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Variability of Cardiorespiratory Responses to a Standardized Submaximal Treadmill Test on Successive Days

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VARIABILITY OF CARDIORESPIRATORY RESPONSES
TO A STANDARDIZED SUBMAXIMAL TREADMILL TEST
ON SUCCESSIVE DAYS

(TITLE)

BY

KENNETH PAUL KLIPP

THESIS

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Chapter 1

INTRODUCTION

Ever since the study of the human body and its performance during physical activity began, coaches and researchers have based much of their research on the premise that "the human body is a machine." The purpose in using this statement seems to be found in another premise that if the body is a machine, then like any other machine, it is subject to the laws of nature, the formulas of physics, and the reactions of chemistry. The actions of levers, the results of oxidation, the laws of stability and motion, the relation of work, mass, strength, speed, and an infinite list of physical laws, formulas, causes, and effects can thus be applied to the body of man.

So the human body has subjected itself to every conceivable test and measurement known, and more tests are conceived every day. Yet, no matter how many tests are run on this machine called the body, one factor can skew the data being collected - the factor that controls the machine - the mind. Even under the careful scrutiny of the most delicate equipment and the trained eye of the researcher, the mind can affect the data being collected. Anxiety, fear, excitement, tension, and many other emotional-psychological factors can cause data on certain physical parameters to be invalid.

Many times the mental aspects of physical performance may be ignored while the machine is being tested. The researcher seems to realize the importance of the mind, but as in many psycho-emotional considerations, the lack of concrete knowledge of how it works or how to control it may cause him to ignore it.

Research in the area of the mind and its effects and control over physical performance has just begun to come under investigation in the physical performance laboratory. The mind cannot be ignored if valid data is to be obtained. The validity of the results of any study depend on the accuracy and stability of the data collected. How many studies have already been conducted, published, and accepted, whose data are possibly invalid because of a lack of consideration of the mental and emotional effects on certain physiological parameters? If accurate physical data is to be collected and studied, attempts must be made to control, or at least account for, the effects of the mind on the parameters being studied.

NEED FOR THE STUDY

There are many areas of research physiology that need to be studied with regard to the effects of the mind, but one of the most critical is the area of heart rates, pulmonary ventilations, and oxygen consumptions. The recent increase in the amount of research concerned with these factors and their relationship to physical condition make it imperative that valid data be collected if meaningful findings are to be reported. These parameters may be affected by many psycho-emotional stimuli. The endocrine system and the nervous system, in the presence of sensory stimulation, can cause heart and ventilation rates to increase or decrease greatly. The effects of these systems must be considered if valid data is to be obtained. Antel and Cumming, in their study of the effect of emotional stimulation on heart rate, stated, "Heart rate is the most commonly measured parameter in submaximal working capacity tests and the effects of emotion are not usually considered."[1]

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[1]Jack Antel and Gordon R. Cumming, "Effect of Emotional Stimulation on Exercise Heart Rate," Research Quarterly, 40:7, March, 1969.

Cooper, in his book Aerobics, explains:

> There's another heart rate that has nothing to do with physical exercise. In medicine, we call it the anticipatory rate or tension rate. You might want to think of it as the emotional heart rate . . . . In periods of acute emotional stress, the sympathetic nervous system . . . combines with the output of the adrenal glands to produce a high level of hormones in the blood, which, when they reach the heart, cause it to increase in rate and strength of contracture.[2]

When attempting to measure the physiological changes in these parameters during activity, the researcher must do his best to negate or account for the effects of the mind on these measurements since the final conclusions are to be based on the physiological response to the activity, not the psychological response. Any apprehension, anxiety, fear, or tension on the part of the subject could cause the data to be invalid as a direct physiological measurement of effect. Antel and Cumming warned:

> In most submaximal working capacity tests . . . the pulse rate response to a work load determines the subjects' fitness level. If pulse rate is increased by emotional factors, then the test gives an erroneously low value for the subjects' working capacity.[3]

The human performance laboratory, its equipment, and testing procedures can be a cause of anxiety in subjects who are not familiar with them. Shepard states that "nothing is more calculated to give falsely high pulse rates and abnormalities of heart rhythm than a large team of overzealous assistants and an excess of complex apparatus."[4] In their study of procedures

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[2]Kenneth H. Cooper, Aerobics (New York: Bantam Books, 1968), pp. 105.

[3]Antel and Cumming, op. cit., p. 10.

[4]Roy J. Shepard, Endurance Fitness (Toronto: University of Toronto Press, 1969), p. 61.

and concepts for stress testing, Taylor and others found "that work pulse rate may be altered by the emotional envolvement of the subject with the test and/or the results."[5]

If measurements of heart rates, pulmonary ventilations, and oxygen consumptions are done in situations where the subjects are not familiar with the laboratory or the testing procedures, the data collected could be invalid as a true measurement of the physical performance of those subjects, and erroneous conclusions could be drawn. Blair and Vincent found:

> If pretraining data is influenced by extraneous factors which become less traumatic during continued familiarity with these factors, then the terminal data may be incorrectly interpreted as being an improvement or training effect.[6]

In order to obtain valid data, the subject must be allowed to become familiar with the laboratory procedures so that any traumatic effects of unfamiliarity may be negated. Acclimatization to the laboratory and the procedures could result in physiological adjustments in the heart and ventilation rates and oxygen consumptions. Blair and Vincent reported that Dotson found that "subsequent visits to the laboratory produced more stable conditions in subjects' heart rates."[7] Although most testing sessions are preceded by a single orientation session, it may not be sufficient to

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[5]H.L. Taylor and others, "The Standardization and Interpretation of Submaximal and Maximal Tests of Working Capacity," <u>Pediatrics</u>, 32:703, Supplement, 1963.

[6]Steven Blair and Murray L. Vincent, "Variability of Heart Rate and Blood Pressure Measurements on Consecutive Days," <u>Abstracts of Research Papers</u> (AAHPER), 1969, p. 93.

[7]C.O. Dotson, "Estimation of Maximal Oxygen Intake from Submaximal Heart Rate" (paper presented at the Southern District Association for HPER Convention, February, 1969, Memphis, Tennessee), cited by Steven Blair and Murray L. Vincent, "Variability of Heart Rate and Blood Pressure Measurements on Consecutive Days," <u>Research Quarterly</u>, 42:13, March, 1971.

stabilize certain physiological processes. As a result of their study, Blair and Vincent found:

> Data from this study indicates that a mere orientation session to the laboratory prior to initiating the study might be inadequate. In fact some of the variables became stable only after several exposures to the laboratory environment . . . it would appear that several laboratory visits are important prior to starting an experiment in order to achieve stabilization of some cardiovascular parameters.[8]

PURPOSE OF THE STUDY

The purpose of the study was two-fold. The first purpose was to study the variability of heart rates, pulmonary ventilations, and oxygen consumptions during a submaximal work load as determined by consecutive testing sessions. The second purpose was to determine if variability was affected by previous laboratory experience and/or previous running experience.

NULL HYPOTHESIS

There is no variability in heart rates, pulmonary ventilations, and oxygen consumptions during a submaximal workload as determined by consecutive testing sessions, regardless of previous running or laboratory experience.

LIMITATIONS

The study was limited to twenty-six male subjects selected from three groups of the Eastern Illinois University Run For Your Life Program. These groups included a group with previous running experience and previous laboratory/treadmill experience, one group with previous running experience

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[8] Steven Blair and Murray L. Vincent, "Variability of Heart Rate and Blood Pressure Measurements on Consecutive Days," Research Quarterly, 42:13, March, 1971.

and no previous laboratory/treadmill experience, and one group with little previous running experience and no laboratory/treadmill experience.

Due to the availability of subjects and the laboratory, each subject was tested only three times.

DEFINITIONS

The following terms are defined for this study:

Previous Running Experience

Subjects who had run a minimum of five hundred miles while in the Run For Your Life program were considered to have previous running experience.

Previous Laboratory/Treadmill Experience

Subjects who had been in the laboratory and on the treadmill for at least fifteen minutes prior to the start of the study were considered to have previous laboratory/treadmill experience.

Little Previous Running Experience

Subjects who had been in the Run For Your Life program less than two months, and who were running less than ten miles a week at the time of the testing were considered to have little previous running experience.

Chapter 2

REVIEW OF RELATED LITERATURE

Although much has been written in the area of research physiology about heart rate, pulmonary ventilation, and oxygen consumption, very little research has been done on the variability of these parameters and their response to anxiety. Many exercise physiology texts acknowledge the fact that many psycho-emotional factors affect the heart rate, but very little research is cited that supports these statements or investigates the variability and effects of familiarization on these parameters. The review of related literature in this chapter will be subdivided into two parts: 1) those sources that discuss the effects of psycho-emotional stimuli on these parameters and 2) those studies that have been done to investigate the variability of these cardiovascular parameters.

EFFECTS OF PSYCHO-EMOTIONAL STIMULI ON CARDIOVASCULAR PARAMETERS

The effect of emotion on cardiovascular responses has been discussed in many physiology, psychology, and exercise physiology texts. Riedman[1] states that next to strenuous exercise, emotional factors cause the greatest increase in heart rate, in some cases doubling the resting rate. Young[2] reports that researchers have consistently found an increase in heart rate

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[1]Sarah R. Riedman, The Physiology of Work and Play (New York: The Dryden Press, 1952), p. 263.

[2]Paul Thomas Young, Emotion in Man and Animal (New York: John Wiley and Sons, Inc., 1943), p. 215.

during emotional excitement, and that almost any exciting circumstance will elicit an acceleration of the heart rate.

Karpovich and Sinning[3] believe that emotion accelerates the heart rate, and that this makes it very difficult or impossible to obtain a true resting heart rate. They caution that even though a subject may appear to be relaxed, his heart rate may be accelerated by emotional stimuli.

This emotional acceleration of heart rate has also been observed during submaximal workloads. Astrand and Rodahl[4] warn that although the relationship between heart rate and workload is linear in many types of work, emotion may influence the heart rate greatly at rest and during work that is submaximal.

It has been noted by de Vries[5] that although this emotional acceleration is most easily observed at rest, it also occurs in exercise and during recovery. Rowell[6] and others also found that submaximal workloads did not extinguish the accelerative effects of emotion.

The effects of emotion on respiratory responses, as well as, heart rate responses have also been observed. Dolley[7] and others state that

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[3]Peter V. Karpovich and Wayne E. Sinning, Physiology of Muscular Activity (Philadelphia: W.B. Saunders Co., 1971), pp. 201-2.

[4]Per-Olof Astrand and Kaare Rodahl, Textbook of Work Physiology (New York: McGraw-Hill Book Co., 1970), p. 166-67.

[5]Herbert A. de Vries, Physiology of Exercise (Dubuque: Wm. C. Brown Co., 1966), pp. 71-2.

[6]Loring B. Rowell and others, "Limitations to Prediction of Maximal Oxygen Intake," Journal of Applied Physiology, 19:920, September, 1964.

[7]Franks Dolley and others, "The Efficiency of the Heart, and the Significance of Rapid and Slow Pulse Rates," American Journal of Physiology, 82:514, November, 1927.

although the heart rate is extremely susceptible to the influences of emotion, the respiratory responses are not. Rowell[8] found that "at any given level of submaximal work, the pulse rate can vary independently of the oxygen intake but directly with the emotional state or degree of excitement of the subject."

Other writers have observed the effects of emotion on cardiorespiratory responses, and their works support the sources just cited.[9,10,11]

RESEARCH ON CARDIORESPIRATORY VARIABILITY

Research in the area of cardiorespiratory variability has been done in a number of areas.

Murphy[12] statistically analyzed thirty-two cardiovascular test variables for young women and found one of the primary factors to be emotional acceleration of the heart that accompanies muscular effort.

Cattrell[13] reported that in a study in which psychiatrists rated subject anxiety and correlated it with heart rate measurements, the correlation coefficient was +.49, which was considered a fairly marked relation as psychological variables go.

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[8]Rowell and others, loc. cit.

[9]Alan J. Barry and Martte J. Karvonen, Physical Activity and the Heart (Proceedings of a Symposium) (Springfield: Charles C. Thomas Publisher, 1967), p. 326.

[10]Kenneth H. Cooper, Aerobics (New York: Bantam Books, 1968), pp. 104-5.

[11]George E. Deanne and David Zeaman, "Human Heart Rate During Anxiety," Perceptual and Motor Skills, 8:103-106, 1958.

[12]Mary A. Murphy, "A Study of the Primary Components of Cardiovascular Tests," Research Quarterly, 11:63, March, 1940.

[13]Raymond R. Cattrell, "The Nature and Measurement of Anxiety," Scientific American, 208:97, March, 1969.

Many studies have observed the effects of anxiety and emotion on cardiorespiratory parameters. Antel and Cumming[14] studied the effect of emotional stimulation on exercise heart rate. Nine boys, thirteen to fifteen years old, took part in three orientation tests on the bicycle ergometer to establish base pulse rates and to familiarize the subjects with the procedures. Each subject was then tested three times, riding at sixty rpm's at a workload to elicit a specified heart rate between 110 and 180 beats per minute. After achieving a steady state, each subject was given two types of stimuli, an electrical shock and the threat of a hypodermic. Increases in pulse rates were obtained in twenty-six of the twenty-seven tests, with a mean increase of 4.7 beats per minute. All of the increases were significant. The pulse rate changes were evident and significant, regardless of the prestimulus heart rate. After the stimulus was removed, all heart rates declined within three minutes, sixty percent returning to the prestimulus rate. The investigators concluded that 1) emotion accelerated the heart rate and 2) exercise did not block the effects of emotion when the prestimulus heart rate was between 110 and 180 beats per minute.

Karpovich and Sinning[15] reported a number of studies that investigated the effects of emotion on the heart rate. In one experiment, a subject had to walk on a treadmill for ten minutes on six occasions. During the third test, his heart rate was 120 beats per minute. He stumbled while getting off of the treadmill, and when he resumed walking, his heart rate rose to 160 beats per minute.

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[14]Jack Antel and Gordon Cumming, "Effect of Emotional Stimulation on Exercise Heart Rate," Research Quarterly, 40:6-10, March, 1969.

[15]Karpovich and Sinning, loc. cit.

In another study, heart rates for a group of men were determined during a medical exam, waiting to run on a treadmill, and while running on the mill. The mean heart rates were eighty-two (range - 50-130), 125 (range - 79-170), and 193 (range - 160-220) respectively.

The authors concluded that some test heart rates have resulted from emotional factors that were not suspected or could not be eliminated.

In a work edited by Rosenbaum and Belknap, Dill[16] found a mean increase of nineteen beats per minute in the resting heart rate of teen-age boys waiting to be tested in his laboratory.

The sources cited thus far have all been concerned with the effect of emotion on cardiovascular responses. They have all indicated that emotion accelerates the heart rate while having little effect on respiratory responses. However, none of them have indicated how the effects of emotion can be negated or accounted for in research studies if valid physiological data is to be obtained. There has been research done on cardiovascular variability and eventual stabilization under conditions of lessoning anxiety.

Some studies have used experimentally induced anxiety to study heart rate variability. Deane and Zeaman[17] used an electrical shock at known intervals to induce anxiety. Sharp increases in heart rate over previously determined basal values were observed during early testing. However, this acceleration decreased and disappeared in subsequent tests, and deceleration replaced it. Respiratory measures were found to be unrelated to cardiac responses.

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[16]D.B. Dill, "Regulation of the Heart," in T.T. Rosenbaum and E.L. Belknap (eds.), Work and the Heart (New York: Paul B. Hoeber, Inc., 1959), p. 210.

[17]Deanne and Zeaman, loc. cit.

Clark and Epstein[18] used three intensities of electrical shock to determine if heart rate response was related to the intensity of the anxiety-producing stimuli. Three groups of ten subjects were each given a different intensity of electrical shock at known intervals. It was found that the intensity of the shock was directly proportional to the degree of the anticipatory heart rate response. The rise in heart rate was significant in all three groups. The respiration rate did not vary significantly regardless of the intensity of the stimulus. The investigation also studied the effect of continued exposure to the stimulus. The heart rate declined continually with each additional exposure to the stimulus.

Other studies have been done to study the cardiorespiratory variability when no anxiety-producing stimuli were used. The testing laboratory and the testing procedures have been found to be causes of anxiety and thus accelerated cardiac responses.

Shepard[19] reported that anxiety was most marked in treadmill exercise, the heart rate during treadmill running averaging five beats per minute higher on the first day than on subsequent test days.

Sime[20] tested eighteen middle-aged men on the treadmill at weekly intervals three times before and two times after a five month training program on the bicycle ergometer. The test consisted of walking at three miles per hour at fourteen percent grade. The heart rate responses to the three

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[18]Samuel Clarke and Seymour Epstein, "Heart Rate and Skin Conductance During Experimentally Induced Anxiety," _Journal of Experimental Psychology_, 84:105-12, April, 1970.

[19]Roy J. Shepard, _Endurance Fitness_ (Toronto: University of Toronto Press, 1969), p. 66.

[20]Wesley E. Sime and others, "Variability of Heart Rate Response to a Submaximal Treadmill Test Before and After Training in Middle-Aged Sedentary Men" (paper presented at the Seventeenth Annual Meeting, American College of Sports Medicine, May, 1970, Alburquerque, New Mexico).

pretraining tests decreased significantly from test one to test three. After the training period, the heart rates again declined significantly from test one to test two. They observed that the variability between tests was small but significant. From the results of their study, they concluded that successive exposures to the test lowered the heart rate and that training did not alter this variability.

Rowell[21] studied the methods of predicting maximum oxygen consumption values from submaximal heart rates and found:

> During the initial work tests which required up to sixty percent of maximum oxygen consumption, pulse rate was usually elevated above values later established as normal for the individual who had become accustomed to the laboratory equipment and personnel. Predictions from the nomogram made during the initial test and again after careful standardization of the subject's responses to work . . . showed differences between first and second predicted values for maximum oxygen consumption . . . significant at the level of P=0.02.

Sharkey[22] found that the anxiety-producing factors of an exercise task in the laboratory tend to decline after repeated exposures. This decline occurred despite a physiologically adjusted workload. He felt that:

> While several explanations are available for such a decline, it is possible that a reduction of somatic input to the higher centers of the CNS or habituation has taken place. If such a process did occur, it would also relate to a reduction of the emotional component in heart rate control. Therefore it could also result in a reduction of the heart rate during a physical performance test.

In another study, Sharkey[23] observed that treadmill performance scores yielded a typical learning curve. Elimination of extraneous muscle contractions and familiarity with the test situation were cited as possible reasons

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[21] Rowell and others, loc. cit.

[22] Brian Sharkey and others, "Exercise, Stress and Blood Clotting in Men," Research Quarterly, 40:431-34, May, 1969.

[23] Brian Sharkey and others, "Cardiorespiratory Adaptations to Training at Specified Frequencies," Research Quarterly, 39:295-300, May, 1968.

for the increased efficiency and lower heart rates.

Blair and Vincent[24] conducted a study on the variability of heart rate on successive days. The heart rates of eleven college males were determined during rest, work, and recovery on five successive days. Heart rates were determined during a five minute rest period, six minute ride on a bicycle ergometer (600 kpm/min), and a two minute recovery period. The same submaximal test was given on each of the five days. All eighteen of the heart rate criterion measurements declined during the five days, eleven of them significantly at the .05 level. The heart rates declined continuously from day to day, becoming significant after several exposures to the test. Many of the readings had still not stabilized by the fifth day. They concluded that several laboratory exposures were necessary in order to overcome the anxiety of early testing sessions if valid heart rates are to be obtained.

SUMMARY

The review of the literature reveals considerable agreement among the researchers in this area. Psycho-emotional stimuli have been shown to accelerate the heart rate while having very little effect on respiratory measurements. The research laboratory and the testing procedures have been shown to be an anxiety-producing factor. Successive exposures to the anxiety-producing situation bring about a lowering of the anxiety with a resulting lowering of the heart rate. If valid physiological data are to be collected, the effects of anxiety and emotion must be considered, and attempts should be made to familiarize the subjects with the procedures thoroughly before a research project is begun.

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[24]Steven Blair and Murray L. Vincent, "Variability of Heart Rate and Blood Pressure Measurements on Consecutive Days," Research Quarterly, 42:7-13, March, 1971.

Chapter 3

METHODOLOGY

The study was designed to investigate the variability of heart rate, pulmonary ventilation, and oxygen consumption responses to a submaximal work-load on successive test days. It was also designed to determine if previous treadmill experience or previous running experience affected this variability. The description of the subjects, the experimental design, an explanation of the testing procedures, and a description of the physiological measurements are included in this chapter.

SUBJECTS

Twenty-six male volunteers from the Eastern Illinois University Run For Your Life Program were the subjects for the study. These subjects were taken from three different groups.

Previous Running and Laboratory/Treadmill Experience(EXP)

The EXP group consisted of ten men who had run a minimum of five hundred miles in the program, and who also had previous laboratory and treadmill running experience. The ten subjects had an age range from twenty-nine to forty-nine, with a mean age of 41.0. Their weight ranged from 140 pounds to 193 pounds, with a mean weight of 163.78 pounds. Two of these subjects had run in the 1972 Boston Marathon, completing it under three hours and twenty minutes.

Previous Running Experience, No Previous Laboratory/Treadmill Experience(NTE)

The NTE group consisted of eight men who had run a minimum of five

hundred miles in the program but who had had no previous laboratory and treadmill running experience. The eight subjects had an age range from twenty-six to fifty, with a mean age of 37.6. Their weight ranged from 143 to 200 pounds, with a mean weight of 169.07 pounds.

Little Previous Running Experience, No Previous Laboratory/Treadmill Experience(NRE)

The NRE group consisted of eight men who had been in the program less than two months and had no previous laboratory or treadmill running experience. Under supervision, these men were running three mornings per week and not more that ten miles per week at the time of testing. The age for this group was twenty-eight to forty-nine, with the mean age being 33.9. The weight range for this group was from 154 to 196 pounds, with the mean weight being 179.28 pounds.

EXPERIMENTAL DESIGN

Each subject was tested three times within an eight day period. The subjects were never tested two days in a row, and no more than three days were allowed to pass between tests. This procedure was chosen for two reasons: 1) the availability of subjects precluded setting up a rigid "every other day" program. In the design used, some flexibility was allowed for the subject to choose his days. 2) it was felt that the testing should be at least a day apart to assure that the physical effort of one test would not be a factor in the next test. Three days was chosen as the maximum time between tests to keep the testing sessions close enough that familiarization with the testing procedures would carry over to the next testing session.

The test was chosen in order to be submaximal for the subjects in-

volved. The NRE Group was given a lighter workload since it was felt that they would not be able to complete the workload set up for the other groups.

Each subject was instructed to keep his physical activities consistent on the days he was being tested. Subjects were instructed not to eat or smoke within two hours of the test. The same test was given to each subject on all three days at the same time of day. The subjects were told in advance that it would be a submaximal workload that they could handle easily, and every effort was made to reduce any anxiety-causing factors related to the testing.

TESTING PROCEDURES

Preliminaries

When the subject entered the laboratory, he was weighed in his running shorts, supporter, socks, and t-shirt on a calibrated Healthometer Scale. His weight was read to the nearest quarter pound and converted to kilograms by dividing by 2.2. This, along with his age and pre-test activities, was recorded on a data sheet designed by Johnson.[1] The subject then put on his shoes and lay down on a table.

The areas for electrode attachment were prepared by shaving the body hair at the V_2 and V_5 positions. A small amount of electrode jelly was rubbed vigorously on these areas with a tooth brush to remove dead skin and provide an area of irritation for electrode attachment and contact. Excess jelly, along with any dead skin, was removed with a towel. Two Telectrode Disposable Electrodes were then attached at the V_2 and V_5 positions with a pea-sized drop of electrode jelly being placed inside the electrode ring to help provide better

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[1]Robert E. Johnson, Francis Robbins, and others, "A Versatile System for Measuring Oxygen Consumption in Man," Journal of Applied Physiology, 22:377-79, February, 1967.

contact with the skin.

The patient cable was attached to the electrodes and plugged into a Telemedics RKG 100 transmitter that sent the electrocardiogram to the receiving unit. The heart beat was monitored through the receiver unit and sent to a Lexington Physio-Scope and a Sanborn Model 500 Viso-Cardiette. The paper was set at twenty-five millimeters per second, and heart rates were determined with a calibrated ruler.

Orientation

After a resting heart rate was obtained, the subject got up and walked over to the treadmill and was given an orientation. An A.R. Young Treadmill was used for the tests. Before beginning the orientation, the procedures to be used in the orientation were explained.

The orientation began with the subject standing on the treadmill, holding on to the safety bar. It was explained that the treadmill would be started at walking speed, and that the subject should walk naturally with his heels hitting first, his back straight, and holding on to the bar. The treadmill, pre-set at three miles per hour, zero grade, was then started. A small window fan suspended in front of the subject was also turned on to simulate air flow, and it remained on whenever the treadmill was running.

When the subject was walking comfortably, he was instructed to release his grip on the bar with one hand and then the other, letting the arms swing naturally at his sides and walking normally. The grade was then raised to four percent (the grade to be used during the test), with the speed remaining at walking pace. This allowed for the subjects' legs to adjust to the grade, and for the suspended mouthpiece to be adjusted for the height of the subject.

Procedures for inserting the mouthpiece connected to the suspended Collins Triple "J" Valve were then explained. Holding on to the safety bar

with one hand, the subject inserted the mouthpiece. He then released the bar and continued to walk naturally. The subject was allowed to practice this until he could do it easily.

The speed was gradually increased to six miles per hour. The subject was instructed to hold onto the safety bar and to begin jogging whenever he felt it was necessary to keep pace with the speed of the treadmill. When the subject was running comfortably, he released the bar and ran normally. He then practiced inserting the mouthpiece on the run, using the same procedure as before. This was practiced until he could do it easily.

The treadmill was lowered to zero grade and slowed to three miles per hour. The subject was then allowed to walk for two minutes.

The Treadmill Test

Instructions for the test were given to the subject while he was walking following the orientation. It was explained that he would run at seven miles per hour at four percent grade for seven and a half minutes. He would be required to insert the mouth piece at three minutes, five minutes, and seven minutes, and to leave it in for forty to forty-five seconds during which time a thirty second measurement of ventilation and a sample of expired air would be taken.

The subject was shown how to put on the noseclips that were worn during the test. It was explained that if they should fall off during the test, he should hold his nose with his fingers whenever the mouthpiece was inserted, and that if he felt he had to stop for any reason, he should say so and the test would be terminated immediately.

With the grade set at four percent, the speed was increased to seven miles per hour. The subject then ran for seven and a half minutes, inserting the mouthpiece on command at three, five, and seven minutes. Each time,

the mouthpiece was left in for a thirty second reading. At seven and a half minutes the treadmill and fan were shut off. The subject was allowed to remove the noseclips and sit quietly on a stool placed on the treadmill while recovery heart rates were taken for three minutes. This completed the test.

The same test was given to the subject on two other occasions within the following eight days, not being given two days in a row and not allowing more than three days to pass between tests. The same procedures were followed throughout, including the orientation.

The test for the NRE Group differed from the test just described in that the speed for the first three and a half minutes of the test was 3.6 miles per hour, being increased to six miles per hour for the remainder of the test.

PHYSIOLOGICAL MEASUREMENTS

The three measurements taken during the test were heart rates, pulmonary ventilation, and oxygen consumption.

Heart Rate

The procedures for determining heart rates were described earlier in this chapter. A resting heart rate was taken while the subject was lying down before the test. Heart rates were taken every thirty seconds during the test, beginning at thirty seconds until three minutes into recovery.

Pulmonary Ventilation and Oxygen Consumption

Data for determining pulmonary ventilation and oxygen consumption values were collected three times during the test - from three to three and a half minutes, from five to five and a half minutes, and from seven to seven and a half minutes. Inspired volumes of air were determined by a Parkinson Cowan CD4 Meter and corrected to Standard Temperature and Pressure Dry (STPD).

During each of the three thirty second periods, a sample of the subject's expired air was collected. A vacuum pump was used to suck a sample of the subject's expired air out of a plexiglass mixing chamber connected by hose to the Triple "J" Valve. The air was collected in a vacuumized metalized bag designed by Johnson.[2]

The temperature of the expired air was measured in degrees Centigrade by an atmospheric probe in the mixing chamber. The probe was plugged into a YSI Tele-Thermometer.

The expired air samples were analyzed by a Beckman Model E2 Oxygen Analyzer and a Beckman LB-1 Medical Gas Analyzer to determine oxygen and carbon dioxide content.

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[2]Johnson, loc, cit.

Chapter 4

ANALYSIS OF THE DATA

The investigation was designed to study the variability of heart rates, pulmonary ventilation, and oxygen consumption responses to a submaximal workload during consecutive testing sessions, and to determine if previous treadmill and/or running experience affects this variability. Twenty-six members of the Eastern Illinois University Run For Your Life program acted as subjects for the study. These subjects were chosen from three groups described in the previous chapter. Each subject within a group took the same submaximal treadmill test three times within eight days, never being tested two days in a row, and never allowing more than three days to pass between tests. An explanation of the measurements taken, the data conversion, the statistical treatment, a presentation of the findings, and a summary and discussion of the data are included in this chapter.

MEASUREMENTS TAKEN

Three physiological parameters were recorded at established intervals during the test. The heart rate was recorded at rest and at thirty second intervals during the test until three minutes into recovery. Pulmonary ventilation and oxygen consumption values were determined three times during the test, at three, five, and seven minutes.

DATA CONVERSION

It was necessary to convert some of the raw data to standardized units

for analysis. The body weight of each subject was recorded in pounds and then converted to kilograms by dividing by 2.2. The pulmonary ventilation data was corrected to Standard Temperature and Pressure Dry (STPD) and expressed in Liters per Minute (L/Min). Oxygen consumptions were expressed in milliliters per kilogram of body weight per minute (ml/kg/min). The heart rates were expressed in beats per minute.

STATISTICAL TREATMENT

A t test for determining the significance of the difference between the means of small correlated samples was used in analyzing the collected data. The mean values for each of the measurements taken within each group were compared to determine any statistical significance between the three test days. No comparisons were made between the groups since the NRE group took a different test than either the NTE or EXP groups.

To establish statistical significance, the .05 level of confidence was selected for the study. Tables from Tate[1] were used to determine the integer denoting statistical significance.

PRESENTATION OF THE FINDINGS

The presentation of the findings has been subdivided into three parts, one for each of the groups. Each of the parameters measured will be discussed for each group individually.

NRE Group (Little Running Experience, No Laboratory/Treadmill Experience)

Heart Rates. The mean heart rates for the NRE group are listed in

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[1]Merle W. Tate, Statistics in Education (New York: The MacMillan Co., 1955), p. 560.

Table 1 and depicted in Figure 1. The heart rate declined on each of the last two days for all but five measurements. All of the heart rates showed a decline between days one and three. However, only thirteen of these changes were significant when all three days were compared. The t's for these sixty-six comparisons are listed in Table 2. More significant differences were found between day one and day three than in any other comparison. Two of the early test heart rate means and each of the heart rate means between five and seven minutes were significant between days one and three. This, along with the declining trend shown by the mean comparisons in Table 1, would seem to indicate a gradual lowering of the heart rate on each of the successive days, becoming significant on the third day.

Pulmonary Ventilations and Oxygen Consumptions. The mean pulmonary ventilation and oxygen consumption values for the NRE group are listed in Tables 3 and 4, and depicted in Figures 2 and 3. Both of these values showed little fluctuation between days, and none of the comparisons approached significance. The t's for these comparisons are listed in Tables 5 and 6. No trend was established, either increasing or decreasing, from day to day in either of the parameters. The largest mean fluctuation in pulmonary ventilation was 2.10 Liters/Minute between days one and three for the 3:00-3:30 reading. The largest fluctuation in oxygen consumption was one of .95 milliliter per kilogram of body weight per minute between days one and three for the 7:00-7:30 reading.

NTE Group (No Treadmill/Laboratory Experience, Previous Running Experience)

Heart Rates. The mean heart rates for the NTE group are listed in Table 7 and depicted in Figure 4. The heart rate declined on each of the

Table 1

Mean Heart Rates for NRE Group
(Beats/Min)

Test Time (Min)	Day 1	Day 2	Day 3	Difference Days 1-2	Difference Days 2-3	Difference Days 1-3
Rest	66.63	66.88	63.50	- .25	-3.38	-3.13
.5	115.50	110.13	107.88	-5.37	-2.42	-7.62
1.0	115.00	111.50	109.63	-3.50	-1.87	-5.37
1.5	114.50	112.50	110.25	-2.00	-2.25	-4.25
2.0	115.50	114.13	112.75	-1.37	-1.38	-2.75
2.5	115.75	114.13	112.75	-1.37	- .75	-2.12
3.0	117.50	114.63	113.63	-2.87	-1.00	-3.87
3.5	117.13	116.50	115.00	- .63	-1.50	-2.13
4.0	139.38	137.25	132.50	-2.13	-4.75	-6.88
4.5	149.50	149.25	144.88	- .25	-4.37	-4.62
5.0	156.50	154.13	151.25	-2.37	-2.88	-5.25
5.5	161.00	158.50	157.50	-2.50	-1.00	-3.50
6.0	165.88	161.88	161.13	-4.00	- .75	-4.75
6.5	167.50	163.25	162.25	-4.25	-1.00	-5.25
7.0	171.25	165.88	164.38	-5.37	-1.50	-6.87
7.5	165.50	167.25	164.75	+1.75	-2.50	- .75
8.0	150.63	145.00	140.63	-5.63	-4.37	-10.00
8.5	124.25	123.13	122.38	-1.12	- .75	-1.87
9.0	115.75	112.75	113.50	-3.00	+ .75	-2.25
9.5	109.38	103.63	105.88	-5.75	+2.25	-3.50
10.0	104.88	102.00	99.88	-2.88	-2.12	-5.00
10.5	99.75	95.38	95.75	-4.37	+ .37	-4.00
			Mean Difference	-2.7	-1.7	-4.4

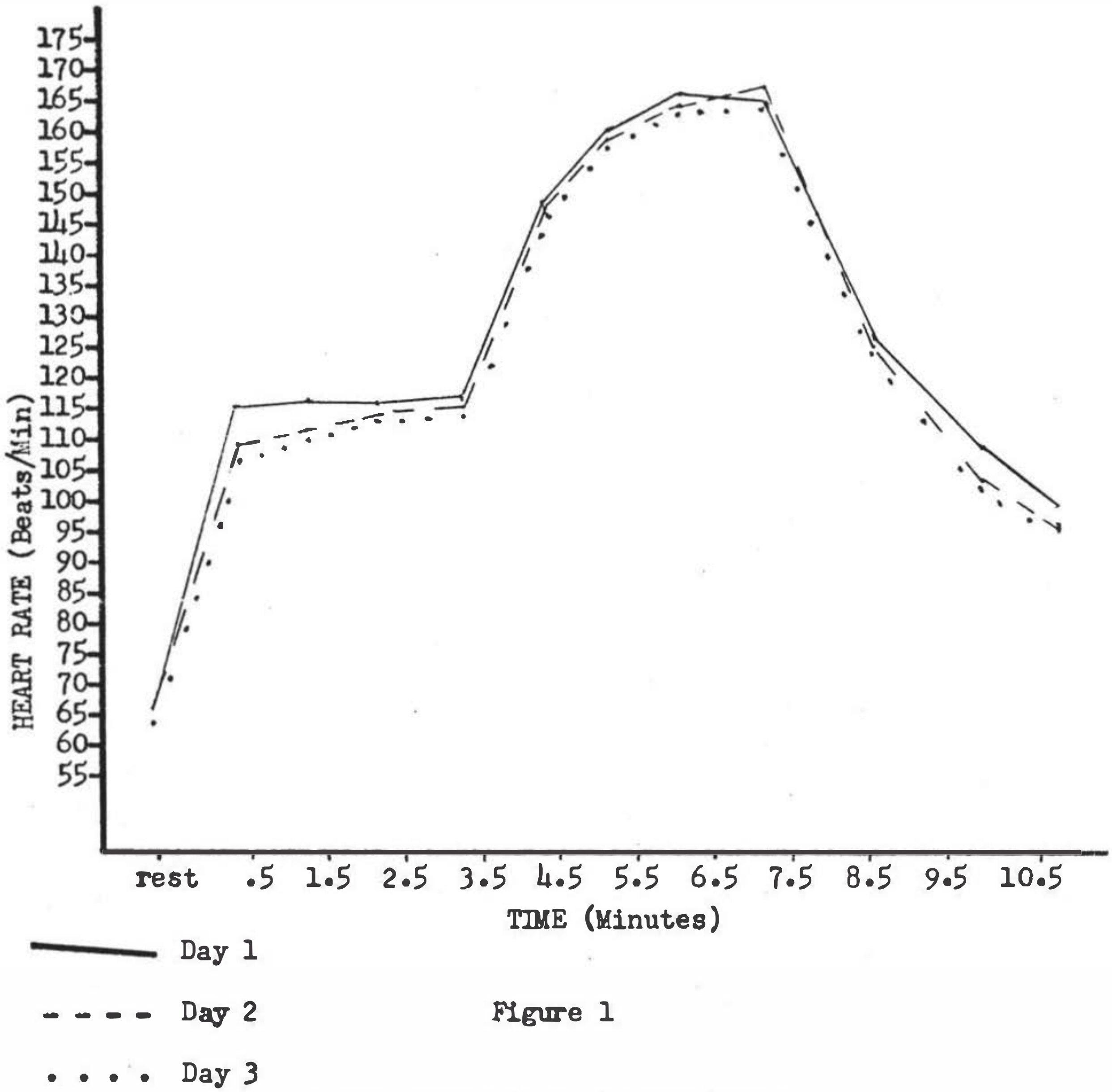

Figure 1

Mean Heart Rates For NRE Group

Table 2

Summary of t Tests For Heart Rates
NRE Group

Test Time (Min)	t Ratio Day 1 vs. Day 2	t Ratio Day 2 vs. Day 3	t Ratio Day 1 vs. Day 3
Rest	.055	.934	.864
.5	2.097	1.029	3.581*
1.0	1.416	.828	2.688*
1.5	.704	2.302	1.779
2.0	.435	.624	1.120
2.5	.411	.269	.697
3.0	1.069	.360	1.407
3.5	.223	.541	.877
4.0	.673	2.068	2.216
4.5	.148	1.565	2.254
5.0	1.665	2.486*	5.700*
5.5	1.279	.481	2.432*
6.0	1.728	.348	4.533*
6.5	2.348*	.748	5.475*
7.0	2.776*	1.061	4.274*
7.5	.350	3.118*	.171
8.0	2.788*	2.218	4.210*
8.5	.338	.240	.356
9.0	.887	.186	.477
9.5	1.656	.851	.850
10.0	.826	1.038	1.331
10.5	1.180	.111	.974

*Significant at the .05 level

Table 3

Mean Pulmonary Ventilatio s For NRE Group
(L/Min-STPD)

Reading (Min)	Day 1	Day 2	Day 3	Difference Days 1-2	Difference Days 2-3	Difference Days 1-3
3:00-3:30	32.67	31.68	30.57	- .99	-1.11	-2.10
5:00-5:30	59.67	61.32	59.74	+1.65	-1.58	+ .08
7:00-7:30	72.91	74.87	73.65	+1.96	-1.22	+ .74
			Mea Difference	+ .87	-1.30	- .43

Table 4

Mea Oxygen Consumptions For NRE Group
(ml/kg/min)

Reading (Min)	Day 1	Day 2	Day 3	Difference Days 1-2	Difference Days 2-3	Difference Days 1-3
3:00-3:30	16.09	16.16	15.52	+ .07	- .64	- .57
5:00-5:30	28.64	28.20	28.12	- .44	- .08	- .52
7:00-7:30	32.95	33.52	33.90	+ .57	+ .38	+ .95
			Mean Difference	+ .07	- .11	- .04

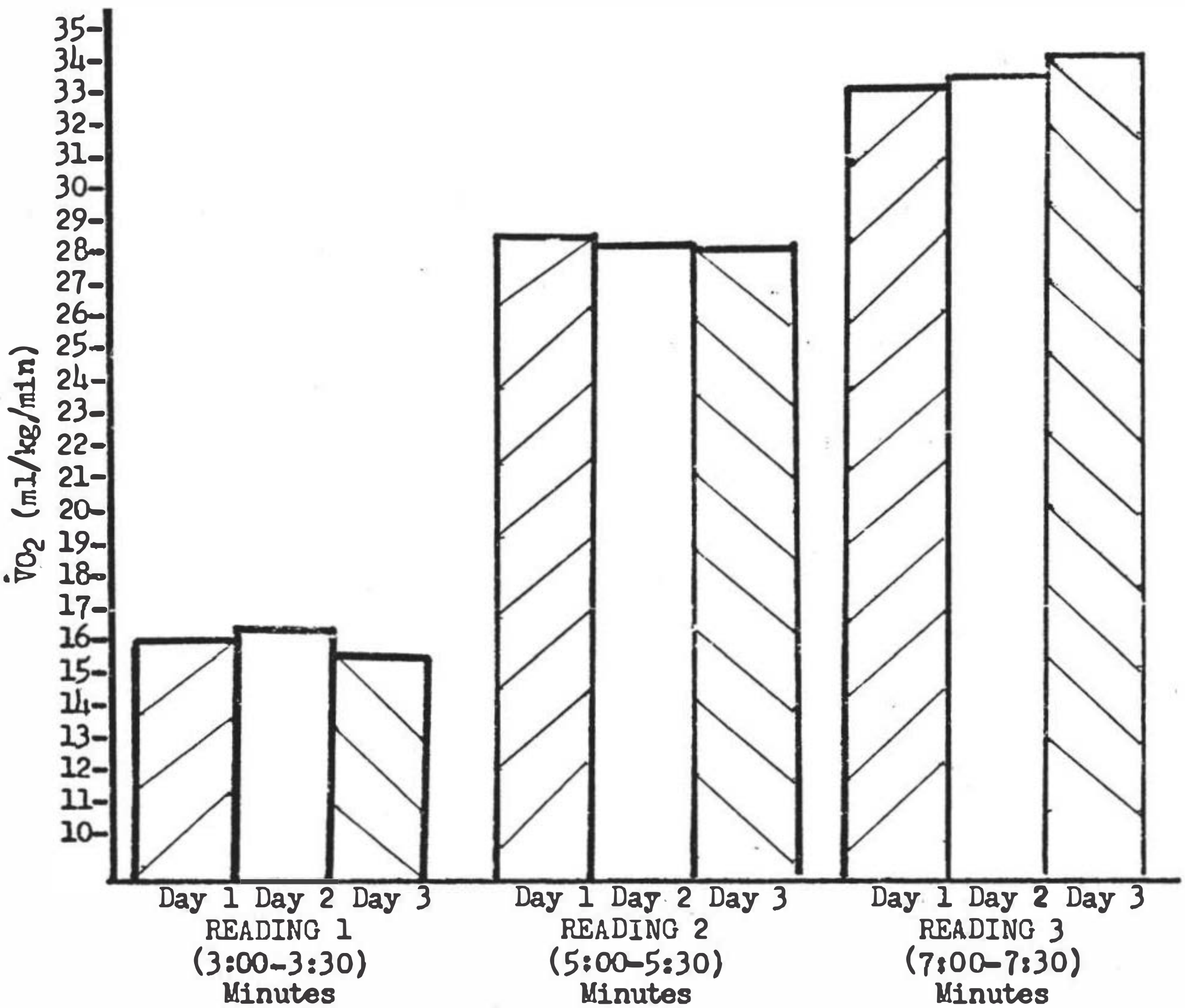

Figure 2

Mean Oxygen Consumptions
For NRE Group

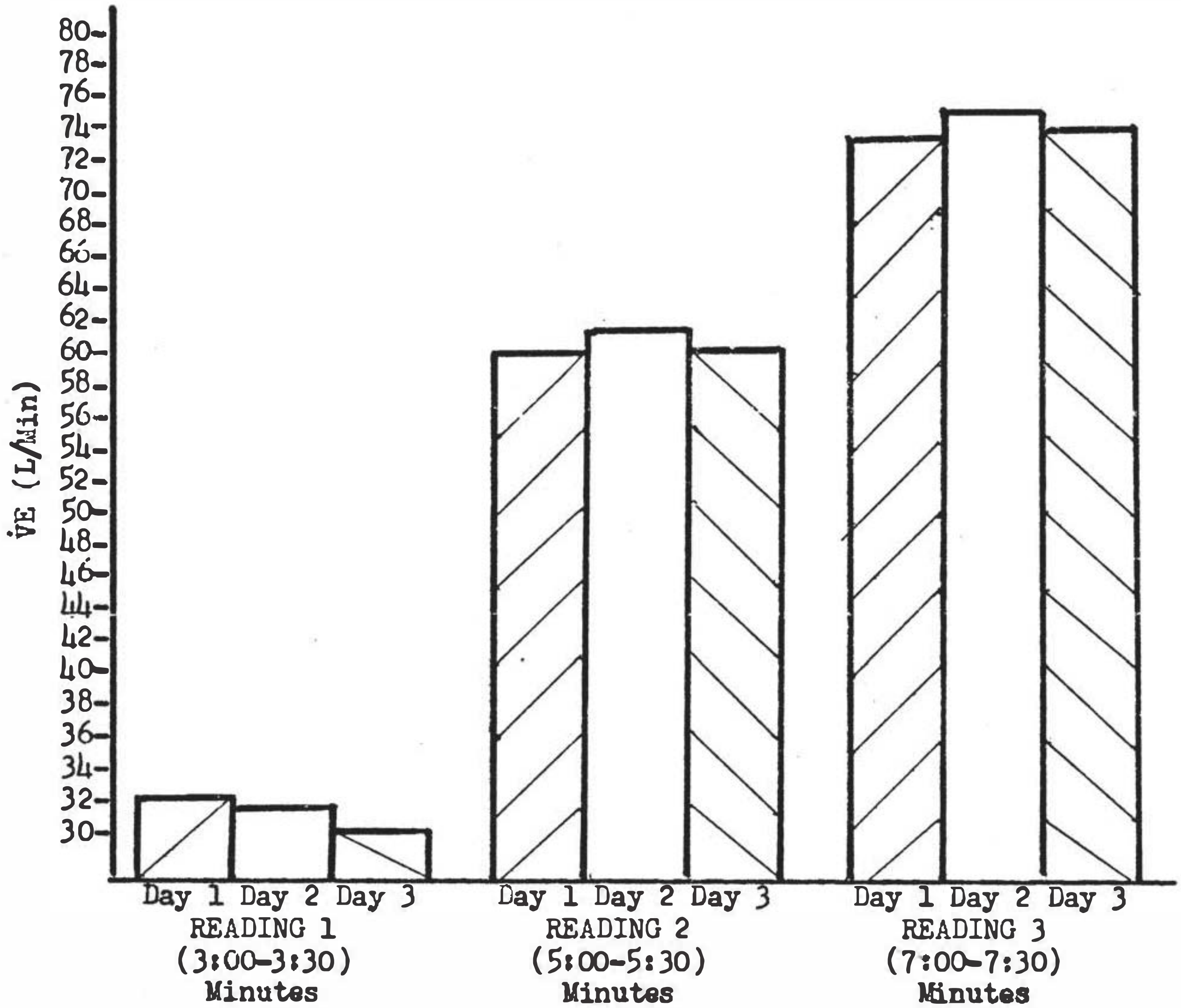

Figure 3

Mean Pulmonary Ventilation
For NRE Group

Table 5

Summary of t Tests For Pulmonary Ventilations
NRE Group

Reading (Min)	t Ratio Day 1 vs. Day 2	t Ratio Day 2 vs. Day 3	t Ratio Day 1 vs. Day 3
3:00-3:30	.674	.917	.833
5:00-5:30	.518	.901	.032
7:00-7:30	.429	.720	.159

*Significant at the .05 level

Table 6

Summary of t Tests For Oxygen Consumptions
NRE Group

Reading (Min)	t Ratio Day 1 vs. Day 2	t Ratio Day 2 vs. Day 3	t Ratio Day 1 vs. Day 3
3:00-3:30	.083	.991	1.151
5:00-5:30	.617	.092	.701
7:00-7:30	.484	.636	.639

*Significant at the .05 level

Table 7

Mean Heart Rates For NTE Group
(Beats/Min)

Test Time (Min)	Day 1	Day 2	Day 3	Difference Days 1-2	Difference Days 2-3	Difference Days 1-3
Rest	61.25	60.00	61.88	-1.25	+1.88	+ .63
.5	142.13	141.13	134.13	-1.00	-7.00	-8.00
1.0	151.38	150.13	147.63	-1.25	-2.50	-3.75
1.5	156.38	155.13	154.25	-1.25	-2.50	-3.75
2.0	159.50	158.50	156.38	-1.00	-2.12	-3.12
2.5	162.00	161.00	159.75	-1.00	- .25	-1.25
3.0	163.75	161.75	160.38	-2.00	-1.37	-3.37
3.5	164.63	163.00	161.63	-1.63	-1.37	-3.00
4.0	165.75	165.00	164.38	- .75	- .62	-1.37
4.5	166.50	165.25	164.13	-1.25	-1.12	-2.37
5.0	167.88	166.25	165.13	-1.63	-1.12	-2.75
5.5	168.75	165.88	168.38	-2.87	+2.50	- .37
6.0	168.25	166.88	168.00	-1.37	+1.12	- .25
6.5	169.38	168.13	167.25	-1.25	- .88	-2.13
7.0	170.25	169.63	167.75	- .62	-1.88	-2.50
7.5	169.25	167.75	167.50	-1.50	- .25	-1.75
8.0	142.25	144.88	141.25	+2.63	-3.63	-1.00
8.5	117.13	118.75	117.00	+1.62	-1.75	- .13
9.0	109.13	105.38	107.38	-3.75	+2.00	-1.75
9.5	105.25	102.38	101.00	-2.87	-1.38	-4.25
10.0	101.50	97.00	94.63	-4.50	-2.37	-6.87
10.5	99.13	97.63	96.25	-1.50	-1.38	-2.88
			Mean Difference	-1.5	-1.2	-2.5

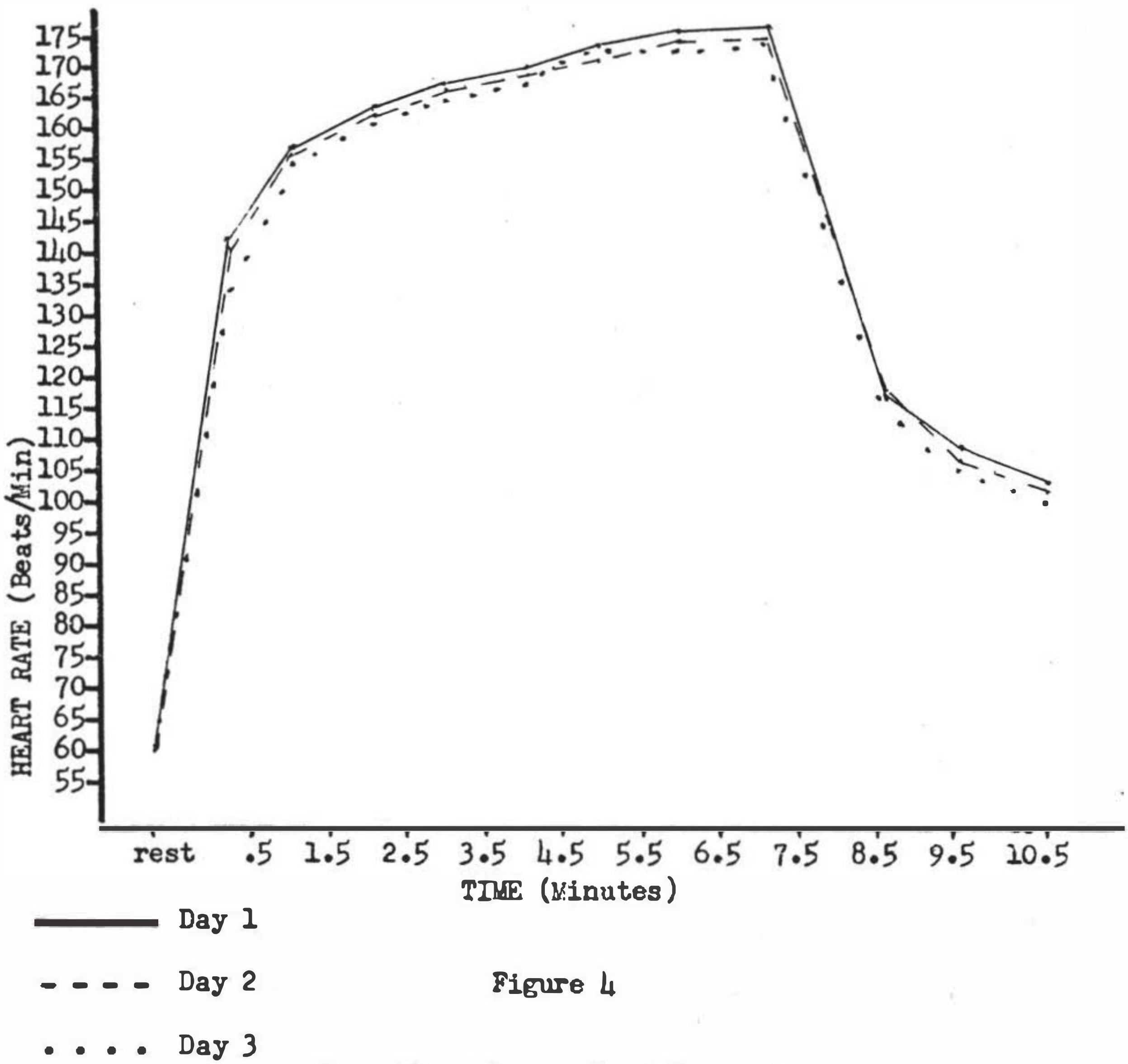

Figure 4

Mean Heart Rates For NTE Group

last two days for all but seven measurements. However, only five of the differences were significant at the .05 level when all three days were compared. The t's for these sixty-six comparisons are listed in Table 8. Three of the significant comparisons were between days one and three, and the other two significant comparisons were one each between days one and two, and days two and three. No pattern of significance was evident, although the heart rate means showed a declining trend as was observed in the NRE group.

Pulmonary Ventilations and Oxygen Consumptions. The means of the pulmonary ventilations and oxygen consumptions are listed in Tables 9 and 10, and depicted in Figures 5 and 6. The pulmonary ventilation values showed very little fluctuation from day to day, the largest mean difference being 2.63 Liters/Minute. None of the differences in the pulmonary ventilation values were significant at the .05 level, and no trend was evident, either increasing or decreasing. The t's for the pulmonary ventilations are listed in Table 11.

The t scores for the oxygen consumptions are listed in Table 12. The oxygen consumption values showed greater fluctuation, but the 3:00-3:30 reading was the only one to show statistical significance or trend. The means for this reading showed a decline from day to day, and the difference became significant when days two and three, and days one and three were compared.

EXP Group (Previous Running and Previous Laboratory/Treadmill Experience)

Heart Rates. The mean heart rates for the EXP Group are listed in Table 13 and depicted in Figure 7. The heart rate declined on both of the last two days at every reading except four, three of which were in recovery. Only three of the changes were significant at the .05 level when all three

Table 8

Summary of t Tests For Heart Rates
NTE Group

Test Time (Min)	t Ratio Day 1 vs. Day 2	t Ratio Day 2 vs. Day 3	t Ratio Day 1 vs. Day 3
Rest	.714	.676	.320
.5	.966	1.691	2.219
1.0	.680	1.559	1.551
1.5	1.452	.435	1.139
2.0	.611	1.060	1.930
2.5	.546	.804	1.780
3.0	1.322	.714	2.251
3.5	1.546	1.181	2.393*
4.0	.782	.407	.717
4.5	.894	.699	1.744
5.0	1.193	1.317	2.434*
5.5	2.520*	2.339*	.326
6.0	1.429	.779	.239
6.5	1.122	.868	1.945
7.0	.377	2.049	2.175
7.5	.814	.137	1.142
8.0	.827	1.716	.290
8.5	.544	.586	.049
9.0	1.480	.644	.983
9.5	1.061	.561	2.005
10.0	2.138	1.013	2.820*
10.5	.798	.688	1.386

*Significant at the .05 level

Table 9

Mean Pulmonary Ventilations For NTE Group
(L/Min-STPD)

Reading (Min)	Day 1	Day 2	Day 3	Difference Days 1-2	Difference Days 2-3	Difference Days 1-3
3:00-3:30	79.78	81.45	79.82	+2.33	-1.63	+ .04
5:00-5:30	83.00	82.40	85.03	- .60	+2.63	+2.03
7:00-7:30	86.21	88.53	87.61	+2.32	- .92	+1.40
			Mean Difference	+1.35	+ .03	+1.15

Table 10

Mean Oxygen Consumptions For NRE Group
(ml/kg/min)

Reading (Min)	Day 1	Day 2	Day 3	Difference Days 1-2	Difference Days 2-3	Difference Days 1-3
3:00-3:30	38.64	37.38	36.06	-1.26	-1.32	-2.58
5:00-5:30	38.76	37.66	38.51	-1.10	+ .85	- .25
7:00-7:30	41.76	42.56	41.52	+ .80	-1.04	- .24
			Mean Difference	- .52	- .50	-1.02

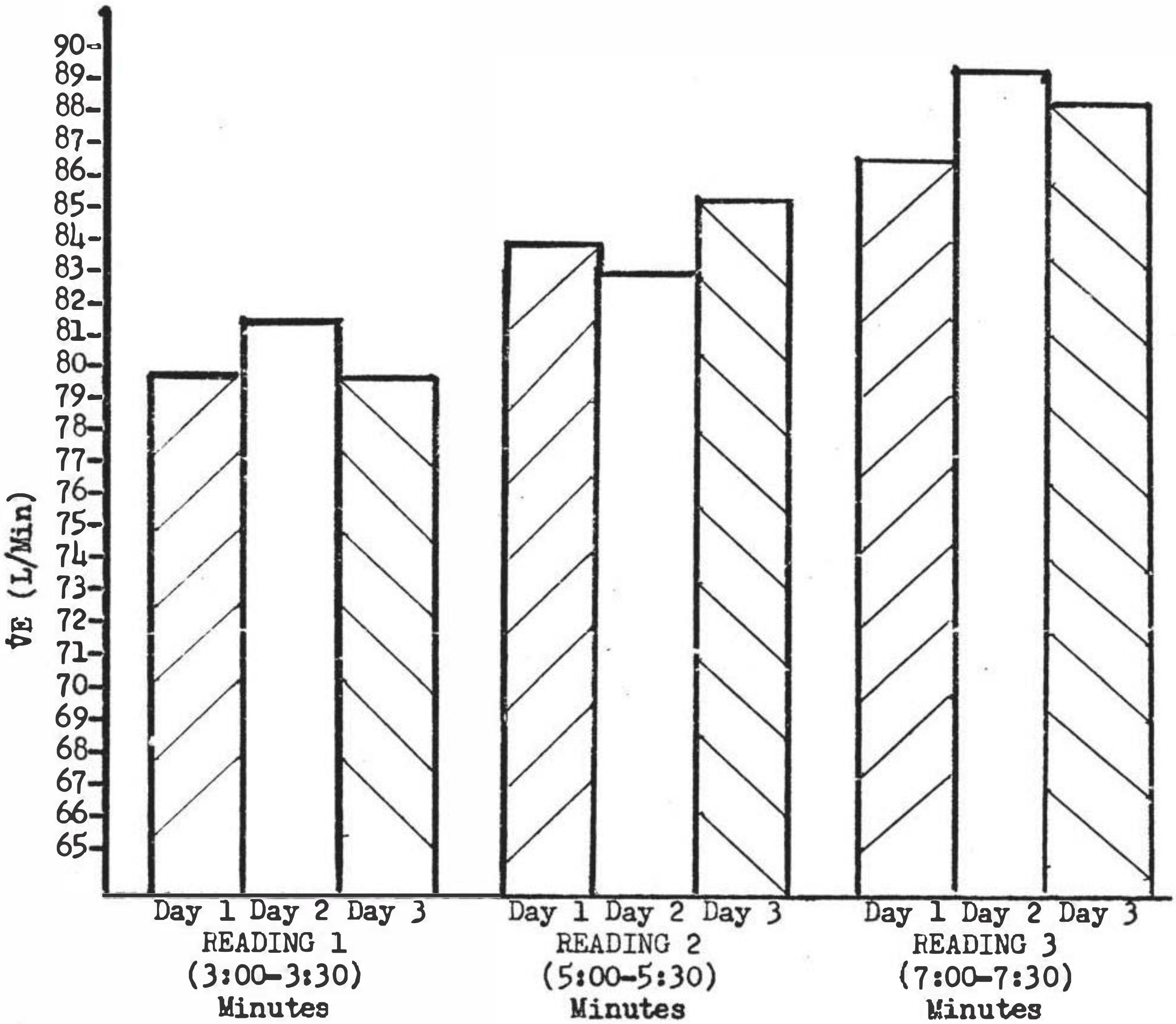

Figure 5

Mean Pulmonary Ventilation
For NTE Group

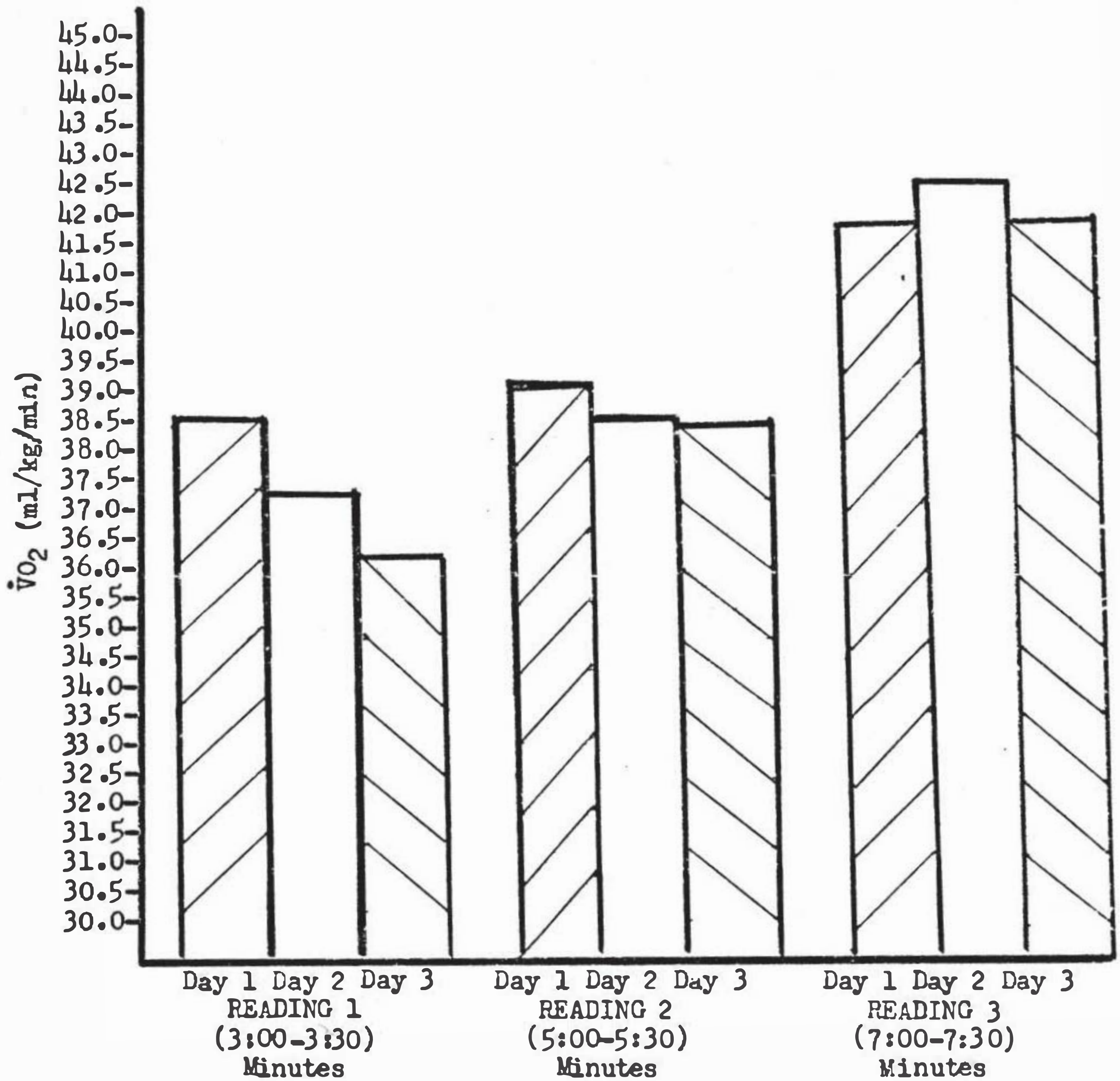

Figure 6

Mean Oxygen Consumptions
For NTE Group

Table 11

Summary of t Tests For Pulmonary Ventilations
NTE Group

Reading (Min)	t Ratio Day 1 vs. Day 2	t Ratio Day 2 vs. Day 3	t Ratio Day 1 vs. Day 3
3:00-3:30	1.794	.586	.012
5:00-5:30	.407	1.798	.920
7:00-7:30	.673	.366	.919

*Significant at the .05 level

Table 12

Summary of t Tests For Oxygen Consumptions
NTE Group

Reading (Min)	t Ratio Day 1 vs. Day 2	t Ratio Day 2 vs. Day 3	t Ratio Day 1 vs. Day 3
3:00-3:30	1.204	2.245*	2.277*
5:00-5:30	1.133	.859	.227
7:00-7:30	1.041	1.189	.320

*Significant at the .05 level

Table 13

Mean Heart Rates For EXP Group
(Beats/Min)

Test Time (Min)	Day 1	Day 2	Day 3	Difference Days 1-2	Difference Days 2-3	Difference Days 1-3
Rest	55.10	54.90	51.70	- .20	-3.20	-3.40
.5	129.00	126.70	125.90	-2.30	- .80	-3.10
1.0	138.80	137.10	136.00	-1.70	-1.10	-2.80
1.5	143.70	143.10	140.00	- .60	-3.10	-3.70
2.0	144.90	144.00	142.30	- .90	-1.70	-2.60
2.5	146.80	144.60	144.00	-2.20	- .60	-2.80
3.0	146.40	143.80	145.30	-2.60	+1.50	-1.10
3.5	146.90	144.80	144.60	-2.10	- .20	-2.30
4.0	149.00	148.10	146.00	- .90	-2.10	-3.00
4.5	148.40	148.00	145.30	- .40	-2.70	-3.10
5.0	148.40	147.60	146.70	- .80	- .90	-1.70
5.5	149.80	148.20	146.80	-1.60	-1.40	-3.00
6.0	150.60	148.80	148.30	-1.80	- .50	-2.30
6.5	150.90	148.70	148.90	-2.20	+ .20	-2.00
7.0	150.00	149.10	148.10	- .90	-1.00	-1.90
7.5	151.40	148.60	147.60	-2.80	-1.00	-3.80
8.0	116.60	116.40	110.00	- .20	-5.40	-5.60
8.5	91.40	89.10	92.40	-2.30	+3.30	+1.00
9.0	81.10	83.60	79.50	+2.50	-4.10	-1.60
9.5	80.20	78.90	75.50	-1.30	-3.40	-4.70
10.0	76.70	75.10	70.10	-1.60	-5.00	-6.60
10.5	73.40	73.90	72.40	+ .50	-1.50	-1.00
			Mean Difference	-1.2	-1.6	-2.8

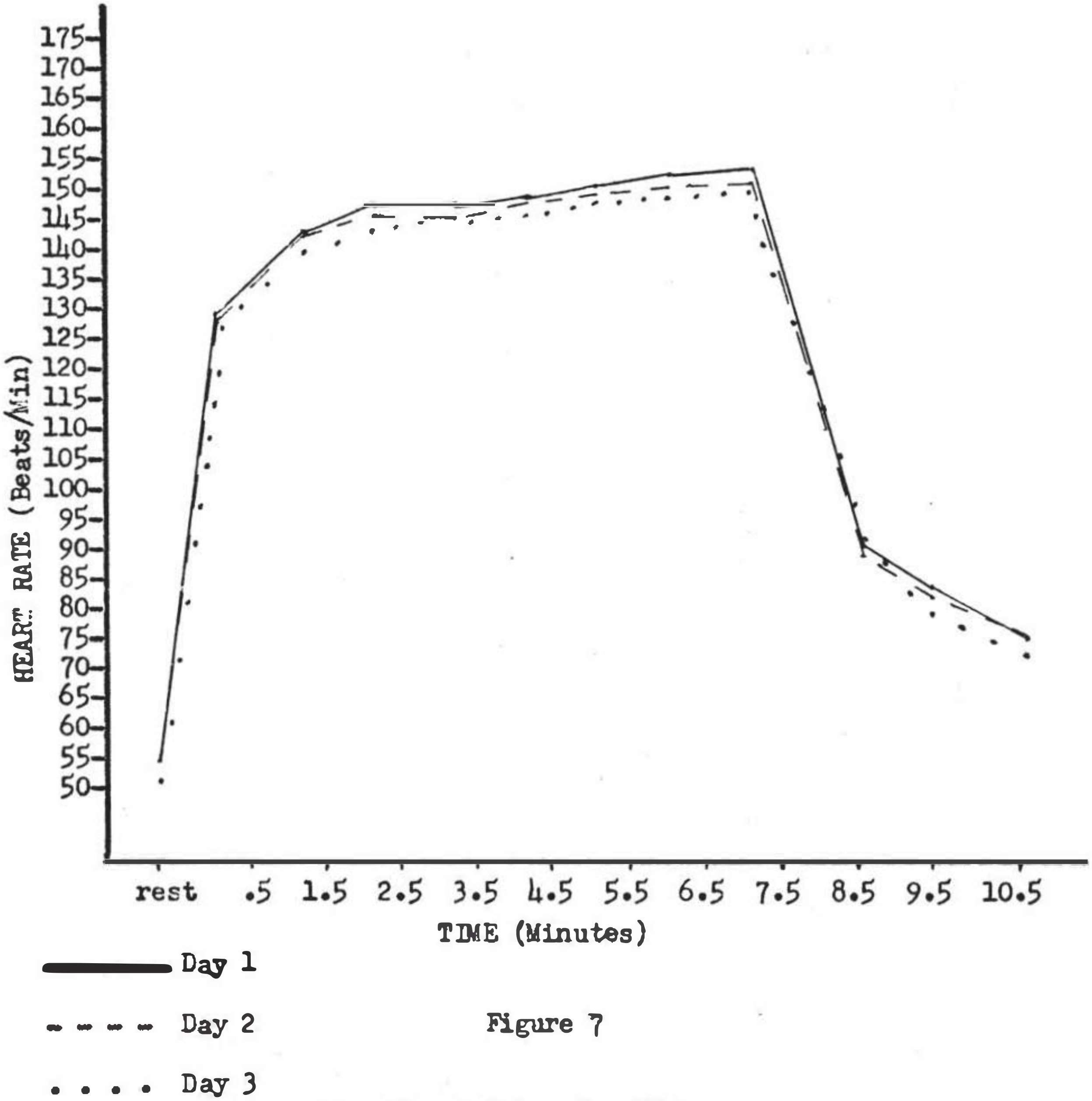

Figure 7

Mean Heart Rates For EXP Group

days were compared. The *t* scores for these comparisons are listed in Table 14. As in the other groups, a declining trend in the heart rates from day to day was evident, but not significant.

Pulmonary Ventilations and Oxygen Consumptions. The mean pulmonary ventilation and oxygen consumption values are listed in Tables 15 and 16, and depicted in Figures 8 and 9. As in the other groups, both of these values showed little fluctuation between days, and none of the differences were significant for either parameter. The *t* scores for these comparisons are listed in Tables 17 and 18. The mean pulmonary ventilations showed a rising trend from day to day for all three readings, but the oxygen consumption values fluctuated very little from day to day, and no trends were evident.

SUMMARY AND DISCUSSION OF THE DATA

Heart Rates

All three groups showed a declining trend in heart rate from day to day. Very few of the differences showed significance, however. The NRE group showed the greatest decline from day to day. Although the difference between the NRE group and the other two is small, its consistency could indicate a greater anxiety reaction to the first testing session. The NTE and EXP groups were very similar in mean heart rate differences.

The declining trend shown by all three groups, although it was not significant in most cases, could be an indication of acclimatization to the laboratory and the testing procedures. If the test had been carried out to a fourth or fifth day, the declining heart rates may have become significant.

Pulmonary Ventilation and Oxygen Consumption

All three groups showed little fluctuation of pulmonary ventilation

Table 14

Summary of t Tests For Heart Rates
EXP Group

Test Time (Min)	t Ratio Day 1 vs. Day 2	t Ratio Day 2 vs. Day 3	t Ratio Day 1 vs. Day 3
Rest	.110	1.899	1.764
.5	1.116	.440	1.637
1.0	1.092	.584	1.446
1.5	.363	1.713	2.314*
2.0	.608	1.283	1.847
2.5	1.107	.330	1.960
3.0	1.998	1.103	.654
3.5	1.317	.105	1.264
4.0	.506	1.406	1.591
4.5	.279	2.119	1.642
5.0	.712	.719	1.229
5.5	.983	.685	1.910
6.0	.974	.342	1.194
6.5	.955	.136	.973
7.0	.395	.539	.988
7.5	1.081	.501	2.187
8.0	.059	2.706*	1.349
8.5	.872	1.323	.316
9.0	.651	1.353	.582
9.5	.385	.959	.995
10.0	.468	2.231*	1.856
10.5	.175	.501	.338

*Significant at the .05 level

Table 15

Mean Pulmonary Ventilations For EXP Group
(L/Min-STPD)

Reading (Min)	Day 1	Day 2	Day 3	Difference Days 1-2	Difference Days 2-3	Difference Days 1-3
3:00-3:30	70.98	73.72	75.48	+2.74	+1.76	+4.50
5:00-5:30	72.58	74.21	75.00	+1.63	+ .79	+2.42
7:00-7:30	72.60	75.58	76.30	+2.98	+ .72	+3.70
			Mean Difference	+2.45	+1.09	+3.54

Table 16

Mean Oxygen Consumptions For EXP Group
(ml/kg/min)

Reading (Min)	Day 1	Day 2	Day 3	Difference Days 1-2	Difference Days 2-3	Difference Days 1-3
3:00-3:30	37.74	37.56	37.07	- .18	- .49	- .67
5:00-5:30	38.27	38.09	38.19	- .18	+ .10	- .08
7:00-7:30	39.89	40.58	40.42	+ .69	- .16	+ .53
			Mean Difference	- .11	- .18	- .07

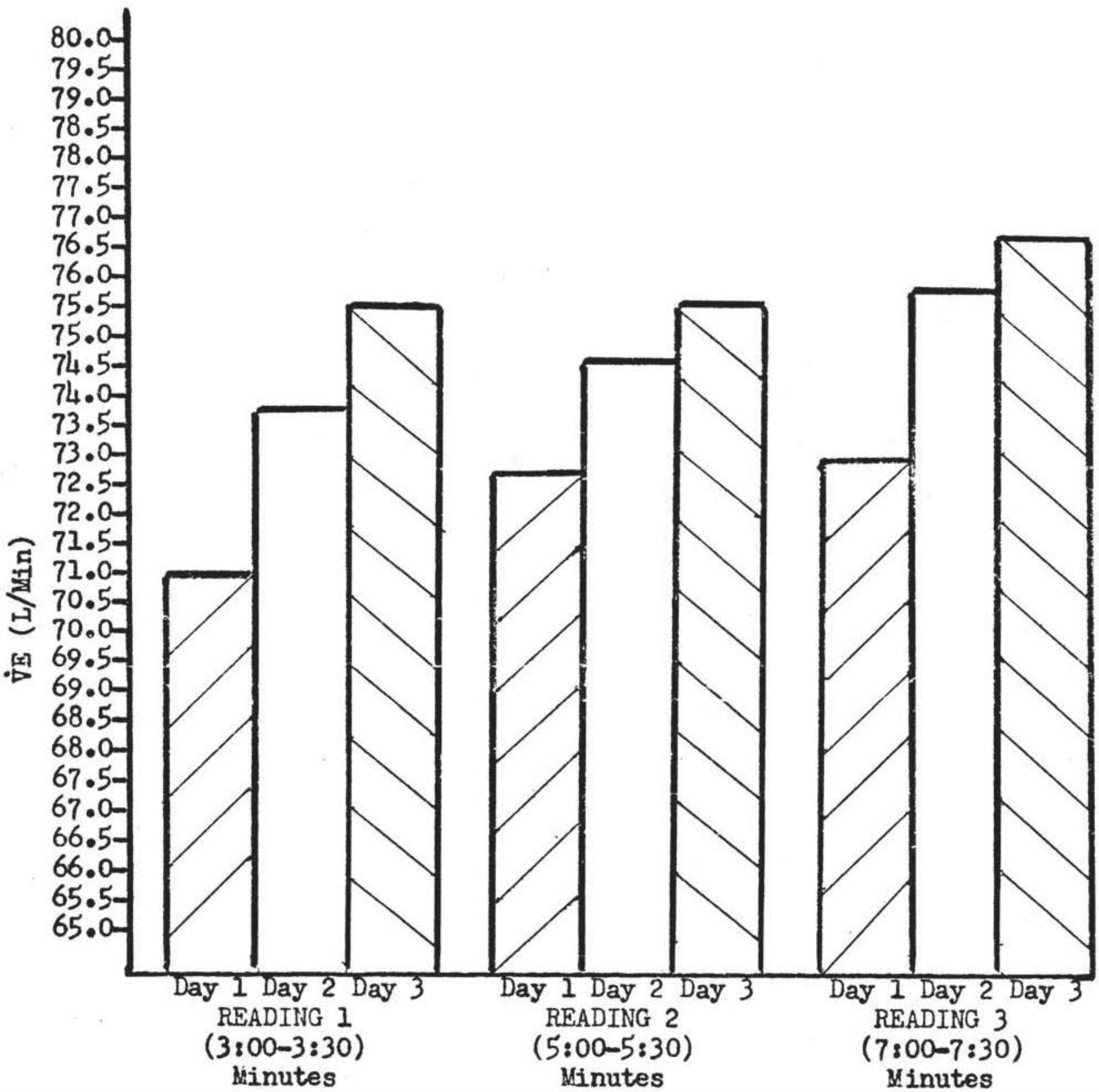

Figure 8

Mean Pulmonary Ventilation
For EXP Group

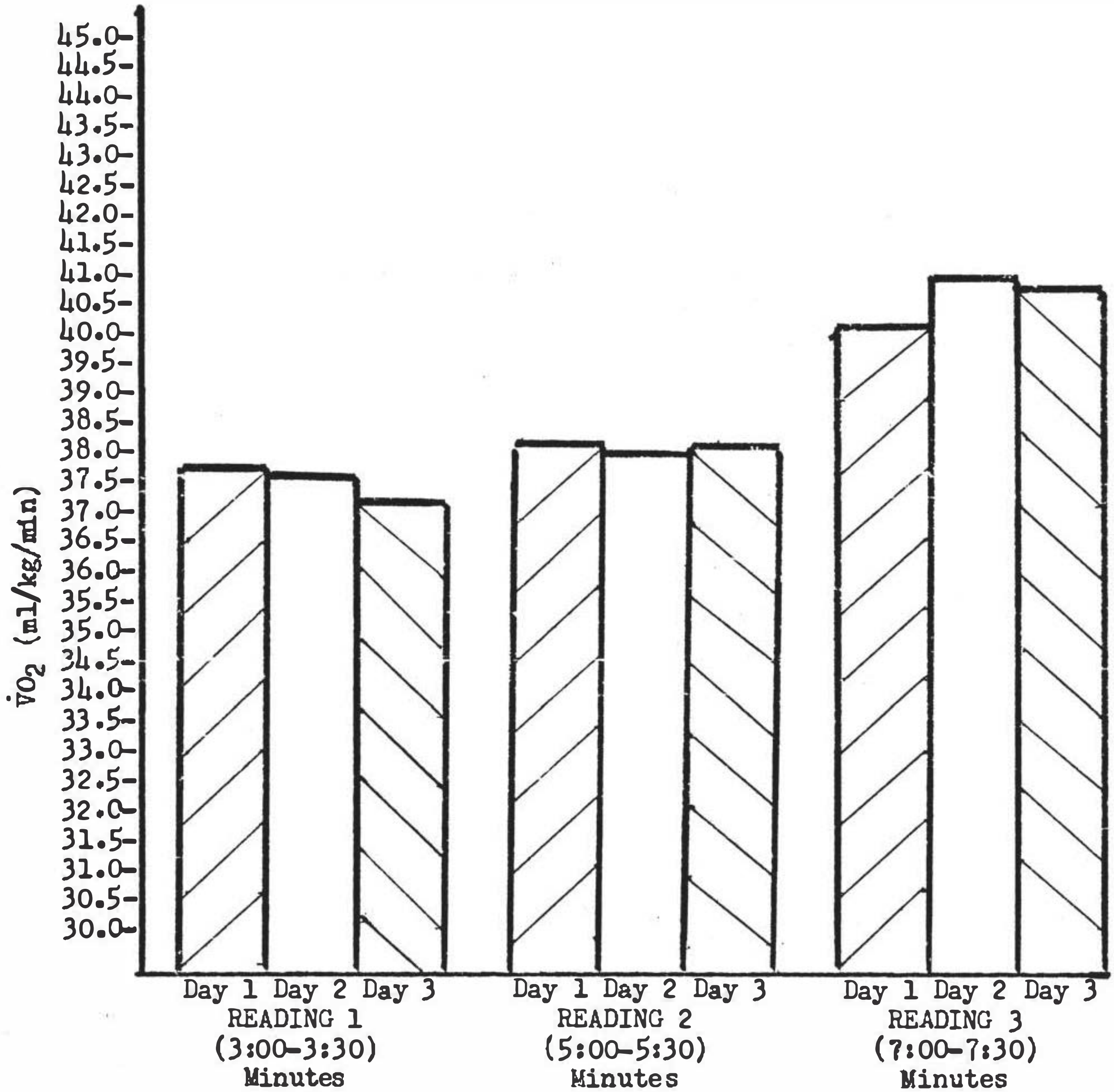

Figure 9

Mean Oxygen Consumptions
For EXP Group

Table 17

Summary of t Tests For Pulmonary Ventilations
EXP Group

Reading (Min)	t Ratio Day 1 vs. Day 2	t Ratio Day 2 vs. Day 3	t Ratio Day 1 vs. Day 3
3:00-3:30	.742	.818	.957
5:00-5:30	.486	.462	.881
7:00-7:30	.710	.218	1.395

*Significant at the .05 level

Table 18

Summary of t Tests For Oxygen Consumptions
EXP Group

Reading (Min)	t Ratio Day 1 vs. Day 2	t Ratio Day 2 vs. Day 3	t Ratio Day 1 vs. Day 3
3:00-3:30	.156	.383	.384
5:00-5:30	.194	.196	.096
7:00-7:30	.164	.340	.619

*Significant at the .05 level

and oxygen consumption values from day to day. The EXP group showed the largest fluctuation in pulmonary ventilation. This was surprising since it was expected that they would show the most stability. Oxygen consumptions showed the smallest fluctuation of all three parameters measured. The mean difference between days only rose above 1 ml/kg/min on five occasions, all of these in the NTE Group where the only two statistically significant differences were found. It would seem that respiratory parameters were more stable than heart rates, though no really significant trends were observed for any of the parameters.

Relationship of Heart Rate and Respiratory Parameters

Criterion for delineating between work and emotional heart rate have not been clearly established. Dolley[2] felt that work heart rate could be differentiated from emotional heart rate by comparing the heart rate responses to the oxygen consumption values. He stated that if the oxygen consumption rose or fell in conjunction with the rise and fall of the heart rate, then the heart rate response was due to the workload. If the oxygen consumption remained stable and the heart rate rose or fell, then the change in heart rate was due to emotional influences, rising as the emotional response increased and falling as the emotional response declined.

Applying Dolley's criterion to the data from the study, the declining trend in the heart rate could be attributed to a lessoning of anxiety with continued exposure to the test. The oxygen consumption values fluctuated very little from day to day in any of the three groups, which

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[2] Franks Dolley and others, "The Efficiency of the Heart, and the Significance of Rapid and Slow Pulse Rates," American Journal of Physiology, 82:512-24, November, 1927.

would indicate that the subjects' response to the workload was consistent. The decline in the heart rate would not be attributed to conditioning, but possibly to a lessoning of the emotional response to the testing situation.

Chapter 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

SUMMARY

The study was conducted to investigate the variability of heart rate, pulmonary ventilation, and oxygen consumption values during successive submaximal treadmill tests. The effects of previous running and/or treadmill running experience on this variability were also studied.

Twenty-six members of the Eastern Illinois University Run For Your Life Program were subjects in the study. The subjects were chosen from three groups: 1) Subjects who had both previous running experience and laboratory/treadmill running experience, 2) Subjects who had previous running experience but no previous laboratory/treadmill running experience, and 3) Subjects who had little previous running experience and no previous laboratory/treadmill running experience.

The same submaximal treadmill test was taken by each subject on three different occasions during an eight day period. Each testing session included an orientation, as well as, the test itself. The test for the two groups with previous running experience consisted of running at seven miles per hour up a four percent grade for seven and a half minutes. The test for the group with little previous running experience consisted of walking at 3.6 miles per hour up a four percent grade for the first three and a half minutes, and then running at six miles per hour up the same grade for the last four minutes.

Heart rates were measured by telemetry at rest and every thirty

seconds during the test, beginning at thirty seconds until three minutes into recovery. Pulmonary ventilation and oxygen consumption data were collected for thirty seconds at three, five, and seven minutes during the test.

A t-test was applied to the data within each group to determine any statistically significant differences between the correlated pairs of means. The .05 level was established for the study to show statistical significance.

CONCLUSIONS

Based on the findings of the study, the following conclusions appear justified:

1. There is no variability of heart rate, pulmonary ventilation, and oxygen consumption responses to a submaximal treadmill test on successive testing days.
2. Previous running and/or previous laboratory/treadmill experience has no effect on this variability.

RECOMMENDATIONS

Based on the findings of the study, the following recommendations appear warranted:

1. A similar study should be done that would carry the testing out for more sessions to determine if the heart rate decline would become significant. This study should be carried out until the heart rate stabilizes.
2. A study should be done to standardize the procedures for delineating between work and emotional heart rates.
3. Further studies should be carried out to determine other causes of emotional-psychological stimulation in the testing design.

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VITA

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The writer was born in Manteno, Illinois, on March 25, 1949. He attended Manteno High School where he earned varsity letters in four sports. He graduated with academic honors in 1967, and entered Eastern Illinois University in the fall of that year. While majoring in physical education, he competed in cross country and track, being elected captain in both sports his senior year and most valuable in cross country. He competed on the EIU cross country teams that won the NCAA College Division Cross Country Championships in 1968 and 1969. At one time he held the school's two and six mile run records and competed in the NCAA College Division and NAIA track and field championships in 1971.

While at Eastern, he was a member of the physical education majors club, Phi Epsilon Kappa, and the Varsity Club. He was a member of the Fellowship of Christian Athletes, and served as captain his senior year. He was awarded the Richard G. Browne Award as the athlete with the highest grade point average in his junior and again in his senior year. He was also awarded the Charles P. Lantz Scholarship his junior year and the Senior Scholastic Award in athletics.

He graduated from Eastern in 1971 with honors, and accepted a graduate assistantship there for the 1971-72 school year. He married Charlene Lahners in August of 1971. He received an M.S. in Physical Education degree in August of 1972, and took a coaching job at Manteno High School for the following school year.