THE EFFECTS OF PACE AND RECOVERY PERIOD TRAINING UPON THE TIME OF 440 YARD SPRINT PERFORMANCE

A Thesis

Presented to

the Faculty of the Department of Physical Education

Kansas State Teachers College of Emporia

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

---

by

Charles Rogers

August 1970

Th
K

Approved for the Major Department

Approved for the Graduate Council

ACKNOWLEDGMENTS

I extend my appreciation to Dr. George Milton for his guidance, to Dr. Raymond Heath for his statistical assistance, and to my wife Pat, for her patience.

C.R.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

THE PROBLEM AND DEFINITION OF TERMS USED

I. INTRODUCTION

Numerous theories have been developed in the methods of training for running events in track, many of which were based upon (1) the performance of successful runners, (2) personal experiences of different coaches, and (3) tradition. Interval training is one method of training for track. Although coaches of various countries called interval training by different names, they generally agree that it consisted of five factors: (1) terrain, (2) distance, (3) number of runs, (4) pace, and (5) recovery period.[1]

Recent publications have stressed the importance of the physiological aspects of interval training on the runner. These publications offered conflicting theories. John Spindler stated that the body adapted during the recovery period and not during the performance,[2] while Zygmunt Litynski claimed that the recovery period was of no importance.[3]

---

[1]John Kenneth Doherty, Modern Track and Field (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1963), p. 176.

[2]John Spindler, "The Physiological Basis of Interval Training," United States Track Coaches Association Quarterly Review, (December, 1966), 58.

[3]Zygmunt Litynski, "Science Muscles in on Athletes," Science Digest (February, 1961), 71.

II. THE PROBLEM

In this study the investigator tested two methods of training for track in an attempt to answer the following questions:

1. Will pace training cause a significant improvement in the running performance of the 440-yard dash?

2. Will recovery training cause a significant improvement in the running performance of the 440-yard dash?

3. Is there a significant difference between the two methods of training, pace and recovery?

Statement of the problem. The purpose of this study was to analyze the effectiveness of two forms of training programs upon the 440-yard running times of high school boys. This study investigated the influence of the two training methods upon the performance of the runners and then compared the results of the performances to see if there was a significant difference between the following two methods: (1) regulating the speed of a race (pace) and (2) regulating the amount of rest (recovery period) between runs.

Purpose of the study. In this study the investigator hoped to contribute some information which would help determine (1) the significance of pace training upon the 440-yard dash, (2) the significance of the recovery period upon the performance of the subjects in the 440-yard dash, and (3) whether one of the two methods was more effective in increasing the speed of the subjects in the 440-yard dash. This information may be used as a guide for track coaches.

III. DEFINITIONS OF TERMS USED

Interval training. A system of repeated efforts in which a distance of measured length is run on a track, at a timed pace alternately with measured recovery periods of low activity.[4]

Pace. The predetermined speed an individual runs a race, which was seventeen seconds in this study.

Recovery period. The rest time between sprints, in this study, the subjects sat in the bleachers. (Total rest time for this study was 16 minutes, approximately.)

Sprint. Any race 440-yards or less. In this study the subjects ran 440-yards for testing and 100 yards for training. (Total time in this study spent running was approximately 10 minutes.)

Subjects. All the sophomore boys enrolled in the fourth hour physical education class at Rosedale High School in Kansas City, Kansas.

IV. LIMITATIONS OF THE STUDY

This study was limited to one male sophomore physical education class for a period of five weeks at Rosedale High School in Kansas City, Kansas. The investigator had no control over the number of times the subjects were missing from class due to illness, other activities, or disciplinary reasons.

---

[4]Doherty, op. cit., p. 175.

CHAPTER II

REVIEW OF RELATED LITERATURE

The effects of pace and recovery time have become a subject of discussion since the innovation of interval training. It was the purpose of this chapter to present a review of the literature under the following headings: (1) training methods of the past, (2) history of interval training, (3) studies related to pace training, and (4) research involved with the recovery period.

I. RESEARCH RELATED TO HISTORY OF TRAINING

A summary of the recent training procedures has been included in this section to show the general trend in track training. These different training methods evolved slowly from each other and were interrelated, making it difficult to pinpoint their origin.

Nurmi, a Finnish runner, was credited with founding the "long distance mental hardening approach."[1] His followers were runners who thought that they had enough speed, but needed more strength to endure distance running. These followers of the Nurmi method trained by running longer distances in practice than in competition.

The Swedish "Fartlek" method was a continuation of the Finnish method only more extended and intensified.[2] Fartlek meant speed play.

---

[1]John Spindler, "The Physiological Basis of Interval Training," United States Track Coaches Association Quarterly Review (December, 1966), 74.

[2]Ibid., p. 75.

It was named and written about first in 1948 by Gusta Holmer, the coach of the Swedish Olympic track team.[3] The Fartlek method consisted of long walks, short sprints, and distant jogging all mixed together at the discretion of the runner. Fred Wilt brought skepticism to the Fartlek method when he said that no one trains to run slower, coaches and runners train only to run faster.[4]

The Cerutty method was a variation of the Swedish Fartlek method.[5] It was founded by Percy Cerutty, the Australian coach of Herb Elliott. There was less freedom in Cerutty's method and it required an enormous determination by the runner. It not only regulated the athletes running, but also his personal life and diet. Included in this type of training were thirty mile runs, sprints up sand dunes, weight training, and relaxation exercises.[6]

II. RESEARCH RELATED TO INTERVAL TRAINING

With the emphasis on science today, it was only logical that training procedures became more scientific. The physiological study of the human body has evolved from this scientific process. Stress and overload are two areas which require discussion to trace the history of interval training.

---

[3]John Kenneth Doherty, Modern Track and Field (Englewood Cliffs: Prentice-Hall Inc., 1963), p. 167.

[4]Fred Wilt, "Training Trends in Distance Running," Scholastic Coach, XXXIII (February, 1964), 75.

[5]Spindler, op. cit., p. 77.

[6]Ibid.

The Finnish used hot and cold baths to expose and condition their sympathetic nervous system to stress long before they understood the physiological implications.[7] Either hot or cold constituted a stress to which the system must react, thus producing a type of stress training. More recently, it was found in a study of two groups of college men that both groups had an increased pulse rate after a step test exercise and a decrease in pulse rate after a cold shower.[8] One group was in good physical condition and the other group was not. It was also found that the conditioned group was more affected by the cold shower (lowered the pulse rate faster) than was the unconditioned group. F. M. Henry found that a decrease in the heart rate (which indicated a more developed heart) was an effective test of athletic conditioning.[9] Jacoby found that the human heart rate during activity actually decreased in the trained individual.[10]

Stress training referred also to exerting maximum intensity to an organism to achieve a result. This maximum stress was the basis of the overload principle which stated that strength or endurance can only come about by placing stress upon the body. Jacoby said that no matter

---

[7]Thomas K. Cureton, "Training Youthful, Record Breaking Athletes," Athletic Journal, XLVI (November, 1965), 32.

[8]Earnest D. Michael, Jr., "Effects of Cold Showers on Circulation of Conditioned and Non-conditioned Men," Research Quarterly, XXXVIII (March, 1957), 38.

[9]Franklin M. Henry, "Influence of Athletic Training on the Resting Cardiovascular System," Research Quarterly, XXV (March, 1954), 28.

[10]Edward G. Jacoby, "Physiological Implications of Interval Training," United States Track Coaches Association Quarterly Review (March, 1969), 44.

how much a muscle is used or fatigued, it would not become stronger unless it was overloaded.[11] The threshold value of the overload stimulus was found by Hettinger to be slightly above 1/3 maximum intensity of an organism or individual.[12]

Local muscle endurance was equal to the ability of cells to adjust to a state of oxygen debt.[13] This came about through training by practice of high repetitions through a moderately fast rate of speed carried through a short time duration. This would be demonstrated by a training session of from 100 to 440 yards at near top speed with a moderate recovery period between each, thus producing a repeated high rate of oxygen debt. Short distant running (10 minutes) was seen to be just as beneficial as long distant running (30 minutes) in a study of cardiovascular development.[14] In fact, it was found that those individuals that had a high degree of cardiovascular efficiency at the start of the study improved the most when running in the shorter time group. Therefore, short distant running in this study was more beneficial to the cardiovascular system than was longer running for the individual in good physical condition (as characterized by a track participant at mid-season).

---

[11] Ibid., p. 42.

[12] Edward G. Jacoby, Physiological Implications of Interval Training (Idaho Falls: Idaho Falls School District 91, 1968), p. 5.

[13] Ibid., p. 6.

[14] George C. Milton, "The Effects of Three Programs of Long Distance Running and an Isometric Exercise Program on the Development of Cardiovascular Efficiency" (Ed.S., Baton Rouge, Louisiana, 1966), p. 59.

Moorehouse points out that in running, a muscle must contract thirty or more times per minute to obtain a benefit from the overload principle.[15] Spindle said that the success of any conditioning process depends on the intensity of the stimuli produced by the muscular or cardiovascular efforts. He referred to the adaptive regulatory process in conditioning the human body to running. Spindle added that this adaptive process occurred only once, at the beginning of the race.[16] By forcing the organism (runner) to adapt forty times (as forty short sprints), the organism achieved a high degree of regulation which was important in development of the cardiovascular and respiratory systems. In other words, forty short sprints of twenty yards (total 800 yards) was more beneficial to the cardiovascular and respiratory systems development than one run of 800 yards at similar speed. Zygmunt Litynski put these ideas into a training program when he stated that athletic training should consist of short periods of strain alternating with similar periods of rest, and repeat this sequence frequently.[17] This was the basis of the interval training method.

Interval training had its origin in the 1920's when athletes ran repeated sprints. According to Doherty, interval training evolved gradually over a period of ten years.[18] Runners in the early 1920's

---

[15]Jacoby, op. cit., p. 5.

[16]Spindler, op. cit., p. 56.

[17]Zygmunt Litynski, "Science Muscles In On Athletes," Science Digest, IL (February, 1961), 71.

[18]Doherty, op. cit., p. 177.

did what they called "ins and outs" or repeat speed work. Woldemor Gerschler and Hans Reindell developed the modern theory of interval training in the late 1930's.

In the past ten years, interval training methods have been used for other sports. Spindler claimed that interval training was helpful in conditioning for soccer, hockey and Lacross.[19] Harold Wissel stated that interval training played an important part in the development of basketball players, swimmers, tennis players, and soccer players.[20]

III. RESEARCH RELATED TO PACE

The speed of a race, also called the pace, was thought of as the end result of the training and conditioning process in track. Since the early 1950's researchers like Kronsbein, Henry, and Spindler have established pace as part of the training procedure.

Kronsbein, in a study on two groups of high school freshmen boys, found that the speed in the 220-yard dash was increased in the group that practiced pace work in contrast to the group which ran the distance in an all out effort.[21] From the physiological standpoint, Henry found that steady pace running (300 yards) had greater physiological economy

---

[19]Spindler, op. cit., p. 65.

[20]Harold R. Wissel, "Interval Training For Basketball Players," Athletic Journal, XLVII (June, 1967), 22.

[21]Fred Kronsbein, "Steady Pace Vs. Variable Speed In High School 220-Yard Run," Research Quarterly, XXVI (October, 1955), 294.

for the human body[22] than did running fast and then slow among two groups of college men.

As to the time and distance of a sprint, Reindell recommended that the length of the performance should be less than sixty seconds in duration while the race anywhere between seventy-five yards and 220-yards for optimum effect.[23]

John Spindler gave the following two reasons why the 100-yard dash was a good distance for interval training. First it did not require any oxygen intake, therefore it was a performance that called for 100% oxygen debt to occur. Secondly, it took about ten seconds to run which brought the performer to the tolerance limit for oxygen debt.[24]

IV. RESEARCH RELATED TO THE RECOVERY PERIOD

There has been disagreement concerning the effect of the recovery period upon training or conditioning for track. Gerschler experimented in the 1930's with half of his subjects remaining quiet and half performing mild exercises. He found their heart rates returned to normal at the same speed.[25] In contrast, some track authorities stated that exercise was not only beneficial but a necessity in training for track during the recovery period.

---

[22]Franklin M. Henry, "Time Velocity Equations and Oxygen Requirements Of All-Out and Steady-Pace Running," Research Quarterly, XXV (May, 1954), 177.

[23]John Spindler, "Views From Foreign Coaches On Training," Track And Field Quarterly Review (October, 1965), 42.

[24]Ibid., p. 43.

[25]Doherty, op. cit., p. 177.

Research in the recovery period received increased attention during the 1960's. Spindler claimed that the recovery period had a double purpose: (1) provide time for the recovery of the performer and (2) offer the opportunity for the regulative adaption to occur.[26] He also mentioned that the length of the recovery period depended upon the intensity of the performance.

Reindell recommended that the recovery period be forty-five to ninety seconds long. He also stated that the main stimulus for the adaptive process does not occur during the single performance but during the recovery period.[27] In agreement with this, Nocker indicated that a minimum of thirty seconds, and a maximum of three minutes be used for recovery, or the benefits of the adaptive process were lost.[28]

Christensen, working with college students, found that the total oxygen consumption of his subjects during a certain amount of work was greater if the work was spaced with rest periods.[29] In another study, Reindell, Roskamm, and Gerschler, indicated that during the resting phase of interval training there was an increased oxygen intake and a lower arterial blood pressure.[30]

---

[26]John Spindler, "The Physiological Basis of Interval Training," United States Track Coaches Associations Quarterly Review (December, 1966), 58.

[27]H. Reindell, H. Roskamm, and W. Gerschler, Das Interval Training (Munich: Johann Ambrosius Barth, 1962), p. 61.

[28]Jacoby, op. cit., p. 48.

[29]Edward G. Jacoby, "Physiological Implications Of Interval Training," United States Track Coaches Association Quarterly Review (March, 1969), 42, citing Arbeitsphysiological, 18:345, 1960.

[30]Jacoby, op. cit., p. 50.

There are contradictory opinions as to what activity the runner should engage in during the recovery period. Gerschler went to one extreme with a group of 3,000 adult subjects. One group laid down on horizontal tables with their heads and feet elevated, and the other group did moderate jogging. Gerschler found that his subjects pulse rates returned to normal just as quickly in both groups after running.[31] In support of jogging, Doherty found that very relaxed jogging during the recovery period was the best possible method of making rapid recovery from fatigue as well as avoiding muscular stiffness or soreness.[32]

---

[31]Doherty, op. cit., p. 181.

[32]Ken Doherty, "Interval Training," Scholastic Coach, XXV (March, 1956), 20.

CHAPTER III

PROCEDURE

Numerous theories have been developed in the methods of training for track, one of these was interval training. Interval training consisted of five factors: (1) terrain, (2) distance, (3) number of runs, (4) pace, and (5) recovery period. This investigator took two of these factors (pace and recovery) and tested them upon thirty-eight high school sophomore boys in a physical education class. The purpose was to investigate the effects of two methods of training: (1) regulating the speed of a race (pace) and (2) regulating the amount of rest between races to determine which method was more effective in increasing the speed of high school sophomore boys in a 440-yard dash. Chapter three contains the procedure the investigator followed to conduct this study.

Selection of subjects. The fourth hour physical education class at Rosedale High School in Kansas City, Kansas was used as subjects in this study. It contained thirty-eight male students, ages fifteen to seventeen. The study was completed in October of 1969 to adjust into a unit of physical fitness and to avoid possible severe weather conditions later in the year. The subjects were divided into two groups in the following manner: (1) they wrote their names on a 3x5 card, (2) the cards were shuffled by the investigator, and (3) the cards were dealt into two different stacks. The first stack became the pace group and the second the recovery group. There were two varsity athletes in this class and they were included in this study because the investigator did not believe they would cause any significant difference.

Administration of the test. All the subjects were pre-tested in a 440-yard dash. They were divided into pairs by the investigator and timed by the investigator using two stopwatches. The subjects were paired together in an effort to group boys of similar speed and ability together so that they would complement each other and provide personal competition. In the pre-test, all of the subjects were: (1) to wear gym shoes and gym uniforms, (2) to run on the cinder track at Rosedale High School, (3) started in a stand up position, and (4) started by the use of a wooden starter which emitted a loud bang when clapped together. (Starting blocks were not used because of the unavailability of them and the time that would have been consumed by the subjects constantly re-adjusting the positions of the blocks.) This same test procedure was repeated once a week on Wednesdays for four weeks. On the fifth week this test was used as the post test. The test was given every week to establish a degree of reliability in determining what the subjects could do in a 440-yard dash. The subjects were started by a Mr. Moses Green, a student teacher in physical education and timed by the investigator. On the other four days of the week, the subjects ran the training program.

Training program. Before starting the training program, the purpose of the study was explained to the subjects and they were asked to do their best. The subjects were also told not to run for time or do additional running outside of class so that they would not change the outcome of the study. The investigator doubted that any subject ran outside of class.

On Monday, Tuesday, Thursday, and Friday, both the recovery group and the pace group performed the training program. Preceding each daily session, all the subjects lined up in their respective group and performed the following warm-up exercises: five push ups, five jumping jacks, five sit ups, and five leg stretches. There are many conflicting theories concerning the value of warm up upon performance. This investigator included warm up exercises in this study as a preventive measure against injury to muscles. After each daily training session, all subjects jogged 220-yards to recover and prevent soreness.

Each of the two groups had a different training schedule to follow. Group one, the pace group, ran three sets of sprints with one minute rest between sprints and a five minute rest between sets. They had to run each sprint under 17 seconds. The entire group ran together and the investigator and Mr. Green took turns starting and timing the two groups. Mr. Green stood at the north end of the straightaway and started the first and third sprints. The investigator stood at the south end and timed the first and third sprints. The investigator started the second sprint and Mr. Green timed the second sprint. At the start of each week, the pace (time required to run each sprint) was reduced by one second. The rest periods remained one minute between sprints and five minutes between sets.

Group two, the recovery group, ran three sets with five minutes rest between sets and one minute rest between each sprint. They were also required to run each sprint under 17 seconds. Every week the one minute rest between sprints was reduced by 10 seconds. The 17 second

pace requirement remained constant for the entire five weeks. They were started, timed and recorded the same as group one.

Motivational factors. Each week the subjects were tested in the 440 to record their progress and maintain interest. Their names and times were placed on a chart in the locker room. A system of points was devised to reward the efforts of the subjects. It had three uses: (1) to maintain interest in the program, (2) to obtain maximum effort from the subjects, and (3) to serve as a criterion for grading the subjects in this unit. Every time a subject ran his sprint under the required time limit for his group he was given a point. At the end of the five week period, the number of points for each subject was totaled and a grade given to the subject on a percentage basis.

CHAPTER IV

ANALYSIS OF DATA

The data used in this study was taken from the pre-test and post test performance (time in seconds) of the subjects in a 440-yard dash. Analysis of this data was by the Analysis of Variance Method. This method was used primarily for two reasons: (1) the groups were randomly selected, and (2) two factors of interval training were tested at the same time.[1]

I. ANALYSIS OF PRE-TEST DATA FOR THE TWO GROUPS

Data was analyzed from the pre-test scores in the 440-yard dash from both the pace group and the recovery group. The mean square for between groups was 187.1336 and the mean square for within groups was 257.7840. This produced an F-ratio of 0.7259 which was not significant at the .05 level of significance. To be significant, the F-ratio should have fallen beyond 4.20 (for .05 level of significance) and 7.64 (for .01 level of significance). The results of the pre-test data analysis are shown in Table I, page 18, while the raw scores for the pre-test are in the Appendix, page 34. This data showed that there was no significant difference between the two sample groups at the start of the study and that the two groups were similar with respect to the pre-test analysis.

---

[1]Armand J. Galfo, and Earl Miller, Interpreting Education Research (Dubuque, Iowa: William C. Brown Company, 1965), p. 173.

TABLE I

ANALYSIS OF VARIANCE OF PRE-TEST FOR RECOVERY AND PACE GROUPS

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F
Between groups	1	187.1336	187.1336	0.7259
Within groups	28	7217.9544	257.7840	
Total	29	7405.0880		

F-ratio necessary at the .05 level of significance with 1,29 degrees of feeedom = 4.20.

II. ANALYSIS OF VARIANCE OF POST TEST DATA FOR THE TWO GROUPS

At the end of the test period, the subjects were again tested in the 440-yard run. This post test data from the pace group and the recovery group was analyzed. The mean square for between groups was 4.2904 and the mean square within the groups was 147.6807. This produced an F-ratio of 0.0290 which was not significant at the .05 level of significance. The results of the post test data analysis are shown in Table II, page 19. The raw scores for the post test are in the Appendix, page 35. This data showed that there was no significant difference between the two groups at the end of the study. The two groups were similar with respect to the post test analysis. From the table of F values, an F-ratio of 0.7259 was not significant at the .05 level of significance. To be significant, the F-ratio should have fallen beyond 4.20. From the same table, an F-ratio of 0.0290 also was not significant at the .05 level.

TABLE II

ANALYSIS OF VARIANCE OF POST TEST FOR RECOVERY AND PACE GROUPS

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F
Between groups	1	4.2904	4.2904	0.0290
Within groups	28	4135.0616	147.6807	
Total	29	4139.3520		

F-ratio necessary at the .05 level of significance with 1,29 degrees of freedom = 4.20.

III. ANALYSIS OF VARIANCE OF PACE GROUP--PRE-TEST AND POST TEST COMPARISON

The pre-test scores from the pace group were compared to the post test scores of the pace group by the Analysis of Variance Method. This was done to see if there was a significant change in their performance from the pre-test to the post test.

The mean square for between groups was 0.9794 and the mean square for within groups was 107.9616.

This produced an F-ratio of 0.0052. The results of the data analysis for the pace group are in Table III, page 20. This data showed that there was no significant difference in the change of times in performance of the pace group from the pre-test to the post test times in the 440-yard dash.

TABLE III

ANALYSIS OF VARIANCE OF PRE-TEST AND POST TEST FOR PACE GROUP

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F
Between groups	1	0.9794	0.9794	0.0052
Within groups	30	5638.8494	187.9616	
Total	31	5639.8288		

F-ratio necessary at the .05 level of significance with 1,29 degrees of freedom = 4.20.

IV. ANALYSIS OF VARIANCE OF RECOVERY GROUP--PRE-TEST AND POST TEST COMPARISON

The pre-test scores of the recovery group were compared to the post test scores of the recovery group to see if there was a significant difference in the performances of the subjects. This data was analyzed by the Analysis of Variance Method. The mean square for between groups was 261.6914 and the mean square for within groups was 219.7756. This produced an F-ratio of 1.1907 which was not significant at the .05 level of significance. The recovery group's results are summarized in Table IV, page 21. This data concludes that there was no significant difference in the change of performance times for the recovery group resulting from the training procedure.

V. ANALYSIS OF VARIANCE OF TIME DIFFERENCE FOR RECOVERY AND PACE GROUP

The Analysis of Variance Method was used to compare the time changes of one group to the time changes of the other group by their

TABLE IV

ANALYSIS OF VARIANCE OF PRE-TEST AND POST TEST FOR RECOVERY GROUP

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F
Between groups	1	261.6914	261.6914	1.1907
Within groups	26	5714.1672	214.7756	
Total	27	5975.8586		

F-ratio necessary at the .05 level of significance with 1,29 degrees of freedom = 4.20.

pre-test times and their post test times in the 440-yard dash. This comparison was done to see if there was a significant difference from one group to the other and therefore a significant difference in the two training procedures. The mean square of between groups was 268.9600 and the mean square within groups was 70.4562. These two means produced an F-ratio of 3.8174. These results are summarized in Table V below.

TABLE V

ANALYSIS OF VARIANCE OF TIME DIFFERENCE FOR RECOVERY AND PACE GROUP

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F
Between groups	1	268.9600	268.9600	3.8174
Within groups	28	1972.7747	70.4562	
Total	29	2241.7347		

F-ratio necessary at the .05 level of significance with 1,29 degrees of freedom = 4.20.

This data indicated that there was no significant difference (at the .05 level) between the recovery group's time changes and the pace group's time changes.

A final analysis of the pre-test times and the post test times of both groups was made by comparing the means for both groups. This final comparison was made for two reasons:

1. The final F-ratio of 3.8174 was non-significant by only .3826 (to be significant it would have had to be 4.20).

2. During the study, the investigator observed some noticable changes in the performance of the subjects.

More specifically the recovery group was more physically affected (tired) by the decrease in rest time than was the pace group affected by running the sprints faster each week. Both groups had some overweight subjects but the only improvement was seen in the recovery group. Also the recovery group had two subjects who suffered football injuries during the study which hindered their training. The initial mean time of the pace group was 76.444 seconds as compared with a final mean time of 76.094 seconds. This represented an increase in the mean time of .350 for the performance in the 440-yard dash. In the recovery group, the initial mean time was 81.450 seconds as compared with the final 440-yard dash mean of 75.336 seconds. This meant that the mean time change was a negative 6.11 seconds or that the mean improvement for subjects in recovery group was 6.11 seconds. These results are summarized in Table VI on the following page.

TABLE VI

COMPARISON OF MEANS FOR PACE AND RECOVERY GROUP IN SECONDS

	N	Mean Pre-Test	Mean Post Test	Mean Difference
Pace group	16	76.444	76.094	- .350
Recovery group	14	81.454	75.336	-6.110

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

This chapter contains a brief summary of: (1) the problem, (2) the procedure used, (3) the method used to analyze the data, (4) the findings from this data, (5) the conclusions and their implications, and finally (6) the recommendations for further study.

I. SUMMARY

The purpose of this study was to analyze the effectiveness of two forms of training programs upon the 440-yard running time of high school sophomore boys. This study investigated pace training and recovery time training and then compared the results to see if there was a significant difference between the two methods of training. The study was conducted in October of 1969. The subjects were selected from the fourth hour physical education class at Rosedale High School in Kansas City, Kansas. They were placed into two groups by the random dealing of name cards into two stacks. All subjects were timed in a 440-yard dash at the start of the study. This was their pre-test scores. Four days a week, the subjects ran three sets of 100-yard sprints. Each set consisted of three sprints so that each day the subjects ran nine 100-yard sprints. All the subjects were given a five minute rest between each set of sprints.

Group I, the pace group, had to run the sprints under 17 seconds the first week and they were given a one minute rest between each

individual sprint. Every week the initial pace requirement (17 seconds per 100-yard dash) was reduced by one second. The one minute rest time remained constant. During the fifth week the pace group was required to run the 100-yard dash in twelve seconds.

Group II, the recovery group, had their pace requirement (17 seconds per 100-yard dash) remain constant. However every week their recovery time (one minute rest between sprints) was reduced ten seconds so that they were resting only ten seconds during the fifth week of the study.

On Wednesday of each week, the subjects ran the 440-yard run to show their weekly improvement and to establish on record what each subject could do. Finally at the end of the five week period the subjects were again timed in the 440-yard run and this score was used as the post test score. Analysis of this data was by the Analysis of Variance Method.

II. FINDINGS

The analysis of the data revealed the following findings:

1. In checking for the Homogeneity of Variance it was found that the two samples were drawn from the same population.

2. That there was no significant difference between the pre-test scores of the pace group and the pre-test scores of the recovery group as noted by the F-ratio of 0.7259.

3. That there was no significant difference between the post test scores of the pace group and the post test scores of the recovery group as noted by the F-ratio of 0.0290.

4. That in the pace group, there was no significant difference between their pre-test scores and their post test scores (F-ratio of 0.0052).

5. That the recovery group had no significant difference between their pre-test scores and their post test scores (F-ratio of 1.1907).

6. There was a 5.760 seconds difference between the mean time change of the pace group (.350) and the recovery group (6.110). This was non-significant.

7. That when the time changes (difference between pre-test score and post test score) of the pace group were compared to the time changes of the recovery group they produced an F-ratio of 3.8174 which was non-significant at the .05 level.

III. CONCLUSIONS

Within the limitations of this study the following conclusions were reached:

1. When the pace was increased in a series of 100-yard sprints, there was a slight improvement in the subject's time in a 440-yard dash.

2. When the rest period was reduced between a series of 100-yard sprints, there was a general improvement in the subject's time in a 440-yard dash.

3. There was no significant improvement in the 440-yard dash as the result of pace training.

4. There was no significant improvement in the 440-yard dash as the result of recovery time training.

5. There was no significant difference in the time changes between the pace group and the recovery group. Therefore, there was no significant difference between the two methods of training (pace and recovery time) in the 440-yard dash for high school sophomore boys.

6. In general, both methods reduced the subjects total time in the 440-yard run in most cases.

IV. IMPLICATIONS

It was observed during the testing period that eight subjects did not attend class regularly or were missing because of disciplinary reasons. This reduced the final number of subjects to thirty. Some of these subjects whose scores were invalid could possibly have changed the outcome of the study.

Also 20% (six subjects) included in the final analysis were poorly motivated and did not, in the opinion of the investigator, run their best in the post test. This statement was based upon the investigator's experience, knowledge, and personal observation of the subjects.

This investigation could have been more accurate if all of the original subjects remained in the test and gave their best effort.

Although statistically there was no significant difference between the time changes of the pace group and the recovery group, there was a mean time difference of 5.760 seconds. To a statistician this was non-significant but to a track coach this could be of some importance. Any method which improved a subjects total time in a 440-yard run five seconds better than another method deserves further investigation.

V. RECOMMENDATIONS FOR FURTHER STUDY

1. Further investigations should be made using a larger number of subjects.

2. Further investigations should be made with more highly motivated subjects willing to give their best effort.

3. Further investigations should be made with subjects using a wider range of ages from junior high to college.

BIBLIOGRAPHY

BIBLIOGRAPHY

A. BOOKS

Bresnakan, George, and W. W. Tuttle. Track and Field Athletics. St. Louis: C. V. Mosby Company, 1937.

Doherty, J. Kenneth. Modern Track and Field. Englewood Cliffs, New Jersey: Prentice-Hall, Incorporated, 1963.

Galfo, Armand, and Earl Miller. Interpreting Education Research. Dubuque, Iowa: William C. Brown Company, 1965.

Hayden, Ted. Interval Training: Notes of the Pan American Games Clinic. Ann Arbor, Michigan: Don Canham Enterprises Incorporated, 1960.

Jacoby, Edward G. Physiological Implications of Interval Training. Idaho Falls, Idaho: Idaho Falls School District 91, 1968.

Reindell, H., H. Roskamm, and Woldemar Gerschler. Das Intervalltraining. Munich: Johann Ambrosius Barth, 1962.

B. PERIODICALS

Adams, William C., and Edmund Bernauer. "The Effect of Selected Pace Variations on the Oxygen Requirement of Running a 4:37 Mile," Research Quarterly, XXXIX (December, 1968), 837.

Christensen, E. H. Arbeitsphysiologie, XVIII (1960), 345.

Coffman, Robert Dean. "A Study of the Reaction Time of Sprinters and Distance Runners at Secondary School Level," Unpublished Master's thesis, Kansas State Teachers College, Emporia, Kansas, 1967.

Cureton, Thomas K. "Training Youthful, Record-Breaking Athletes," XXXXII (November, 1965), 50.

Doherty, Kenneth. "Interval Training," Scholastic Coach, XXV (March, 1956), 20.

Henry, Franklin M. "Force-Time Characteristics of the Sprint Start," Research Quarterly, XXIII (October, 1952), 301-318.

_____. "Influence of Athletic Training On The Resting Cardiovascular System," Research Quarterly, XXV (March, 1954), 28.

_____. "Time-Velocity Equation and Oxygen Requirements of All-Out and Steady Pace Running," Research Quarterly, XXV (May, 1955), 164-177.

_____, and Irving Trafton. "The Velocity Curve of Sprint Running With Some Observations On The Muscle Viscosity Factor," Research Quarterly, XXII (October, 1951), 409-422.

Hipple, Joseph E. "Warm Up and Fatigue in Junior High School Sprints," Research Quarterly, XXVI (May, 1955), 246-247.

Jacoby, Edward G. "Physiological Implications of Interval Training," United States Track Coaches Quarterly Review, (March, 1969).

Jensen, Clayne. "The Controversy of Warm-Up," Track and Field Quarterly Review (May, 1968).

Karpovitch, Peter V., and Creighton Hale. "Why Warm-up?" Newsweek, XXXXVIII (November 19, 1956), 124.

Kronsbein, Fred. "Steady Pace Vs. Variable Speed in High School 220-Yard Run," Research Quarterly, XXVI (October, 1955), 289-294.

Mathews, Donald, and H. A. Snyder. "Effects of Warm-up On The 440-Yard Dash," Research Quarterly, XXX (December, 1959), 446-451.

Michael, Earnest D. Jr. "Effects of Cold Showers on Circulation of Conditioned and Non-Conditioned Men," Research Quarterly, XXVIII (March, 1957), 38.

Milton, George Cole. "The Effects of Three Programs of Long Distance Running And An Isometric Exercise Program on the Development of Cardiovascular Efficiency." Unpublished Doctor's dissertation, Louisiana State University, 1966.

Pierson, William. "Body Size and Speed," Research Quarterly, XXXII (May, 1961), 197-200.

Rose, Kenneth, and F. Lowell Dunn. "A Study of Heart Function in Athletes," Track and Field Quarterly Review (February, 1965).

Spindler, John. "The Physiological Basis of Interval Training," United States Track Coaches Quarterly Review (December, 1966).

_____. "Views From Foreign Coaches On Training," Track and Field Quarterly Review (October, 1965).

Skubic, Vera, and Jean Hodgins. "Effect of Warm-up Activities On Speed, Strength, and Accuracy," Research Quarterly, XXVIII (May, 1957), 147.

Walters, C. Etta. "A Study of the Effects Of Prescribed Strenuous Exercise On The Physical Efficiency of Women," Research Quarterly, XXIV (March, 1953), 102.

Wilt, Fred. "Training Trends In Distance Running," Scholastic Coach, XXV (March, 1956), 20.

Wissel, Harold R. "Interval Training For Basketball Players," Athletic Journal, XXXXVII (June, 1967), 47.

APPENDIX

APPENDIX

TABLE I

A COMPARISON OF PRE-TEST AND POST TEST TIMES FOR PACE GROUP IN 440 YARD DASH

Subject Number	Pre-test Time in Seconds	Post test Time in Seconds	Time Change in Seconds
1	95.5	92.5	-3.0
2	88.0	85.3	-2.7
3	67.5	67.2	-0.3
4	113.6	115.6	+2.0
5	65.0	64.9	-0.1
6	66.6	64.5	-1.9
7	67.5	67.1	-0.4
8	74.2	72.0	-2.2
9	72.6	78.2	+5.6
10	72.2	79.3	+7.1
11	69.8	72.2	+2.4
12	64.7	62.9	-1.8
13	76.9	77.2	+0.3
14	66.7	67.6	+0.9
15	70.5	66.6	-3.9
16	91.8	84.4	-7.4

TABLE II

A COMPARISON OF PRE-TEST AND POST TEST TIMES
FOR RECOVERY GROUP IN 440 YARD DASH

Subject Number	Pre-test Time in Seconds	Post test Time in Seconds	Time Change in Seconds
1	73.7	81.2	+ 7.5
2	65.7	67.7	+ 2.0
3	61.0	62.3	+ 1.3
4	85.4	79.8	- 5.6
5	64.0	66.4	+ 2.4
6	64.7	61.6	- 3.1
7	81.1	79.9	- 1.2
8	103.8	98.5	- 5.3
9	109.0	72.2	-36.8
10	75.3	73.0	- 2.3
11	69.8	68.1	- 1.7
12	121.5	87.7	-23.8
13	82.1	79.3	- 2.8
14	83.2	77.0	- 6.2