schwartz et al. (1978) who proposed the multidimensionality of anxiety. They found that exercise reduced the somatic components of anxiety while the cognitive component remained manifest.

The results of the running treatment on DST were not significant. DST was used as an additional psychophysiological method of assessing a physiological component of psychological anxiety. Slight increases in DST readings found in the Running Group were of clinical interest and in the desired direction, but the lack of statistical significance permits no firm conclusions about this effect. However, since patients in both the running treatment and corrective therapy treatment were on medications which have peripheral vasconstriction properties and all readings were taken in the winter (many patients had to walk outside for several hundred yards to the Day Treatment Center prior to readings), perhaps the results were contaminated.
The results obtained from measurements of body composition showed no significant reduction in percent body fat, suggesting that neither the running treatment nor the corrective therapy treatment was facilitative in significantly altering body composition over the eight-week experimental period. This outcome was not surprising in light of recent suggestions that in order to reduce percent body fat, one must exercise at least four times per week. In the present study subjects engaged in exercise only three times per week. Moreover, no dietary restrictions were placed on any of the subjects. Since all subjects were on some form of antidepressant or neuroleptic medication, any changes were not expected to be dramatic. Antidepressant and neuroleptic medications accelerate fat weight gains, and most patients have difficulty losing the fat weight unless they discontinue the medication. Even though the Running Group did not lose statistically significant percentages of body fat, they did lose more than the Corrective Therapy Group. Again, this is suggestive even though it was not a significant decrease statistically.

In the present study, an attempt was made to summarize existing literature dealing with the influence of exercise (especially running) on dependent measures of cardiovascular fitness, depression, self-esteem, and anxiety. Theoretical and experimental evidence was presented. While most of the literature suggested that running is associated with an
improved psychological state, there was a paucity of research attempting to identify the mechanisms underlying such improvements in humans. This has become increasingly understandable in light of the risks involved when doing research with humans. Considering the array of confounding variables inherent in this type of pursuit, the present investigator agrees that, while clinical evidence may be obtained, true experimental research using human subjects is extremely difficult (Folkins & Sime, 1981). The tacit assumption in the experimental research is that exercise is responsible for, or causes, the observable changes. Such an assumption was regarded with caution in light of the fact that few researchers to date have used physiological data in conjunction with psychological measures. The present study served to reveal some of the inherent problems which exist when using human subjects, especially subjects with a great deal of psychopathology and at high risk for physiological complications. However, the information and data obtained hopefully will serve to narrow the parameters of future research in this area.

The challenge for the present study was the adoption of psychophysiological measurements for self-esteem and anxiety (BCA, EMG, and DST respectively) in concordance with psychological measurements of the same (including depression). Unfortunately, physiological measures for depression for the
present study were considered too variable, invasive, and dangerous for this population.

The purpose of this two-dimensional approach was to further substantiate the theory that mind and body cannot be separated when treating patients in clinical settings. It is felt that the present study does support Harris' (1978) somatopsychic theory in that behavior defined as exercise does affect emotional functioning. Moreover, it continues to be the contention of the present investigator that physiology and psychology are intimately interrelated. The results of the present study will hopefully open the door for more extensive research in this area. Further, the results of the present study offer some support for the philosophy of Health Psychology. That is, Health Psychology focuses on a holistic approach to the treatment and prevention of psychophysiological disorders as opposed to a unidimensional approach, oriented only toward symptomatic remediation.

In conclusion, the present study used a two-dimensional approach to investigate the effects of a running program on dependent measures of depression, anxiety, and self-esteem. Even though running proved to be effective in reducing depression and producing decrements in somatic anxiety, it was not an effective treatment for improving self-esteem or reducing cognitive anxiety within this population. Even though further research needs to be conducted in this area, it appears that a running program can be an effective
therapeutic modality in a psychiatric setting, especially if the intensity and frequency of exercise could be increased. It is suggested that future research might focus on the parameters of an exercise prescription for this population.
Appendix A

Research Consent Form

The Effects of Aerobic Exercise and Corrective Therapy on the Quality of Life

This is a research project designed to examine how a running/jogging or corrective therapy program influences the quality of your life. This project will last approximately eight weeks. If you agree to participate, you will be asked to complete four psychological inventories at the beginning and end of treatment. These inventories will show a change (if a change exists) in your psychological functioning regarding anxiety, depression, self-esteem, and generally how you view your world. In addition, you will be asked to give a blood sample (one vial) and will be connected to equipment measuring electrical activity in your muscles. These procedures will also be conducted at the beginning and end of the study and will yield information about how the jogging or corrective therapy is affecting you physically. Finally, you will be asked to complete (whether you walk or jog) one and one-half miles at the beginning or end of the study in order to measure how physically fit you are.

If you are assigned to the running group, you will jog or fast walk for approximately 30 minutes and stretch for another 30 minutes. If you are assigned to the corrective therapy group, you will swim, work with weights, and do exercises (push-ups, sit-ups, etc.) for approximately one hour.

On rare occasions, persons who exercise strenuously develop complications. Some of these complications include: heart problems; heat related problems; dizziness; cramps; and other difficulties involving the lungs and circulation. The researchers will take every possible measure to reduce the likelihood of any health-related complications, and will answer any questions to your satisfaction.

This study is designed to improve the quality of your life and currently no alternate treatment is available that the experimenters are aware of. At the completion of this study, you will be able to continue the exercise therapy without supervision, however, you may want to continue participating with the Day Treatment staff.
You may choose not to answer some questions on the psychological inventories or, if you decide that you no longer want to participate in the study, your treatment at the Day Treatment Center/Mental Hygiene Clinic will not be compromised in any way. Any and all questions regarding the study or any of its components will be answered to your satisfaction. Names will not be used on any of the experimental data in order to insure confidentiality.

I understand completely the conditions required and agree to participate in the above study, releasing from any liability the Veterans Administration Medical Center and the experimenters.

Signed: ____________________________  Date: ___________

Witness: ____________________________

Experimenter: ____________________________
Appendix B

Part 1-Agreement to Participate in Research
By or Under the Direction of the Veterans Administration

1. I, ____________________________, voluntarily
   (Type or print subject's name)
   consent to participate as a subject in the investigation
   entitled ____________________________
   (Title of Study)

Program on Self-Esteem, Anxiety, and Depression

2. I have signed one or more information sheets with this
   title to show that I have read the description including the
   purpose and nature of the investigation, the procedures to
   be used, the risks, inconveniences, side effects and benefits
   to be expected, as well as other courses of action open to
   me and my right to withdraw from the investigation at any
   time. Each of these items has been explained to me by the
   investigator in the presence of a witness. The investigator
   has answered my questions concerning the investigation and I
   believe I understand what is intended.

3. I understand that no guarantees or assurances have been
   given me since the results and risks of an investigation are
   not always known beforehand. I have been told that this in-
   vestigation has been carefully planned, that the plan has
   been reviewed by knowledgeable people, and that every rea-
   sonable precaution will be taken to protect my well-being.

4. In the event I sustain physical injury as a result of
   participation in this investigation, if I am eligible for
   medical care as a veteran, all necessary and appropriate care
   will be provided. If I am not eligible for medical care as
   a veteran, humanitarian emergency care will nevertheless be
   provided.

5. I realize I have not released this institution from
   liability for negligence. Compensation may or may not be
   payable, in the event of physical injury arising from such
   research, under applicable federal laws.

6. I understand that all information obtained about me
   during the course of this study will be made available only
   to doctors who are taking care of me and to qualified in-
   vestigators and their assistants where their access to this
   information is appropriate and authorized. They will be
bound by the same requirements to maintain my privacy and anonymity as apply to all medical personnel within the Veterans Administration.

7. I further understand that, where required by law, the appropriate federal officer or agency will have free access to information obtained in this study should it become necessary. Generally, I may expect the same respect for my privacy and anonymity from these agencies as is afforded by the Veterans Administration and its employees. The provisions of the Privacy Act apply to all agencies.

8. In the event that research in which I participate involves certain new drugs, information concerning my response to the drug(s) will be supplied to the sponsoring pharmaceutical house(s) that made the drug(s) available. This information will be given to them in such a way that I cannot be identified.

I

NAME OF VOLUNTEER

HAVE READ THIS CONSENT FORM. ALL MY QUESTIONS HAVE BEEN ANSWERED, AND I FREELY AND VOLUNTARILY CHOOSE TO PARTICIPATE. I UNDERSTAND THAT MY RIGHTS AND PRIVACY WILL BE MAINTAINED. I AGREE TO PARTICIPATE AS A VOLUNTEER IN THIS PROGRAM.

9. Nevertheless, I wish to limit my participation in the investigation as follows:

VA FACILITY

SUBJECT'S SIGNATURE

WITNESS'S NAME AND ADDRESS

WITNESS'S SIGNATURE

INVESTIGATOR'S NAME

INVESTIGATOR'S SIGNATURE

SUBJECT'S IDENTIFICATION

SUBJECT'S ID NO. WARD
Appendix C

Patient Medications Listed by Groups

<table>
<thead>
<tr>
<th>Subject</th>
<th>Medication</th>
<th>Amount/Route</th>
<th>Frequency</th>
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<tr>
<td>1</td>
<td>Thorazine</td>
<td>200 mg PO</td>
<td>hs</td>
</tr>
<tr>
<td></td>
<td>Artane</td>
<td>5 mg PO</td>
<td>B.i.D.</td>
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<tr>
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<td>Prolixin</td>
<td>1cc IM</td>
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<tr>
<td>2</td>
<td>Ludiomil</td>
<td>200 mg PO</td>
<td>hs</td>
</tr>
<tr>
<td></td>
<td>Stelazine</td>
<td>10 mg PO</td>
<td>Q.i.D.</td>
</tr>
<tr>
<td>3</td>
<td>Prolixin</td>
<td>2 cc IM</td>
<td>q 2 weeks</td>
</tr>
<tr>
<td></td>
<td>Cogentin</td>
<td>2 mg PO</td>
<td>B.i.D.</td>
</tr>
<tr>
<td></td>
<td>Elavil</td>
<td>25 mg PO</td>
<td>hs</td>
</tr>
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<td>Thorazine</td>
<td>100 mg PO</td>
<td>hs</td>
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<tr>
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<td>Lithium</td>
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<td>Haldol</td>
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<td>hs</td>
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<td>Cogentin</td>
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<td>hs</td>
</tr>
<tr>
<td></td>
<td>Lithium</td>
<td>600 mg PO</td>
<td>B.i.D.</td>
</tr>
<tr>
<td></td>
<td>Cogentin</td>
<td>2 mg PO</td>
<td>B.i.D.</td>
</tr>
<tr>
<td>7</td>
<td>Thorazine</td>
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<td>hs</td>
</tr>
<tr>
<td>8</td>
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<td>hs</td>
</tr>
<tr>
<td>9</td>
<td>Thorazine</td>
<td>200 mg PO</td>
<td>hs</td>
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### Appendix C

<table>
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<th>Amount/Route</th>
<th>Frequency</th>
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</thead>
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<td>hs</td>
</tr>
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<td>4</td>
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<td>hs</td>
</tr>
<tr>
<td></td>
<td>Elavil</td>
<td>100 mg PO</td>
<td>hs</td>
</tr>
<tr>
<td>5</td>
<td>Prolixin</td>
<td>3 cc IM</td>
<td>q 2 weeks</td>
</tr>
<tr>
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<td>Artane</td>
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<td>B.i.D.</td>
</tr>
<tr>
<td>6</td>
<td>Thorazine</td>
<td>200 mg PO</td>
<td>hs</td>
</tr>
<tr>
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<td>Thorazine</td>
<td>200 mg PO</td>
<td>Q.i.D.</td>
</tr>
<tr>
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<td>T.i.D.</td>
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<td>Thorazine</td>
<td>200 mg PO</td>
<td>Q.i.D.</td>
</tr>
<tr>
<td></td>
<td>Elavil</td>
<td>150 mg PO</td>
<td>hs</td>
</tr>
<tr>
<td></td>
<td>Benadryl</td>
<td>50 mg PO</td>
<td>T.i.D.</td>
</tr>
<tr>
<td>9</td>
<td>Prolixin</td>
<td>2 cc IM</td>
<td>q 3 weeks</td>
</tr>
<tr>
<td></td>
<td>Artane</td>
<td>5 mg PO</td>
<td>B.i.D.</td>
</tr>
</tbody>
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### Appendix C

<table>
<thead>
<tr>
<th>Subject</th>
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<th>Amount/Route</th>
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</tr>
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<td>1.5 cc IM</td>
<td>q 2 weeks</td>
</tr>
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<td>Cogentin</td>
<td>2 mg PO</td>
<td>B.i.D.</td>
</tr>
<tr>
<td></td>
<td>Thorazine</td>
<td>50 mg PO</td>
<td>hs</td>
</tr>
<tr>
<td>4</td>
<td>Navane</td>
<td>10 mg PO</td>
<td>hs</td>
</tr>
<tr>
<td></td>
<td>Phenobarbitor</td>
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</tr>
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<td>Prolixin</td>
<td>1 cc IM</td>
<td>q 2 weeks</td>
</tr>
<tr>
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<td>Benadryl</td>
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<td>T.i.D.</td>
</tr>
<tr>
<td>6</td>
<td>Amoxapine</td>
<td>200 mg PO</td>
<td>hs</td>
</tr>
<tr>
<td>7</td>
<td>Xanax</td>
<td>1 mg PO</td>
<td>T.i.D.</td>
</tr>
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<td>Thorazine</td>
<td>200 mg PO</td>
<td>hs</td>
</tr>
<tr>
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<td>hs</td>
</tr>
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<td>q AM or PRN</td>
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<td>q 3 weeks</td>
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### Appendix D

**Means and Standard Deviations**

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<th>Midtest</th>
<th>Posttest</th>
<th>Pretest</th>
<th>Midtest</th>
<th>Posttest</th>
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<tbody>
<tr>
<td>1.5 mile Run (minutes)</td>
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<td>24.31</td>
<td>20.40</td>
<td>19.20</td>
<td>4.24</td>
<td>3.39</td>
<td>2.98</td>
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<tr>
<td></td>
<td>CT</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>WLC</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
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<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>EMG (microvolts)</td>
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<td>1.55</td>
<td>.96</td>
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<td>CT</td>
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<td>-</td>
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<td>SDS (summed scores)</td>
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<td>39.11</td>
<td>8.27</td>
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Appendix E

Adjusted Means

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<th>Measure</th>
<th>Group</th>
<th>Midtest</th>
<th>Posttest</th>
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<tr>
<td>BCA</td>
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<td>(millimeters)</td>
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<td>-</td>
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<td>WLC</td>
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<tr>
<td>EMG</td>
<td>Experimental</td>
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<td>(microvolts)</td>
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<td>4.27</td>
<td>3.89</td>
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<td>WLC</td>
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<td>-</td>
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<td>EMG Latency</td>
<td>Experimental</td>
<td>2.90</td>
<td>2.51</td>
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<tr>
<td>(microvolts)</td>
<td>CT</td>
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<td>3.38</td>
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<td>WLC</td>
<td>-</td>
<td>-</td>
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<tr>
<td>DST</td>
<td>Experimental</td>
<td>92.10</td>
<td>92.46</td>
</tr>
<tr>
<td>(degrees Fahrenheit)</td>
<td>CT</td>
<td>89.52</td>
<td>88.34</td>
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<td>WLC</td>
<td>-</td>
<td>-</td>
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<td>WLC</td>
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<td>(summed scores)</td>
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<td>Experimental</td>
<td>-</td>
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<tr>
<td>(summed scores)</td>
<td>CT</td>
<td>-</td>
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<tr>
<td></td>
<td>WLC</td>
<td>-</td>
<td>38.98</td>
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Appendix F

Table 1

Analysis of Variance of Cardiovascular Fitness of Experimental Subjects as Measured by Running Speed

<table>
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<tr>
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<tbody>
<tr>
<td>Time</td>
<td>128.2962</td>
<td>2</td>
<td>64.14844</td>
<td>36.7177</td>
<td>.00001</td>
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<tr>
<td>Subjects</td>
<td>279.5391</td>
<td>8</td>
<td>34.9424</td>
<td>20.0000</td>
<td>.05</td>
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<tr>
<td>Error</td>
<td>27.95312</td>
<td>16</td>
<td>1.74707</td>
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<td>Total</td>
<td>435.7891</td>
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Appendix G

Table 2

Analysis of Covariance of Body Fat

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<tbody>
<tr>
<td>Group</td>
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<td>1</td>
<td>1.430</td>
<td>1.395</td>
<td>.256</td>
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<tr>
<td>Error</td>
<td>15.370</td>
<td>15</td>
<td>1.025</td>
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<td>Total</td>
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Appendix H

Table 3

Analysis of Covariance of Frontalis EMG Data

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<tbody>
<tr>
<td>Groups</td>
<td>11.441</td>
<td>1</td>
<td>11.441</td>
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<td>.0497</td>
</tr>
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<td>Subjects within Groups</td>
<td>37.667</td>
<td>15</td>
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<tr>
<td>Time of Measurement</td>
<td>.887</td>
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<td>.887</td>
<td>2.76</td>
<td>.1159</td>
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<tr>
<td>Time x Group</td>
<td>.043</td>
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<td>.043</td>
<td>.14</td>
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<td>Group x Subjects within Groups</td>
<td>5.134</td>
<td>16</td>
<td>.321</td>
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<td>Total</td>
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Appendix I

Table 4

Analysis of Covariance of Latency Data

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</thead>
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<tr>
<td>Groups</td>
<td>13.331</td>
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<td>13.331</td>
<td>4.82</td>
<td>.0444</td>
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<tr>
<td>Subjects within Groups</td>
<td>41.524</td>
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<td>2.768</td>
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<td>Time</td>
<td>5.063</td>
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<tr>
<td>Time x Group</td>
<td>1.174</td>
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<td>Group x Subjects within Groups</td>
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<td>Total</td>
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## Appendix J

**Table 5**

Analysis of Covariance of Digital Skin Temperature Data

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<tbody>
<tr>
<td>Groups</td>
<td>76.467</td>
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<td>76.467</td>
<td>2.28</td>
<td>.1517</td>
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<td>502.615</td>
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<td>Time</td>
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<td>1</td>
<td>1.529</td>
<td>.35</td>
<td>.5632</td>
</tr>
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<td>Time x Group</td>
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<td>70.199</td>
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<td><strong>Total</strong></td>
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Appendix K

Table 6

Analysis of Covariance on Zung Self-Rating Depression Scale Scores

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<tbody>
<tr>
<td>Group</td>
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<td>81.007</td>
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<tr>
<td>Error</td>
<td>516.095</td>
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<td>Total</td>
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Appendix L

Table 7

Analysis of Covariance on Rosenberg Self-Esteem Scale Scores

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<tr>
<td>Group</td>
<td>34.326</td>
<td>2</td>
<td>17.163</td>
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<td>.455</td>
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<td>484.759</td>
<td>23</td>
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<td>Total</td>
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Appendix M

Table 8

Analysis of Covariance of Spielberger State-Trait Anxiety Inventory Scores (state portion)

<table>
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<tr>
<td>Group</td>
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References


